ANALYSIS OF QUALITY AND ORIGIN ATTRIBUTES OF KENYAN HONEY FOR GEOGRAPHICAL INDICATION LABELLING IN WEST POKOT, BARINGO AND KITUI COUNTIES

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DECLARATION

This thesis is my original work and has not been submitted for a degree in any other university

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This work is dedicated to my husband Peter and children; Bernard, Genevieve and Henry.

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LIST OF ABBREVIATIONS/ACRONYMS

ANOVA	Analysis of Variance
AOAC	Association of the Official Analytical Chemists
ARIPO	African Regional Intellectual Property Organization
ASALS	Arid and Semi-Arid Lands
ASDSP	Agricultural Sector Development Support Programme
EAS	East African Standards
EC	European Commission
EPC	Export Promotion Council
EU	European Union
FGD	Focus Group Discussion
GI	Geographical Indications
GoK	Government of Kenya
HHH	Household Head
HHs	Households
HMF	Hydroxymethylfurfural
ICIPE	International Centre of Insect Physiology and Ecology
JAICAF	Japan Association for International Collaboration of Agriculture and Forestry
KEBS	Kenya Bureau of Standards
KHC	Kenya Honey Council
KIPI	Kenya Industrial Property Institute
KOAN	Kenya Organic Agricultural Network
MoA	Ministry of Agriculture
MTIE	Ministry of Trade, Industry and Enterprise
NBI	National Beekeeping Institute

NGO	Non- Governmental Organization
OAPI	African Regional Intellectual Property Organization
PDO	Protected Designation of Origin
PGI	Protected Geographical Indications
QSI	Quality Services International
TRIPS	Trade Related Intellectual Property Rights
WIPO	World Intellectual Property Organization

GENERAL ABSTRACT

African countries have potential for adding market value to their unique origin products similar to how the European Union create additional monetary value from agricultural origin products protected with Geographical Indications (GI). Registering origin products with GI creates an opportunity to foster economic growth and build livelihoods of rural communities while stewarding the natural environment.

Producers of Kenyan honey can gain additional benefits from their unique products, however, the prospects for protecting the honey with GI have not been explored. Information on quality and origin attributes which can facilitate GI labelling of Kenyan honey have not been documented. Therefore, the objectives of this study were to (1) assess the suitability of honey from West Pokot, Baringo and Kitui Counties for GI labelling; (2) determine the physicochemical and melissopalynological parameters of honey from West Pokot, Baringo and Kitui Counties; (3) determine the diversity and frequency of visitors of *Acacia brevispica* and extent of pollination by honey bees in Kitui County; (4) determine factors influencing collective action among producers of honey from West Pokot, Baringo and Kitui Counties; and (5) evaluate existing value addition initiatives enhancing recognition of territorial traits of honey from West Pokot, Baringo and Kitui Counties.

This study was carried out in West Pokot, Baringo and Kitui Counties, Kenya. Methods used in data collection included; literature review, interviews with various actors in the honey sub-sector and representatives from other organizations supporting honey production, household surveys, field observations and honey analysis.

Results showed that West Pokot, Baringo and Kitui honey have potential for protection with GI mainly based on their specificity and quality traits which are closely linked to the natural

environment (floral sources) in the area of production and producer know-how. Eighteen out of 21 honey samples analysed in this study had all parameter values within the limits set in the East African Standards for honey, Codex Alimentarius Standards for honey and the European Union directive for honey. Pollen analysis showed a total of 29 pollen types in the honey samples analysed and *Acacia spp.* was the predominant pollen type in 4 of the 21 honey samples.

Findings of this study also showed that honey bees were the most frequent flower visitors and pollinator of *A. brevispica*. Acacia pollen was the predominant pollen type in all the honey samples collected within the study area where bees visiting *A. brevispica* were observed. This showed a link between pollination of *A. brevispica* and honey production. Honey bees provide pollination services to *A. brevispica* for the return of pollen and nectar for the production of honey.

Factors determining collective action, include experience in beekeeping, distance from farms to the honey processing centre, education level, number of hives owned, use of modern hives, GI awareness (awareness of link between product quality and production region), production of honey with origin linked attributes and access to information on production and value addition of honey. Results showed that initiatives undertaken by actors within and outside the honey sub-sector play a great role in enhancing recognition of territorial or local traits of the Kenyan honey, which are important aspects in GI registration of products. However, prospects for protecting Kenyan honey with GI are hampered by inadequate support by institutional and legal framework.

Findings of this study will inform development and operationalization of infrastructure, programs, policies and other institutional frameworks which are essential in enhancing capacity of honey producers for protection of origin products with GI. Further, results are

useful to Counties seeking to ensure economic growth from local natural resources while enhancing their protection.

Key Words: Geographical Indications, Origin products, Honey, Melissopalynological analysis, Physicochemical analysis, Collective action, Pollination service, Value addition initiatives, West Pokot, Baringo and Kitui Counties

CHAPTER 1 : GENERAL INTRODUCTION

1.1 Background information

1.1.1 Honey production – importance and challenges

Globally, honey production plays an important role in enhancing economic growth, food security, biodiversity conservation and community livelihoods. This is because it serves as a foreign exchange earner for many countries (Buba et al., 2013) and a source of employment as well as income generation (Shenkute et al., 2012; Getachew et al., 2014). Honey production also plays major role in improving biodiversity and increasing crop productivity through pollination (Martins, 2014). Honey bees gather nectar and pollen to produce honey and in the process they pollinate crops and natural vegetation (VanEngelsdorp & Meixner, 2010), thereby enhancing food production and plant regeneration.

In Kenya, the honey sub-sector contributes to the country´s agricultural gross domestic product, income generation, employment creation, nutritional benefits and improved livelihoods especially in the rural areas (GoK, 2013). However, the sub-sector has unexploited potential for creating additional monetary value from unique honey (KIPI, 2009; GoK, 2013). Adding this value to Kenyan honey is challenged by environmental degradation, minimal vertical integration between honey producers and other value chain actors, concentration of honey production in arid and semi-arid areas, inadequate regulatory frameworks, varying honey quality, inconsistent supply, fragmented markets and limited infrastructure, finances and technical support (Muli et al., 2007; GoK, 2013).

Challenges in the honey sub-sector have resulted in opportunistic behaviour (e.g. honey adulteration, side selling and free riding among the value chain actors), leading to low product quality, damaged reputation, informal markets, thus, low product prices. Presence of unscrupulous traders in the honey market can adversely affect product demand and benefits which are meant for producers (Nyaga, 2004). A study conducted in Kenya reported that consumers are keen on honey characteristics when purchasing the commodity and are willing to pay a higher price for quality attributes which they trust (Juma, 2017). Challenges in the honey sub-sector are therefore likely to influence product recognition as well as its market value.

Some initiatives have been put in place to address challenges in Kenya´s honey sub-sector. They include introduction of more suitable equipment (e.g. improved bee hives and honey refineries) to modernize operations in order to improve quality and increase quantity of honey; expansion of beekeeping in other agricultural potential areas; honey quality assurance; and provision of honey marketing facilities (JAICAF, 2009; Carroll & Kinsella, 2013). Despite these efforts, the potential to create market value to unique Kenyan origin honey (i.e. honey with specific quality characteristics which are attributed to their geographical origin) remains untapped. Therefore, there is need for innovative strategies and initiatives that can enhance expansion of economic opportunities for origin honey while conserving the natural environment.

1.1.2 Geographical Indications – what and why

Geographical Indications (GI), a form of intellectual property right can contribute greatly in adding value to Kenya´s honey sub-sector, through acknowledgment and promotion of origin honey produced in different regions within the country. According to the Trade-Related aspects of Intellectual Property Rights (TRIPS) definition (Article 22), GI identify products originating from a territory, or a region where a given quality, reputation or other characteristics of the product are exclusively or essentially attributable to its geographical origin. According to Mancini (2013), GI is a branding tool that is collective in nature as it gives ñprivate rightsò to a group of producers in a given production region (Vandecandelaere et al, 2010). Protection of origin products with GI is dependent on some conditions which should be met by producers of the product, the product itself and the external environment (Giovannucci et al., 2009; Bramley & Biénabe, 2013).

Geographical Indications enhance flow of information between consumers and producers thereby addressing market failures (Belletti, 2000; Bramley et al., 2003; Chever et al., 2012). This can lead to higher value-added products and empowering of smallholders and small and medium enterprises (SMEs) to cope with market competition (Egelyng et al., 2017). GI also enhance access to better markets and product premium prices (Barjolle & Sylvander, 2002; Vandecandelaere et al., 2010; Blakeney et al., 2012; Chever et al., 2012), since it protects producers from exploitation while products are protected from imitation and fraud (Vandecandelaere et al., 2010; Bramley & Biénabe, 2013). Premium prices can create incentives for producers to protect biodiversity e.g. bee flora for sustainable production and consistent product quality (Larson Guerra, 2004; Marie-Vivien et al., 2014; WIPO, 2014). Thus, GI is an instrument which can enhance economic growth, biodiversity conservation and food security, thus addressing several aspects of sustainable development (Izac et al., 2009; Marie-Vivien et al., 2014).

Use of GI to differentiate and market origin products has increased significantly in the global market (Augustin-Jean et al., 2012; Blakeney et al., 2012; Egelyng et al., 2017). In the European Union (EU), a GI branding strategy was initially used for protection and promotion of wines and spirits in the market (Chever et al., 2012). However, the establishment of a harmonized regulatory system in 1992 (Allaire, 2012; Egelyng et al., 2017) led to the expansion of GI to include agricultural food products. This resulted in an increase in the number of registered origin products from within EU as well as from Asia and South America. Among the food products protected with GI are several origin honeys from EU.

In 2012, the European Commission (EC) and the African Regional Intellectual Property Organization (ARIPO) signed an agreement to improve legal protection of origin products in Africa (ARIPO & EU, 2012). Since then, African countries have been seeking to protect their origin products with GI. However, African products are underrepresented among the world´s GI products. This is despite the fact that most African countries have the regulatory framework for protecting their origin products (Bramley & Biénabe, 2013; Egelyng et al., 2017). In 2013, three African products were registered with GI by the African Organization of Intellectual Property (OAPI). They included Ziama-Macenta coffee from Guinea, Oku White honey and Penja pepper from Cameroon (Chabrol, et al., 2017). Several other African products have been proposed to have potential for GI protection and among them are Zanzibar cloves from Tanzania, Kenyan tea, cocoa from Ghana and Madagascan vanilla (Blakeney et al., 2012). Some African countries are developing GI regulatory frameworks (Egelyng et al., 2017), which will increase the opportunity for Africa to tap benefits derived from protection of origin products.

Kenya is among African countries with an interest in protecting its origin products. Although GI is a relatively new concept in Kenya, initiatives have been carried out in the country to recognize and create awareness on the benefits of GI registration of certain origin products (KIPI, 2009). A project carried out by the Kenya Industrial Property Institute (KIPI) in collaboration with the Swiss government identified a number of so-called pilot GI products from agricultural, agroforestry and forested areas (KIPI, 2009). These products included tea, coffee, honey, wines, horticultural crops, wild silk, soapstone, and handicrafts. The country however lacks a fully operational GI regulatory framework (Blakeney et al., 2012; Egelyng et al., 2017) and this has hindered protection of these potential GI products. KIPI developed a draft GI Bill in 2007 which is still awaiting enactment. The Kenya Trade Marks Act (CAP 506) however, allows for protection of origin products using collective and certification marks.

Globally, there is increased demand of origin linked products (quality products whose attributes are linked to geographical origin) (Vandecandelaere et al., 2010). Therefore, producers of origin products in Kenya can catch up with global trends and exploit the opportunity by registering their products with GI. Protecting Kenyan origin products is anticipated to bring positive social, economic and environmental changes to the country (KIPI, 2009).

1.2 Problem statement

According to reports by KIPI (2009) and Blakeney et al. (2012), GI can be used as a strategy to add market value to origin honey in Kenya. The aforementioned Swiss-Kenyan project (KIPI, 2009) on pilot GI products identified honey from six arid and semi-arid areas of Kenya among other products. They included Kitui, Yatta, Turkana, Mwingi, West Pokot and Baringo honey (KIPI, 2009; Blakeney et al., 2012). This clearly indicates that there is an opportunity for Kenya to add value to the honey through GI labelling. These honeys were selected based on their socio-economic importance, comparative advantage in the market and producer associations involved in their production (KIPI, 2009). However, information on the potential for protecting the identified honey with GI based on other conditioning factors is scarse.

Physicochemical properties such as sugar content, moisture content, water insoluble content, electrical conductivity, free acid, diastase activity and hydroxymethylfurfural of honey sold in Kenyan urban retail market (Ng´ang´a et al., 2013) and those processed through traditional methods (Muli et al., 2007) have been assessed. However, there is inadequate knowledge on physicochemical properties and floral sources of origin honey derived directly from producers of a particular region. Also quality traits which can differentiate honey from different regions based on the link between product quality attributes and its area of production has not been explored.

Acacia woodlands in arid and semi-arid areas have been under pressure, due to human activities for income generation. Therefore, local communities in some areas where Acacia woodlands dominate have been supported in undertaking sustainable farming practices such as beekeeping for income generation (Gichora, 2003; ICIPE, 2009). Acacia plants rely on insects for pollination and bees among other insects, have been documented as flower visitors of most *Acacia spp*. (Stone et al., 2003). However, there is no documented information on the relationship between pollination of Acacia woodlands by honey bees and honey production for sustained livelihood and environmental conservation.

The market potential for Kenyan honey has not been fully exploited. This is associated with inadequate volumes and value addition of the commodity which influence its quality (Muli et al., 2007; Berem, 2015; Egelyng et al., 2017). Actors in the honey sub-sector have supported collective action (proxy for producer membership in groups) through establishment of honey groups. However, participation of honey producers in groups is still low (GoK, 2013), leaving producers to market honey individually. This is a hindrance to GI labelling of honey.

Factors (i.e. farm characteristics, household characteristics and producer characteristics including GI awareness and production of honey with origin linked attributes) influencing membership of producers in West Pokot, Baringo and Kitui to honey groups have not been documented. Also, other value addition initiatives undertaken by various actors/organizations to enhance recognition of territorial traits of Kenyan honey have not been documented.

1.3 Objectives of the study

1.3.1 Overall objective

To analyse the quality and origin attributes of Kenyan honey for Geographical Indication (GI) labelling

1.3.2 Specific objectives

1. To assess the suitability of honey from West Pokot, Baringo and Kitui Counties for GI labelling
2. Determine the physicochemical and melissopalynological parameters of honey from West Pokot, Baringo and Kitui Counties
3. To determine the diversity and frequency of visitors of *Acacia brevispica* and extent of pollination by honey bees in Kitui County[1]
4. To determine factors influencing collective action among producers of honey from West Pokot, Baringo and Kitui Counties
5. To evaluate existing value addition initiatives enhancing recognition of territorial traits of honey from West Pokot, Baringo and Kitui Counties

1.4 Hypothesis and research questions

The following hypothesis was tested under Objective 4

[1] *Due to inadequacy of financial resources this objectives was only carried out in Kitui County, however Kitui County may not be representative of the other two study areas*

1. GI awareness (awareness on the link between product quality and production region) and production of honey with origin linked attributes positively influence collective action in West Pokot, Baringo and Kitui Counties

The study answered the following research questions

1. What is the suitability of honey from West Pokot, Baringo and Kitui Counties for GI labelling?
2. What are the physicochemical and melissopalynological parameters of honey from West Pokot, Baringo and Kitui Counties?
3. What is the diversity and frequency of visitors of *Acacia brevispica* and extent of pollination by honey bees in Kitui County?
4. What are the value addition initiatives enhancing recognition of territorial traits of honey from West Pokot, Baringo and Kitui Counties?

1.5 Justification of the study

This study is timely as the County governments in the study areas seek to develop and implement strategies to add value to honey and improve the honey sub-sector as part of the agriculture´s role in enhancing the economic growth in the Counties. Assessment of potential of protecting Kenyan honey with GI is a step towards value addition of the products for increased income generation, creation of employment and sustainable livelihoods. Therefore, findings of this study will contribute towards agriculture and rural development as stipulated in County Integrated Development Plans.

Results of this study will create awareness on origin honey and their attributes which can enhance product access to market as well as additional value. Information gathered from this study will be useful in informing development and enactment of GI regulatory framework, beekeeping policy, honey policy, honey monitoring plan and other relevant institutions. These policies and laws can address hindrances in GI labelling of origin honey. The study will also contribute to scientific literature on existing potential GI products in Kenya and Africa as well as the criteria for selecting potential GI products.

Marketing of Kenyan honey is challenged by lack of information on the product quality. Characterizing honey based on physicochemical properties e.g. moisture content, electrical conductivity, free acidity, diastase activity and hydroxymethylfurfural and melissopalynological parameters e.g. botanical origin based on pollen type will provide information on the quality and content of honey produced in a particular origin and the link to geographical origin. This can be used in differentiating honey produced in different regions. This information will be useful in enhancing access, expansion and diversification of market which contribute to diversification of market. Results will also inform enforcement of existing honey quality standards.

Assessing the extent of pollination of Acacia woodlands and honey production by honey bees will provide some information on the link between pollination service and honey production which can enhance livelihoods and biodiversity conservation. Producers of an origin product are the custodians of the production environment and hence their actions can positively or negatively influence existence and market of a product. Results will therefore provide useful information which can be used by honey producers in adding market value to their products through indicating important plants in the labels and this will enhance their conservation for sustainable production. The study will also inform government´s plan of promoting honey production activities in areas adjacent to conservation areas as well as encourage honey production in participatory forest management as stipulated in the National Beekeeping Policy in Kenya.

GI is collective in nature thus determining the factors influencing collective action among producers of honey will inform interventions undertaken by actors involved in facilitating development and strengthening of producer cooperation. This will enhance collective efforts in definition of origin products, promoting origin-based product reputation, marketing and conservation of natural resources which are essential in labelling GI product.

Evaluating existing value addition initiatives in the honey sector and their contribution in enhancing recognition of territorial or local traits will inform development programs in the honey sub-sector. Areas of coordination between actors working to improve the honey sector will be identified. Results of this study will also inform policy makers and relevant actors in the honey sub-sector on institutional and capacity building gaps which can hinder development of GI honey. Thus, this will present an agenda for actions that need to be undertaken to promote origin honey in Kenya.

1.6 Scope and limitations of the study

Geographical Indications is still a new concept in Kenya and the protocol/criteria for assessing potential GI honey, does not exist. The study was therefore based on GI case studies from other countries. The GI conditioning factors considered in this study might not be exhaustive. Although there exists other conditions which can facilitate GI labelling of origin products, this study analysed those factors which are only specific to honey.

Honey analysed for physicochemical properties and pollen content were specific to particular season and sub Counties within the three areas of study. Therefore, results of this study may not be a representative of other seasons of honey production and sub-Counties with varying vegetation.

Honey bees visit a variety of plant species for pollination as well as for collection of pollen and nectar. In this study, only pollination of Acacia woodlands was assessed since it dominated the study area due to its agro-ecological zonation. Acacia plant is an important bee forage which enhances production of quality honey with high demand in the country.

Actors´ value addition initiatives which can facilitate GI labelling of honey in the study areas were assessed based on the development programs and policies which were being implemented during the study period. The study did not take into consideration plans, policies, laws and new programs which had not been enacted/ implemented during the study since amendments are likely to take place.

1.7 Organization of thesis

This thesis is divided into nine chapters. Chapter 2 presents a review of literature related to the study objectives. Chapter 3 provides the methodology of the study and a brief description of the study area, sampling procedures, data collection and analysis methods employed. Chapter 4 to 8 are chapters which provide empirical evidence of the problem being investigated. These chapters are linked to specific objectives.

Chapter 4 looks at the potential for protecting honey with GI based on criteria used in determining GI potential of a product. Chapter 5 presents the physicochemical properties and floral sources of honey from the three study areas based on laboratory analysis. Chapter 6 addresses objective three and it assesses the extent of pollination of acacia woodlands by honey bees and production of honey in Kitui.

Chapter 7 highlights the factors influencing collective action (proxy for producer membership to groups) among producers of honey. Chapter 8 discusses existing value addition initiatives enhancing recognition of honey territorial traits. Chapter 9 provides the general conclusion and recommendations/policy implications based on the results obtained for each objective.

CHAPTER 2 : LITERATURE REVIEW

2.1 Beekeeping and honey production in Kenya

2.1.1 Beekeeping practises and trends in honey production

Beekeeping in Kenya has been practiced since the hunting age where traditional honey production methods were used (JAICAF, 2009). Most communities collected honey from the wild, but today bees are actively managed in modern hives for production of honey and other hive products. Modern beekeeping was introduced by the colonial government in 1950s and later promoted by the Kenyan government in collaboration with OXFAM and SNV (JAICAF, 2009; Carroll & Kinsella, 2013).

Initially, honey production was viewed as a pro-poor activity suitable for rural-poor and marginalized communities. However, realization of its benefits has led to mass production of the commodity by other communities. Beekeeping in Kenya is mainly practised for honey production despite the fact there are other useful hive products (Gichora, 2003). Expansion of honey production activities has been supported by governmental and non-governmental organizations in the honey sub-sector and other organizations outside honey sub-sector (JAICAF, 2009; Carroll & Kinsella, 2013). Today, Kenyan honey is produced for both commercial and subsistence purposes. Most communities in rural areas use it as source of income, food and medicine as well as in religious, therapeutic and cultural ceremonies (Gloor, 2011). Although some studies have shown that honey bees are important pollinators of important crops and natural plants (Kasina, 2007; Karanja et al., 2010), there is low knowledge on pollination among beekeepers in Kenya.

It is estimated that about 80% of honey produced in Kenya come from arid and semi arid areas, where crop production is limited due to unreliable rainfall (Carroll & Kinsella, 2013; GoK, 2013). The leading honey production areas in Kenya are Kitui, Baringo and West Pokot

(Gichora, 2003; ICIPE, 2009; Berem, 2015). These areas are characterised by dominant woodland forests which provide bees with nectar throughout the year. Honey producers often organize themselves into groups that work together in processing and marketing activities (Gloor, 2011; Berem, 2015; Egelyng et al., 2017).

Carroll & Kinsella (2013) reported the number of beehives in Kenya to be approximately 1,440,640 and the number of producers to 144,000, whereas the majority are small scale. Production of honey in Kenya is estimated at 25% of the country´s total potential metric tonnes per year (Carroll & Kinsella, 2013), an indication that honey production potential in the country has not been fully exploited. Although Kenya has consistently been a net importer of honey, to meet its own needs (Carroll & Kinsella, 2013), producers in some regions of Kenya sell their honeys to a number of markets. Due to food safety and quality standards requirements, Kenya sells its honey in the local markets and to a lesser extent to the regional and international markets e.g. East Africa, United States and Asia.

Beekeeping practices differ across countries and this is associated with culture and initiatives by the development partners. Although both traditional and modern methods are used by in production and processing of honey in Kenya (Carroll & Kinsella, 2013), traditional methods are largely used in most parts of the country especially in arid and semi-arid areas where beekeeping knowledge is passed from one generation to another.

Honey production methods i.e. honey harvesting, processing and handling as well as bee flora management practices play an important role in determining the quality of honey, thus its market. While modern hives have a queen excluder and movable combs which easily allow inspection of hives, traditional hives e.g. log hives which lacks a queen excluder, make it difficult to inspect the hive. However, previous studies have shown that use of traditional methods does not affect the quality of honey (Muli et al., 2007). Different honey processing methods are in Kenya and they include centrifugal, pressing and draining. However availability of processing equipment is the main determinant of the processing methods used.

In Kenya, honey production is undertaken both individually and communally. Some communities share beekeeping sites by establishing communal apiaries (Egelyng et al., 2017). Bee floral sources are communally managed and in such cases as beekeepers involved have an obligation to protect natural resources.

2.1.2 Production challenges and opportunities

Honey production in Kenya is constrained by; inadequate human and physical capacity, financial constraints, lack of coordination among actors in the sub-sector and alteration of the naturural environment (GoK, 2013). These constraints influence value addition and exploitation of existing market opportunities. Production of low volumes of honey coupled with varying qualities of the honey have greatly affected marketing of Kenyan honeys (Muli et al., 2007). The government of Kenya has developed a beekeeping policy with an aim to improve the honey sub-sector (GoK, 2013) as well as enhance the living standards of rural communities. Protection of Kenyan honeys with GI has also been proposed as a strategy to enhance the marketing of honey (KIPI, 2009; Blakeney et al., 2012).

2.2 Geographical Indication

2.2.1 What is GI?

Geographical Indication (GI) is used to differentiate products based on their characteristics and attributes which are linked to the geographical region where they are produced (Giovannucci et al., 2009; Bagal & Vittori, 2011). These attributes are often a combination of the natural environment in a region and cultural assets passed on from one generation to another, thus building reputation for the products over time.

GI is a collective right, meaning that benefits from an origin product are not limited to a single producer but all producers in a particular region where a product originates (Blakeney et al., 2012; Bramley & Biénabe, 2013). The quality of an origin product and its value is often, at least partially, an outcome of cooperation and collective efforts by producers (Blakeney et al., 2012; Bramley & Bienabe, 2013). Therefore, collective action enhances collective reputation of a product (Winfree & McCluskey, 2005), a foundation on which GI is built and sustained (Bramley & Bienabe, 2013). GI provides producers opportunities to collectively define production standards (codes of practice) and to state specific attributes linked to the place of origin (Bagal and Vittori, 2011). This offers an avenue to foster not only economic benefits but also social e.g. employment creation and environmental sustainability, hence greening growth (Giovannucci et al., 2009). Economic benefits can be derived through product differentiation, which establishes niche markets and long-term benefits (Grote, 2009) to maintain or even enhance a premium price or preferred markets (Blakeney et al., 2012, Bramley & Biénabe, 2013). GI is thus an economic policy instrument which can enhance economic development, rural development while stewarding the natural environment (Bramley & Biénabe, 2013; WIPO, 2014; Egelyng et al., 2017).

2.2.2 Development of GI and legal protection

Worldwide, efforts to protect origin products can be traced to the 19th century (Larson, 2007). GI was regarded as a tool to show product authenticity. This generated a common ground within the international community for the protection of GI products through various international agreements. The agreements included; Paris Convention on the protection of industrial property 1883, which provided for appellations of origin and indications of source. The Paris convention also made a distinction between trademarks and GIs without defining either concept. Other treaties included Madrid agreement for the repression of false and deceptive indications of source on goods of 1891; Stresa Convention, also referred to as the international convention on the use of appellations of origin and denominations of 1951; Lisbon agreement for the protection of appellations of origin of 1958; and Trade Related Aspects of Intellectual Property (TRIPS) agreement of 1994 which was developed by the World Trade Organization (WTO) members for protection of GI products. GI is defined in Article 22 of TRIPS.

In 1992, European Community enacted laws for registration of agricultural products and foodstuffs with Protected Designation of Origin (PDO) and Protected Geographical Indication (PGI). A product is registered with PDO when it is produced, processed and prepared in a specific geographical area. The productôs quality or characteristics are essentially or exclusively attributable to that area. PGI registration is given when a product is produced and/or processed and/or prepared in a specific geographical area. The product should possess specific quality, reputation, or other characteristics attributable to its geographical origin.

Origin products can be protected using Trademarks Act either as collective mark or certification mark. A certification mark which is used by a person other than the owner, certifies certain standards, product characteristics and quality based on the indicated standards. On the other hand, a collective mark is one that distinguishes the geographical origin, material, mode of manufacture or other common characteristics of goods and services from others. A collective mark is owned by an organization or association and can be later registered as geographical indications where the geographical link exists. An origin product can also be protected using specific *sui generis* GI laws. Unlike trademarks where products are privately owned (Bramley & Biénabe, 2013), *sui generis* GI system is unique since it allows producers of origin products to apply for product registration by submitting an application accompanied by a product and production specification (Barham & Sylvander, 2011). Under *sui generis,* an origin product is owned by the entire group and cannot be transferred from one owner to another outside the region (Blakeney et al., 2012).

Use of Geographical Indication to differentiate and market origin-based products has greatly increased in the global market (Vandecandelaere et al., 2010). Most products registered with GI come from the European and Asian countries and very few African countries have protected their origin products with GI. The different countries have different legal mechanisms for protecting their origin products (Giovannucci et al., 2009; Blakeney et al., 2012) based on existing regulatory framework, economic situation of the country and its history (Opiyo, 2014). European Union member states and some Asian countries use a *sui generis* GI system to protect origin products. United States protect origin products using certification and collective marks under the Trademark Act. Some African countries have a *sui generis* GI system, whereas others have Trademark Acts which provide for protection of origin products (Opiyo, 2014). Kenya has a Trademark Act which provides for protection of origin products.

2.2.3 Opportunity of GI in Africa and its status in Kenya

African Union and European Union have collaborated on promoting GIs in Africa (ARIPO & EU, 2012). The two bodies are responsible for intellectual property related issues, that is, the African Regional Intellectual Property Organization (ARIPO), and, the African Intellectual Property Organization (OAPI) (Mupangavanhu, 2013). ARIPO has the mandate and capacity to process applications for the registration of trademarks and patents in its Member States. In November 2012, ARIPO and EC signed a cooperation agreement to improve the legal protection of agricultural products in Africa (ARIPO & EU, 2012). So far, three African food products i.e. Oku White Honey and Penja pepper from Cameroon and Ziama-Macenta coffee from Guinea have been awarded PGI by OAPI.

Kenya has been a member of the World Trade Organisation (WTO) and a signatory to the TRIPS agreement since 1995 January (Opiyo, 2014). The country has identified origin products with potential for GI registration. Although Kenya lacks a fully developed and operational *sui generis* and protocol for description of a GI product, the country has advanced its interest in protecting some of its origin products using i.e. tea and coffee as Trade Marks Act (Musungu, 2008). This shows that if a specific GI legal framework is put in place, a certain number of relevant origin products already identified as potential GIs would be registered. The products would include honeys and other agri-foods with potential for GI labelling.

A study on willingness to pay for potential GI honeys indicated that honey consumers are willing to pay a higher price for unique honeys with origin-linked attributes (Juma, 2017). Results of this study indicated that consumers have a positive perception on the attributes, thus, this can form a basis of discussion of GI implementation in Kenya.

2.3 Factors considered in GI registration of honey

Origin honeys i.e. honeys with specific quality traits attributed to their geographical origin can be defined based on floral sources, quality i.e. physicochemical properties and sensory characteristics e.g. tastes (Chabrol et al., 2017; Egelyng et al., 2017). These characteristics can be attributed to production processes/methods used and the natural environment characteristics (Blakeney et al., 2012; WIPO, 2014). Production methods may be influenced by traditions, culture and local know-how (Vandecandelaere et al., 2010). The natural environment may include climate, weather variations, seasons, soil and topography which influence vegetation in a particular area (Coulet & Mahop, 2012). Together, the natural environment in a particular place and production processes/methods by people in a region results in product quality characteristics which cannot be reproduced outside the area of origin (Mancini, 2013).

Physicochemical parameter values defined for the EU honeys registered with PGI or PDO in EU door database include sugar content, moisture content, water insoluble content, electrical conductivity, free acid, diastase activity and HMF. These parameters represent the quality indicators that characterize each individual honey variety. Analyses of parameters for EU origin honeys is based on set standards by EU directive for honey (2001/119/EC). Botanical and geographical origin of the EU honeys have also been determined through pollen analysis. Examples of EU PDI/PDO honeys whose quality and floral sources have been determined through analysis include Mel Do Alentejo from Portugal, Miel De Tenerife from Spain, Miele Varesino from Italy, Miód Drahimski from Poland and Miel De Sapin Des Vosges from France (DOOR Database). Other parameters considered in defining an origin honey are reported in Boussaid et al. (2018) where carotenoids and invertase, a natural enzyme found in Tunisia honey, were observed as indicators of geographical and floral origin of the honeys. Also, a study conducted by Alda-Garcilope et al. (2012) showed a significant difference in mineral content among rosemary honeys obtained from different geographical areas. Therefore, botanical and geographical origin information was used to classify the honeys.

Sensoric characteristics (acidic flavour and white colour) of Oku white honey, a GI registered honey (WIPO, 2014; Chabrol et al., 2017) from Kilum-Ijim mountain forest in Cameroon have been linked distinctive and dominant vegetation especially *Schefflera abyssinica* and *Nuxia congesta* found in the region of production (Coulet & Mahop, 2012; WIPO, 2014). The existence, growth and regeneration of the two plants are attributed to the high altitude and cold climate in Kilum-Ijim forest, nature of the trees (small and thick) which make the forest inaccessible to loggers, and pollination of the plants by honey bees (Coulet & Mahop, 2012; WIPO, 2014).

Further, characteristics of Oku white honey are attributed to the hive construction methods, hive type and positioning in the forest, honey harvesting and processing methods (Coulet & Mahop, 2012). These methods are linked to traditions and local know-how. For instance, the use of cylindrical hives, harvesting of the honey in broad day light ensures that ripe honey is harvested. Inspection of honey before processing and the draining methods used in extracting honey from combs ensures that the final honey product obtained is uncontaminated. Hives are covered with reeds to prevent rains from getting into the hives as this may alter honey quality. Placement of hives in specific location with target vegetation ensures that the desired quality honey with specific attributes is obtained. Similarly, the quality of Mwingi honey was attributed to flowering patterns of Acacia woodlands and human know-how in honey handling (Egelyng et al., 2017).

A study conducted by Stolzenbach et al. (2011) in Denmark indicated that sensory characteristics (taste and flavour) of honeys from different locations varied based on the different vegetation types in those locations. He also observed that sensory characteristics of honey from different locations with similar vegetation differed because of seasonal climatic conditions in the different locations. Atrott & Henle (2009) associated methylglyoxal, an antibacterial compound found in Manuka honeys from New Zealand with Manuka tree (*Leptospermum scoparium*) which is dominates the production area.

Additional elements have been developed to evaluate GI potential of honeys (Egelyng et al., 2017). These elements were identified through a review of PGI and PDO products in EU door database, Oku white honey and other GI case studies outside EU. They include the following:

a) Product reputationï This links consumer awareness to honey specificity, thereby creating a possibility of a premium. Reputation is based on the recognition of a product in the market and consumer perceptions about it due to experience in use/consumption. Also reputation can be created through creative and skilful marketing, which establishes the extra value in the mind of the consumers (Giovannucci et al., 2009).
b) Collective action ï This involved producer cooperation and collective action/efforts (social ties) in production, processing and marketing. A common product produced in a particular geographical origin linked together with the producers their activities influence product characteristics (Vandecandelaere et al., 2010). Collective action plays a critical role in maintaining the productôs reputation through quality standards development and control.
c) Institutional environment and organizational supportï institutions may include formal and informal rules which govern production and marketing of honey. Understanding the prevailing organizational structure and institutional environment is important in enhancing success of establishing a GI (Bramley & Biénabe, 2013). Various actors and their specific roles and influence protection of a product with GI.

Based on literature review, factors considered in defining and describing origin honeys for their registration with PGI and PDO, guided in assessing the potential of protecting West Pokot, Baringo and Kitui honeys with GI.

CHAPTER 3 : METHODOLOGY

3.1 Conceptual Framework

The conceptual framework for this study is illustrated on Figure 3.1. This study conceptualized that ecosystem characteristics, pollination service of Acacia woodlands, production systems, institutional environment, honey producer and other actors´ initiatives influence the quality traits of honey, an important aspect which determine GI potential of honey.

Ecosystem characteristics directly or indirectly influence the quality of honey. These characteristics encompasses the natural environment e.g. floral plants and composition which provide nectar and pollen that yield special quality attributes to the final product (Coulet & Mahop et al., 2012). These attributes may include; flavour, aroma, colour, viscosity and texture. The growth, survival and components of floral plants are influenced by the climatic conditions e.g. temperatures, rainfall, soils and topographical features that are attributed to agro ecological zonation. Also, climatic conditions e.g. rainfall, temperatures and humidity can directly influence honey quality, specifically, moisture content.

Bees contribute to ecosystem services e.g. pollination service of Acacia species (Stone, et al., 2003) and this supports reproduction success of the plants. Acacia plants are useful bee floral sources for production of honey (Martins, 2014). Studies have observed that in areas where the value of pollination services is known, conservation of bees is enhanced e.g. through farming without use of harmful pesticides and weed control chemicals (Martins, 2014), which enhance production of quality honey.

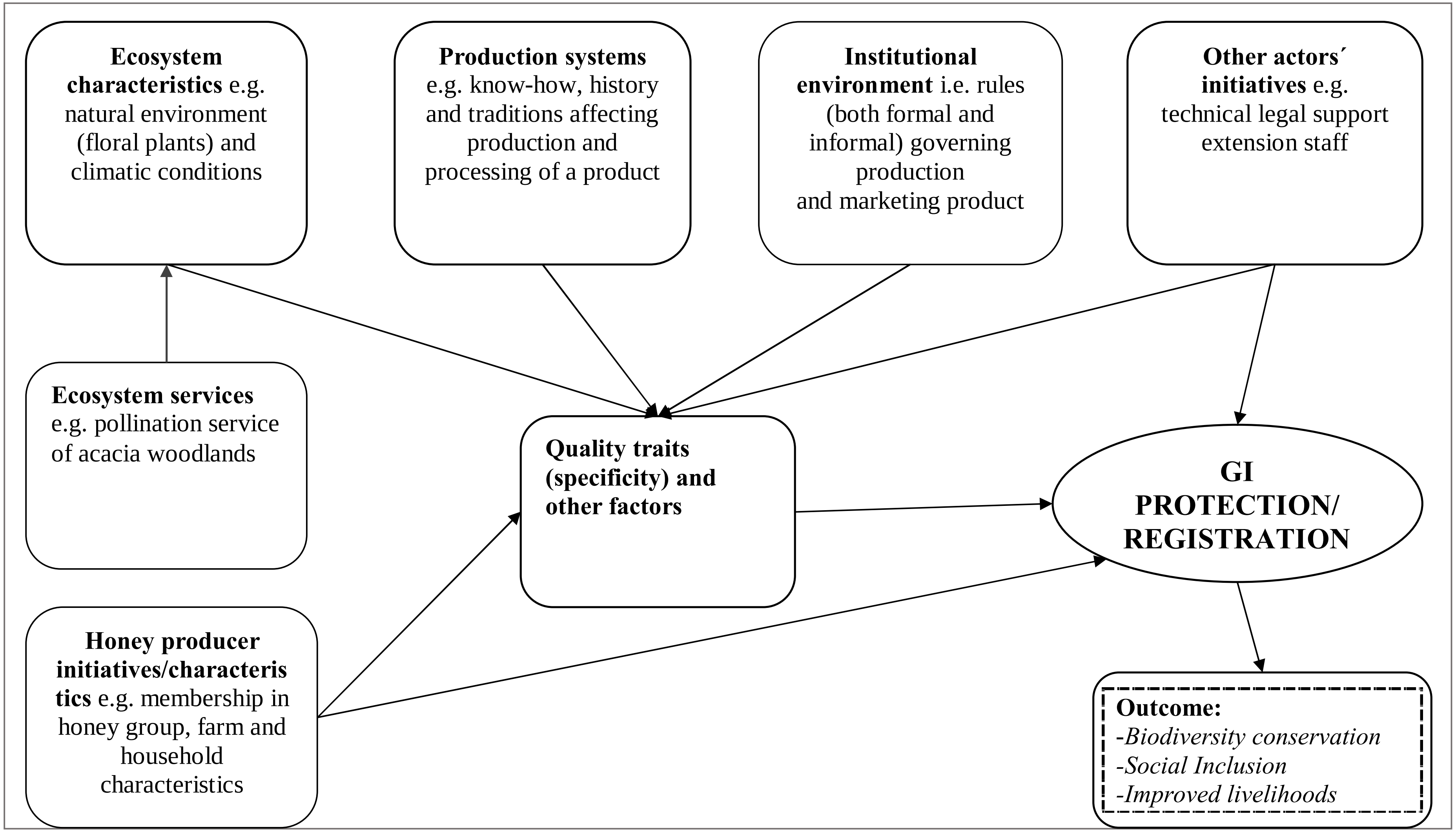

Figure 3.1: Conceptual framework for analysis of quality and origin attributes of GI potential honey as an economic and biodiversity conservation tool (*Source: Author´s schematic)*

Production systems of a product which are influenced by producer know how, history and traditions, harvesting, processing, handling and storage influence the content of honey, thus its quality (Muli et al., 2007).

Producer initiatives e.g. being a member of a honey producer group (proxy for collective action) enhances cooperation of producers and collective efforts and other opportunities which are very influential on the success of the processes in GI registration and protection (Bramley & Bienabe, 2013). Household and farm characteristics influence the decision of a honey producer to become a member of a group which can be beneficial in enhancing GI potential of a product. This study hypothesized that GI awareness and production of honey with origin linked attributes are likely to positively influence membership to honey group.

Initiatives by other actors e.g. governmental and non-governmental organizations are also important in enhancing product quality. This is attributed to support given to producers and processors in their production and processing activities. The support may include training, information dissemination, technical and financial assistance. Such initiatives provide useful skills and know how in production of quality products (Vandecandelaere et al., 2010; Blakeney et al., 2012).

Presence of institutions i.e. formal and informal guidelines governing production and marketing of honeys, equitable participation especially of the producers; strong market partners; and effective legal protection can determine quality of honey product. These institutions can influence honey quality in two ways. First, institutions that affect how honey is being produced (e.g. norms, production rules, codes of practice) and secondly, institutions that may establish quality traits, be decisive for GI labelling and marketing of a product (e.g. trade agreements, standards).

Origin honeys registered with PGI/PDO based on the discussed GI potential factors play a role in enhancing biodiversity conservation, social inclusion and improved livelihoods. GI is a collective mark thus, all producers within a particular geographical region and who meet the GI standard can benefit from it, thus enhancing social inclusion (Giovannucci et al., 2009). To maintain product quality, producers develop and implement specific codes of conduct, which enhance biodiversity conservation.

GI registration eliminates unfair competition and opportunistic behaviours e.g. product imitations. Therefore, this ensures that the product value and benefits derived from the origin linked quality and the associated good reputation, is transferred solely to the producers in the specific geographical area of production (Bramley & Biénabe, 2013). Farmers also get access to niche markets where they gain premium prices (Vandecandelaere et al., 2010). This increases the positive impact on the involved local communities and producersô livelihood. Product premium prices form incentives to conserve biodiversity (Marie-Vivien et al., 2014; WIPO, 2014; Chabrol et al., 2017; Egelyng et al., 2017) in order to maintain quality and ensure sustainable production. The factors discussed above (those in the rectangle with dotted line in the conceptual framework) were beyond the scope of this study.

3.2 Study areas

The study was conducted in West Pokot, Baringo, Kitui Counties, Kenya (Figure 3.2). These areas fall within arid and semi- arid areas and each area has a highland and lowland zone (Gachimbi, 2002; Gichora, 2003; Government of West Pokot, 2013). Lowlands are characterized by low/unreliable rainfall and high temperatures while highland have low temperatures and they receive considerable amount of rainfall as compared to lowlands. Forests in the three areas are dominated with different Acacia species e.g. *Acacia mellifera*, *Acacia brevispica* and *Acacia nilotica* and other indigenous trees and shrubs which form good floral sources and bees and fodder for livestock.

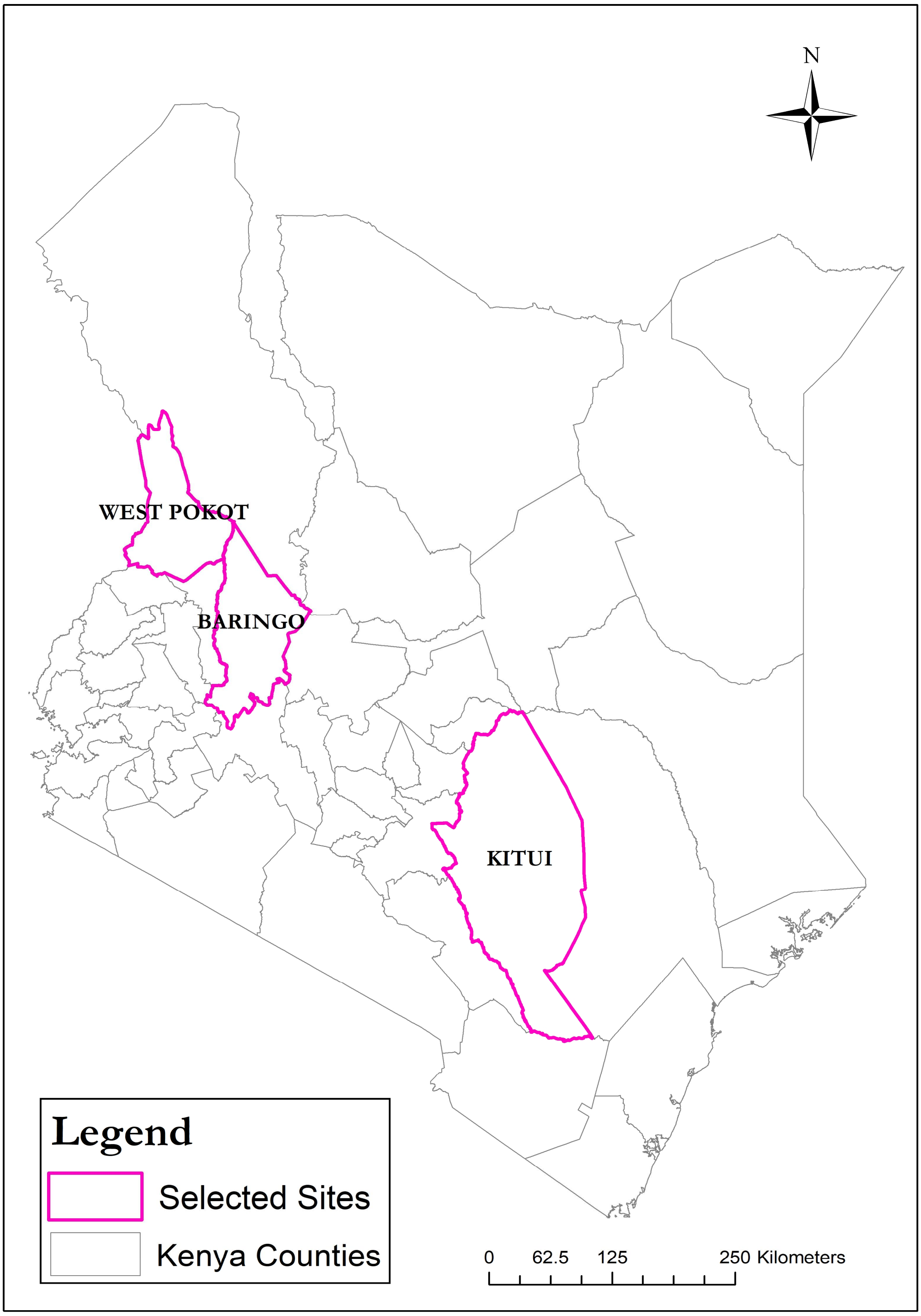

Figure 3.2: A Map of Kenya showing the study areas

A larger portion of each of the three Counties fall in the lowland agricultural potential category. The rainfall distribution is such that major cropping/farming activities are concentrated in the highland areas. The lowland zones are essentially rangelands with major socio-economic activities centering on beekeeping and livestock rearing (Gichora, 2003; Gloor, 2011; Berem, 2015). The areas also have tourist attraction sites which contribute to the economy of the Counties. According to the Kenya Honey Council, West Pokot County leads in honey production followed by Baringo County.

Traditional hives (log hives) are mostly used by honey producers in the three areas. These hives have been reported to produce good quality honey with demand in the market (Muli et al., 2007). Although modern hives have been introduced in the three areas through programs undertaken by governmental and non-governmental organizations, the adoption rate is still low (GoK, 2013). Modern hives are said to be unsuitable in arid and semi-arid lands due to high temperatures which make bees uncomfortable. Bees abscond from the hives during the hot seasons and this has an effect on honey yields. Honey is used as food, medicine and it traditional ceremonies e.g. cleansing ceremonies, brewing beer and paying dowry (bride price) (Gichora, 2003; Gloor, 2011).

Selection of study sites was based on the information provided by actors in the honey sector and review of documents and reports on honey production in Kenya. Based on the information gathered, the lowlands West Pokot, Baringo and Kitui were purposively selected for this study.

3.3 Research Design

The study was carried out using three approaches in which qualitative and quantitative data were collected. The approaches included field surveys, on-farm experiments and laboratory experiments.

3.3.1 Field surveys

Key informant interviews and in-depth interviews were held with actors in the honey subsector and other relevant actors within three study areas and those at the national level. Also, focus group discussions and household surveys were held with honey producers in each study region. Review of scientific literature, reports and records was also undertaken to collect qualitative data.

3.3.2 On-farm experiments

Experimental farms and target plants were identified for this study and appropriate number selected. Field observations were made on the selected plants and information gathered recorded.

3.3.3 Laboratory experiments

Honey samples were collected from beekeepers/processors in the three study areas. The honeys were taken to the National Museums of Kenya and Quality Service International in Germany where parameters relevant to this study were analysed using accredited equipment.

3.4 Sampling approach

3.4.1 Field surveys

Selection of study areas and respondents for the interviews and focus group discussions was purposive to ensure that information relevant to this study was gathered as much as possible. The number of the respondents were determined by the functions/roles of the actors in relation to honey production as well as on the information that was required to address objective of this study.

Household survey was conducted on producers in each of the study regions. Sampling targeted honey producers of a particular region since GI protection of a product produced in a particular region would involve all producers within the particular region. For each study area, a sampling frame was developed through the respective extension offices and chiefs. The sample size was determined based on the following equation by Israel (2009):

$$n = \frac{z^2pq}{e^2}$$

Where; n is the required sample size; z is the standard variate at a given confidence level; the value is 1.96 for commonly used at 95 percent confidence level; p is the proportion of the target population estimated to have attributes characteristics being measured (0.80); q = 1-p (0.20); and e = the acceptable error (desired level of precision) set at 7% for this study. This gave a calculated sample size of household in each study area was 125. However, due to issues of insecurity and finance in the study areas, the resulting sample sizes for the producer surveys was 105 households in West Pokot, 110 in Baringo and 103 in Kitui Counties.

3.4.2 On-farm experiments

Four farms with similar plant species belonging to different families, including Acacia trees were purposively selected in Kitui County. In each farm, 14 Acacia trees were selected based on their form and structure. In each of the tree, five branches with similar form, size, shape and an average of five flowers were selected in the middle of the crown for observation.

3.4.3 Laboratory experiments

Honey collection areas/points were purposively identified. To determine the physicochemical and melissopalynological parameters of honey from West Pokot, Baringo and Kitui Counties, 21 honey samples (7 from each study area) were collected from designated honey processing centres in within a study area. To assess the link between pollination of *Acacia brevispica* and production of Kitui honey, 8 eight unprocessed honey samples were collected from hives placed in areas surrounding the four farms selected for the experiments during the .study season.

3.5 Data collection and analysis

3.5.1 Field surveys

Qualitative data were gathered using key informant interviews, in-depth (detailed) interviews and focus group discussions. This information was useful in assessing suitability of West Pokot, Baringo and Kitui for GI labelling. Also, actors´ initiatives enhancing recognition of the honeys and their territorial or local traits were identified. Checklists (Appendix 4-7) were used in collecting qualitative data. Supporting information was collected from secondary sources which included review of GI case studies of origin and GI registered products including honeys, honey literature from scientific studies and reports, policies and laws related to honey production and quality assurance.

Household surveys in the study areas were conducted using the semi-structured questionnaire (Appendix 3) where the factors influencing collective action among producers of Kenyan honeys were determined. Data were entered in STATA statistical software version 13.0 and logit regression was done to determine factors influencing collective action among producers of honey in West Pokot, Baringo and Kitui Counties using.

3.5.2 On-farm experiments

Data were obtained from observation of flower visitors on *Acacia brevispica* and their activities. The frequency and diversity of the visitors and seed set of *Acacia brevispica* as a result of pollination were determined using STATA statistical software version 13.0.

3.5.3 Laboratory experiments

Honey samples collected were to determine physicochemical properties (moisture content, HMF, diastase activity, free acidity and electrical conductivity) and pollen types in West Pokot, Baringo and Kitui honey. Physicochemical properties were analyzed based on methods described by the Association of the Official Analytical Chemists (AOAC, 1990) and harmonized methods of the International Honey Commission (Bogdanov et al., 1997; Bogdanov et al., 1999). One way ANOVA was used to determine statistical difference between means of physicochemical parameter values of honey from the three study areas. The pollen content in honey was assessed using the methods described by Louveaux et al. (1970), Louveaux et al. (1978), Feás et al. (2010), and Yang et al. (2012)..

CHAPTER 4 : ASSESSMENT OF THE SUITABILITY OF HONEY FROM WEST POKOT, BARINGO AND KITUI FOR GI LABELLING[2]

Abstract

African countries have potential for creating monetary value from origin products similar to how products registered with Protected Geographical Indications (PGI) and Protected Denomination of Origin (PDO), add billions of Euros annually to the European agricultural sector. Following Kenya´s interest in developing Geographical Indications (GI) products, this study investigated the prospects of protecting three Kenyan honeys- West Pokot, Baringo and Kitui honeys with GI. Protecting these honeys with GI can improve producer livelihoods while conserving the natural environment. The study employed different data collection methods including observations, focus group discussions and interviews with various actors in the honey sub-sector and representatives from various organizations supporting honey value chain. The GI potential of West Pokot, Baringo and Kitui honeys was assessed based on four factors, namely product specificity, collective action, market attractiveness, institutional and organizational support, which are considered in identifying/selecting potential GI products. This study showed that West Pokot, Baringo and Kitui honey have potential for protection with GI based mainly on their origin specific qualities and link to geographical origin. However, their GI labelling is constrained by inadequate institutional and organizational support. Findings of this study will inform policy makers and other actors in the honey sector on areas of support in development of GI honeys.

Key Words: Geographical Indications, Honey, Origin products, West Pokot, Baringo and Kitui Counties

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4.1 Introduction

Use of Geographical Indications (GI) to protect origin products, i.e. products with unique characteristics attributed to their origin, is increasing globally (Vandecandelaere et al., 2010; Blakeney et al., 2012; Egelyng et al., 2017). GI is an intellectual property right that protects collectively owned products produced in a particular territory (Hermitte, 2001; Augustin-Jean et al., 2012), where a given quality, reputation or any other characteristic of the good is essentially attributable to its geographical origin. Origin agricultural products and food stuffs protected with GI add 13-15 billions of Euros annually to the European agricultural sector (Chever et al., 2012). GI can also be used as a tool to conserve biodiversity (Larson Guerra, 2004; Williamson, 2012; Marie-Vivien et al., 2014) and have been suggested as an economic policy instrument to enhance sustainable development especially in rural areas (Izac et al., 2009). Developing countries in Africa encounter a challenge of expanding economic opportunities in order to sustain the growing populations. To address this challenge, developing countries can use GI to create additional monetary value from origin products, while addressing environmental pressures.

Kenyaȏs Vision 2030, points out agriculture as one of the key drivers for development. This includes beekeeping, which is seen as a low-entry-barrier business among the different communities living in Kenya (GoK, 2010). Honey is produced in different regions of Kenya and income from its sales is a major source of livelihood, especially to populations in arid and semi-arid areas. Value addition in Kenya´s honey sub-sector and higher incomes among producers are aimed for, through promoting investments and improving honey producers´ market access (GoK, 2013).

Advancement of the honey sub-sector in Kenya is however, affected by opportunistic traders who change the quality of honey through adulteration, register origin honeys as their own or misuse honey labels which indicate the origin of honeys. These traders label honeys derived from other countries as origin honeys from specific regions of Kenya (Nyaga, 2004). This is detrimental to (i) consumers, who are deceived when buying quality and origin products; (ii) legitimate producers, who are deprived of valuable business and benefits from their products; and (iii) the products whose reputation is damaged. Protecting Kenyan origin honeys with GI can address the identified challenges by protecting producers and products from imitation and fraud. A GI label can also provide product information on origin and quality parameters to consumers, thereby building consumer confidence/trust in the product, possibly resulting in consumer preferences (Bramley & Biénabe, 2013). GI offers an opportunity for the smallholder producers and small and medium enterprises to access market and gain from the added value, as shown by the first African honey with a GI registration acknowledged in the EU; the Oku white honey in Cameroon (WIPO, 2014).

Geographical Indications has been proposed as a strategy to add market value to high quality Kenyan honeys (KIPI, 2009; Blakeney et al., 2012). However, the prospects for protecting Kenyan honeys with GI have not been adequately assessed. Although Kenya lacks a fully developed and operational *sui generis*, the country has advanced its interest in protecting some of its origin products. Currently, Kenyan origin coffee and tea, are protected as certification marks under Section 40A (5) of the Kenya Trade Marks Act, CAP 506 (Musungu, 2008). This shows that if a specific GI legal framework is put in place, a certain number of relevant products already identified as potential for GI registration ï among these a number of honeys that are produced by rural households, stand to benefit from an origin based quality label.

Drawing on GI literature and case studies, this study assessed the GI potential of three Kenyan honeys- West Pokot, Baringo and Kitui honeys. The three honeys were selected based on a previous scoping study which involved an assessment of seven honey from different regions (Warui et al., 2014). The potential to protect the three honeys with GI was evaluated based on four factors which are considered in developing/selecting successful GI products. These factors included product specificity, collective action, market attractiveness, institutional and organizational support. This paper contributes to the growing scientific literature on potential GI products in developing countries. Findings of this study will inform development of policies and other interventions to overcome barriers for development of GI products in Kenya.

4.2 Factors determining GI potential of a product

Through review of GI literature and case studies of potential GI products conducted across the world (Giovannucci et al., 2009; Vandecandelaere et al., 2010; Bramley & Biénabe, 2013; WIPO, 2014), four factors are considered in determining GI potential of a product. These factors include;

a) Product specificity- this refers to specific unique product characteristics which can differentiate a product from other similar products in other regions (Coulet & Mahop, 2012; Bramley & Biénabe, 2013; WIPO, 2014). According to Mancini (2013) specificity of an origin product cannot be reproduced outside its geographical origin. These characteristics are expected to fulfil consumers´ expectations based on perceptions/opinion formed about a product based on past purchasing and consuming experience.

   Product specificity is an important GI requirement which should be linked to the natural environment and human resources/factors within the area of production. Natural environment entails the climatic condition and flora in an area while the human resources /factors involve producer local know-how, history and traditions which influence characteristics of a product. Product attributes arising from one of or both links should result in a preferential reputation and demand of the product (Vandecandelaere et al., 2010; Bramley & Biénabe, 2013) among consumers in different markets, leading to better market access and/or higher prices.

b) Collective action- this entails cooperation of producers and other relevant stakeholders in production, promotion and marketing of a product (Blakeney et al., 2012; Bramley & Biénabe, 2013). Collective action plays an important role in maintaining collective reputation of a product and its characteristics (Winfree & McCluskey, 2005), thus enhancing product demand. Often, there is a need for collective action among producers as well as supporting institutions and organizations to sustain, promote and market the origin specific quality.

c) Institutional and organizational supportï this support include provision of GI regulatory frameworks (Giovannucci et al., 2009) and enforcement procedures as well as infrastructural development and the provision of finances and information to facilitate production and marketing of a potential GI product. This support can be offered by public institutions or non-governmental organizations (Blakeney et al., 2012).

d) Market attractivenessï this entails demand of a product and its competitiveness in the market, based on its attributes which can be reinforced by the image of the area where a product is derived (Bramley & Biénabe, 2013). Information provided to consumers about the origin of a product is important in promoting a product, thus its attractiveness in the market. Market attractiveness and commercialization of a product can be enhanced by preserving and promoting the image of a region in order to obtain and maintain the origin linked quality (Vandecandelaere et al., 2010). Commercialization of a product based on origin linked quality enhances market attractiveness and creates an economic opportunity and incentive for producers and other actors to sustain the environment in which the product is produced.

Some studies conducted on proposed African agricultural origin products have demonstrated that some factors have hindered their protection with GI, despite their unique attributes (Giovannucci et al., 2009; Blakeney et al., 2012; Bramley & Biénabe, 2013; Egelyng et al., 2017). These factors include lack of a fully operational GI legislative and institutional framework, inadequate product information to support GI protection, financial constraints, undocumented product specifications, inadequate infrastructure, lack of producer and consumer awareness on GI protection and its impacts, inadequate market structures and divided interests by stakeholders in relevant sectors (Blakeney et al., 2012).

Despite challenges hindering GI protection of products in African countries, three products i.e. Ziama-Macenta coffee from Guinea, Penja pepper and Oku White Honey from Cameroon have been awarded protection with GI (Chabrol et al., 2017). One of the PGI product i.e. Oku white honey has brought positive social, environmental and economic changes in its area of production (WIPO, 2014). In the same way, Kenya can achieve its goals on improving community livelihoods and achieving sustainable development (GoK, 2010; GoK, 2013) through identifying potential honeys for GI registration using the factors outlined above. Once this has been done, strategies can be devised to overcome identified challenges which are likely to hinder protection of origin honeys, thus the need for this study.

4.3 Methodology

4.3.1 Study area

This study was conducted in Kenya in the period 2014-2015. Three honeys namely, West Pokot, Baringo and Kitui honeys were selected for this study from an initial sample of seven

Kenyan honeys through a scoping study perceived honey characteristics which are attributed to geographical origin (Warui et al., 2014). The three honeys are produced in similar agro ecological zones i.e. arid and semi-arid areas, which are characterized by low, unreliable and poorly/unevenly distributed rainfall, low elevations, high temperatures and frequent droughts, which limits agricultural activities especially if irrigation is not an option (Gachimbi, 2002; Gichora, 2003; Government of West Pokot, 2013). Similar vegetation types are found in these study sites with *Acacia spp.* being the dominant vegetation type. West Pokot, Baringo and Kitui honeys are produced for sale, consumption as food and medicine, and for use during traditional ceremonies (e.g. payment of dowry and cleansing rituals). These honeys are among the main sources of livelihoods for communities in their area of production.

4.3.2 Data collection

To collect data regarding the potential of the three honeys for protection with GI, focus group discussions, observations and interviews with a number of actors in the honey sub-sector including representatives from various organizations supporting the honey value chain were carried out. At the national level, six key informant interviews were conducted with representatives from: National Beekeeping Institute (NBI), Kenya Organic Agricultural Network (KOAN), Kenya Bureau of Standards (KEBS), Kenya Industrial Property Institute (KIPI), Kenya Honey Council (KHC) and International Centre of Insect Physiology and Ecology (ICIPE). In each of the three study areas, in-depth interviews were conducted with five honey producers, three processors/marketing agents, three consumers, one representative from Ministry of Agriculture (MoA), one representative from Agricultural Sector Development Support Programme (ASDSP) and one representative from the Ministry of Trade, Industry and Enterprise (MTIE) (Table 4.1). Respondents of this study were purposively selected based on their experience, understanding and role in honey production activities. Referrals were also used to identify new informants in order to collect comprehensive information to inform the study. Consumers targeted were the main users/suppliers of the honeys produced in the study areas, thus they interact with other honey consumers/users. Additionally, two Focus Group Discussions (FGDs) with producers were held in each study area. Each FGD consisted of 10 people. Data collection methods used aimed to collect data regarding the elements of GI potential described in section 4.2.

Table 4.1: An overview of interviews conducted and gender proportions of respondents

Category	Respondent/informant	No. of respondents	
		Male	Female
Key informants	Representatives of various organizations supporting honey value chain	13	2
Honey producers	Individuals producing honey	10	5
Processors/traders	Processors/marketing agents	5	4
Honey consumers	Users of honey within a region	3	6
Producer groups (individuals in FGDs)	Producers who are members of a honey group	38	22
Total respondents and proportions		**69 (0.64)**	**39 (0.36)**

To evaluate the GI potential of West Pokot, Baringo and Kitui honeys, sub-factors (variables) for each of the four GI factors discussed earlier under section 4.2 were developed (Barjolle & Sylvander, 2002). The level of fulfilment of the GI sub-factors for the three honeys were assessed based on information collected from interviews, focus group discussions and observations. For instance, product specificity was evaluated based on unique/specific honey characteristics and demonstration of the link between product characteristics and natural environment and human resources/ factors in the region of production. Collective action was evaluated in terms of cooperation among producers and other stakeholders as well as collective efforts in honey production and marketing. Institutional and organizational support was evaluated based on access and use of supportive functions (e.g. finances, infrastructure, and extension officers) in governing production and marketing of honeys. Formal and informal rules were assessed based of their facilitation of a GI potential product. Effectiveness of institutions and support by organizations in building local capacities to support value addition and market development for the honeys was also evaluated. Lastly, market attractiveness was evaluated based on whether the honeys are perceived positively by consumers based on their specificity and image of the area of production. Initiatives undertaken to promote the honey and the region where produced were evaluated based on provision of information to consumers about a product.

Fulfilment of the GI sub-factors for the three honeys was evaluated at three levels (i.e. low, medium and high). A score of one (1) was assigned to a variable where perceptions on fulfilment was low, two (2) where perceptions was medium and three (3) where the perceptions was high. An average score for the GI factors for each honey was obtained by summing up the scores of the sub-factors under each GI factor, divided by the number of the sub-factors under each main factor (Barjolle & Sylvander, 2002).

4.4 Results and discussion

Results are presented in two sub-sections; section 4.4.1 presents a description of West Pokot, Baringo and Kitui honeys in relation to their production, processing, marketing, producer organization and institutions supporting the honeys. Information presented was gathered from focus group discussions, interviews with relevant actors, review of documents and researcher´s observations. Section 4.4.2 analyses fulfillment of the four factors of GI potential for West Pokot, Baringo and Kitui honeys based on information presented in section 4.4.1. Scores of each of the four factors of GI potential are presented for each honey and discussed. A likert scale of 1-3 has been used in summarizing the scores where 3 is the highly fulfilled.

4.4.1 Description of West Pokot, Baringo and Kitui honey in relation to their potential for GI labelling

4.4.1.1 West Pokot honey

Information collected from producers and consumers revealed that West Pokot honey has unique taste, colour, texture and viscosity which is distinct from honeys produced in other regions within Kenya and in the neighbouring country (i.e. Uganda) according to the respondents. Consumers interviewed said that the honey has a strong sweet taste and it is sticky to the tongue, a characteristic which the consumers like. The colour of the honey ranges between light brown to dark brown depending on the season of production. Honey producers interviewed mentioned that the honey has medicinal properties which they have observed through continued use. Honey producers in the region attributed the distinctive characteristics of their honey to vegetation and the high temperatures in the region. Beekeepers have knowledge on bee floral sources, thus they place their hives near suitable vegetation for bees to forage on their nectar and/or pollen. Although the langstroth hives (a particular type of modern hives with queen excluder) have been introduced in West Pokot, hollow tree trunks (traditional log hives) are still the most preferred among the producers. Producers claim that the traditional hives provide suitable climatic conditions for bees compared to modern ones. Traditional hives are placed on top of tall trees, thus it is not easy to monitor the hives regularly. Most producers using such hives therefore use local know-how in determining whether honey is ripe for harvesting. However, before harvesting the honeys, producers check the ripeness of the honeys before harvesting and this is useful in ensuring good quality honey once harvested.

Three centralised honey centres, which were initiated by association of beekeepers within the region, were in existence during the time of the fieldwork. They include; Cabesi, Pokot beekeepers cooperative- Kitelakapel and Kodich honey cooperative societies. Activities undertaken at the centralised honey centres include processing and marketing of the honey as well as training of honey producers on proper production methods. The centres are equipped with processing machines, through support by non-governmental organizations and the local government. Each of the processing centre has established honey collection points within the production regions where producers deliver their honey. Honey producers who are members of existing producer groups are required to deliver comb honey and an initial quality check is undertaken. Honey with brood, dirt, dead bees and high moisture content is rejected. Producers are paid upon delivery of their honey. During the honey harvesting seasons, honey producers receive clean food grade honey storage buckets from the centres. These buckets are labelled in order to differentiate honeys harvested from different localities within a region. Management at the centres organizes collection and transportation of honey from the collection points at the local level to the centralised centres.

Extraction of honey from comb is done through centrifuging and recommended heat used during processing is based on the harvesting season and the form/type of honey. Honey received from different regions is processed and packaged separately. Kenya Bureau of Standards (KEBS) certifies honey processed at the three centralised centres in West Pokot, thus a certification mark is included in the honey labels as an indication that the honey meets the required local and national market standards for honey quality. This also indicated the human link to product quality, an important aspect in GI labelling. One honey centre, that is, Cabesi has obtained an organic honey label from organic certification of East Africa (Kilimohai) and EnCert (Kenya). The name ´West Pokot´ which designates the geographical origin of West Pokot honey is included in the labels of honey marketed by the three centres in the region. West Pokot honey is sold to supermarkets within West Pokot and in some urban market centres within Kenya. During the study period, members of Pokot beekeepers cooperative exhibited their honey at the Rwanda international trade fair which was organised by the export promotion council of Kenya.

During the focus group discussions, honey group members explained how informal rules e.g. norms and taboos have played a role in maintaining the characteristics of the honey and in conserving bee floral sources in West Pokot. Community elders in the area have developed some informal rules (norms) to prohibit activities that alter the quality of honey and/or are harmful to the environment. These rules are enforced by community elders who punish the culprits. Violation of these rules is regarded as a bad omen which can negatively affect a family/society. For instance, any person who gets involved in honey adulteration or cutting down of trees within communal land has to be cleansed through a traditional ceremony in order to protect his life and that of his family as well as their property. During the study period, the Ministry of Agriculture in West Pokot in collaboration with the three honey centres were in the process of developing honey value chains (honey support services, value addition, linkages to market), in order to improve production and marketing of West Pokot honey.

4.4.1.2 Baringo honey

Interviews held with Baringo honey producers and consumers revealed that Baringo honey has a unique sweet taste with colours that varied from light yellow to dark brown across production seasons. Producers also mentioned that the honey is useful in treating colds, cough, wounds and stomach related problems. Producers associated these honey characteristics with vegetation types in the natural forests where production of the honey takes place. During the focus group discussions, beekeepers mentioned that they have communal land where apiary sites are shared. People living around the apiary sites are obliged to protect the flora within the areas. Rules have been laid down to facilitate apiary management and responsibilities are shared. Close monitoring is done by the elders and action is undertaken to unresponsive community. Honey producers use both traditional hives (log hives) and modern hives (langstroth hives and Kenya Top Bar Hives). At the time of the study, honey producers were being trained on how to modify log hives by including a queen excluder in order to separate honey from the brood. Producers who are members of honey groups own communal modern hives and each member of the group is required to participate in their management.

Honey producers have formed honey producer groups where issues of honey production, value addition and marketing are addressed. There were five active honey producer groups located in various areas within Baringo during this study. These producer groups have established honey processing/marketing centres where interaction between honey producers, processers, traders and consumers takes place. The honey groups have invested in some equipment to facilitate honey processing and marketing activities. The groups participate in trainings, workshops, exhibitions and exchange visits where they have learnt best practices on honey production, value addition and marketing.

Development of the honey value chain in order to improve honey production activities in Baringo was ongoing during the study. The local government has been involved in building capacity of the producer groups through trainings, infrastructure development and linking groups with relevant service providers e.g. financial institutions and input suppliers. During fieldwork, the local government of Baringo in collaboration with the Ministry of Agriculture was recruiting honey producers into the existing honey groups. Governmental organizations at the local level in collaboration with some non-governmental organizations was in the process of forming of an umbrella honey association in Baringo to enhance marketing of Baringo honey.

Honey processing and marketing is done collectively at the group level and sold to wholesale and retail buyers within and outside the region of production. Also, producer/processor groups of Baringo honey have small shops located at the processing centres and/or along roadsides where buyers travelling to different destinations can access the products. Buyers, who are not able to buy honey from the shops in Baringo, place their postal and online orders and honey is delivered to them as a parcel. Baringo honey is also sold in some selected supermarkets in Baringo and other urban centres in Kenya. Through initiatives by the export promotion council in Kenya, honey produced by one of the honey producer groups in Baringo was exhibited at Rwanda international trade fair. Other honey producer groups exhibit their honeys at the agricultural trade shows and conferences taking place within and outside Baringo. According to a representative in the Ministry of Trade, Industry and Enterprise, these initiatives have expanded the market for Baringo honey.

The Kenya Bureau of Standards based on the East African Standards for honey certifies the honey sold by producer/processor groups in the county. Producers of Baringo honey also rely on informal rules (norms) in governing the quality of the honey they produce. These rules can only enhance honey quality to some extent thus, there is need for use of the formal rules in governing honey quality. Trader groups in Baringo provide the group name and/or the name of honey geographical origin i.e. ´Baringo´ on the honey label. Some groups also include the name of the dominant flora in the region (i.e. *Acacia spp.)* or renowned tourist attraction sites in the area (i.e. Lake Baringo and Lake Bogoria) in the honey labels as a marketing strategy.

4.4.1.3 Kitui honey

According to honey producers and consumers interviewed, Kitui honey has a faint to moderate sweet taste, high viscosity and distinctive brownish colour. Producers of the honey attribute these characteristics to homogenous vegetation in forests dominated by *Acacia spp.* where most hives are placed. Honey characteristics are also attributed to high temperatures in the area of production. Traditional hives (log hives), which were observed hanging on trees (mostly Acacia trees), dominate most of the beekeeping areas. However, a few modern hives (box hives, langstroth hives and Kenya Top Bar Hives) were noted in some apiaries. Honey producers in Kitui know the important bee flora, thus they place their hives in the areas where the food resources required by the bees are available. Producers mentioned that flowering vegetation types vary across regions and to some extent, this influences honey characteristics (colour, taste, viscosity).

Some honey producer groups in the county have an umbrella association to handle honey production, processing and marketing activities. ICIPE, an international non-governmental organization based in Kenya supported the establishment of a cooperative and a processing centre/market place known as the ´Mwingi honey market place`. The market place was the only functional sales outlet for the honey produced by members of honey groups in Kitui at the time of the study. However, the Kitui government was in the process of establishing and equipping six other honey collection/processing centres. The Mwingi honey market place has equipment to facilitate processing, packaging of the honey produced within the region. The market place brings together over 1800 producers, who are all members of active producer groups in different areas within Kitui. These producers are expected to sell their honey at the market place, however, a study conducted by Musinguzi et al. (2018) revealed that some of these producers sell large quantities of honeys to brokers, thus forcing the market place to source honeys from other producers and brokers. Honey delivered at the market place is checked for quality and separated during processing based on the region of production. Processing is done through centrifuging using a special equipment for both honey combs from modern and log hives. The honey sold at Mwingi honey market place is certified by the Kenya Bureau of Standards, an indication that quality assurance for the honey is undertaken in accordance with quality standards specified in the East African honey standards.

The honey sold at Mwingi market place is also certified organic by the Institute of Market Ecology in Switzerland with support from ICIPE and the Ministry of Agriculture in Kenya. Organic certification presents a link between honey quality and geographical origin (natural environment and human factors). According to the chairman of the market place, organic certification of the honey has created reputation and demand for the honey at the local and national level. During the study, it was evident that buyers travelled from other Counties/regions to purchase honey from Mwingi honey market place. During FGDs, producers explained the importance of local rules i.e. taboos and norms in preserving honey quality and in conserving indigenous vegetation. Interviews with honey traders revealed that the farmers who deliver their honey at the market sell their honey at higher prices compared to those who sell their honey to middlemen. A study conducted by Musinguzi et al. (2018) confirmed that the fair prices at the market place applied for organic certified producers. Non certified producers sell their honey at significantly higher price to brokers as compared to prices offered at the market place. During focus groups discussions, honey producers who delivered their honey to the market place indicated that besides the good pay they receive after delivering their honey, they also receive annual bonuses which are pegged to their honey sales.

Members of the market place advocate for capacity building on proper beekeeping practices in order to improve their honey production. Producers are trained on biodiversity conservation to enhance sustainable production. Honey sold at the market place in Kitui is labelled as ` Eco-honey´ followed by the words ´linking forest biodiversity to sustainable livelihoodsq, and precise information on sources of nectar for the honey. Producers interviewed were aware of the link between honey quality, natural environment and community livelihoods. They stated that their understanding on this link has been enhanced through benefits acquired from conservation programmes in the region initiated by ICIPE whose focus is to maintain the quality of honey.

4.4.2 An assessment of the three honeys against four factors of GI potential

The three honey case studies described above show strengths and weaknesses for each honey in terms of GI potential. Figure 4.1 shows scores on perceptions of fulfilling the four GI potential factors for West Pokot, Baringo and Kitui honey.

Product specificity is the strongest GI factor in the three honey cases. The three regions are renowned for production of quality honeys. Producer capacity and know-how (Muli et al., 2007) as well as vegetation (i.e. the dominant Acacia trees and other indigenous plants) (Gichora, 2003; Gloor, 2011; Egelyng et al., 2017) contribute to the unique attributes of the three honeys. Other products identified to have GI potential based on product specificity include Oku white honey in Cameroon and PGI/PDO EU honeys in the EU DOOR database. Specificity of the products is based on their organoleptic traits and physicochemical properties which are linked to specific floral nectar sources and activities undertaken by producers during production of the honeys (WIPO, 2014). Pollen analysis provided the evidence on floral sources surrounding the apiaries where these honeys were produced while physicochemical analysis revealed the quality of the honeys based on different parameters.

For the three honey cases under this study, the capacity of the producers/processors to demonstrate the link between the honey quality and natural environment and human factors/resources remains a challenge. This was also noted in assessment of GI potential for Karoo lamb (Bramley & Biénabe, 2013). Construction of facilities at the local level e.g. accredited laboratories, where sensory, physicochemical and pollen analysis can be conducted to demonstrate the link is therefore needed. There is also a need to document the honey production processes and other features contributing to the characteristics of the three honeys.

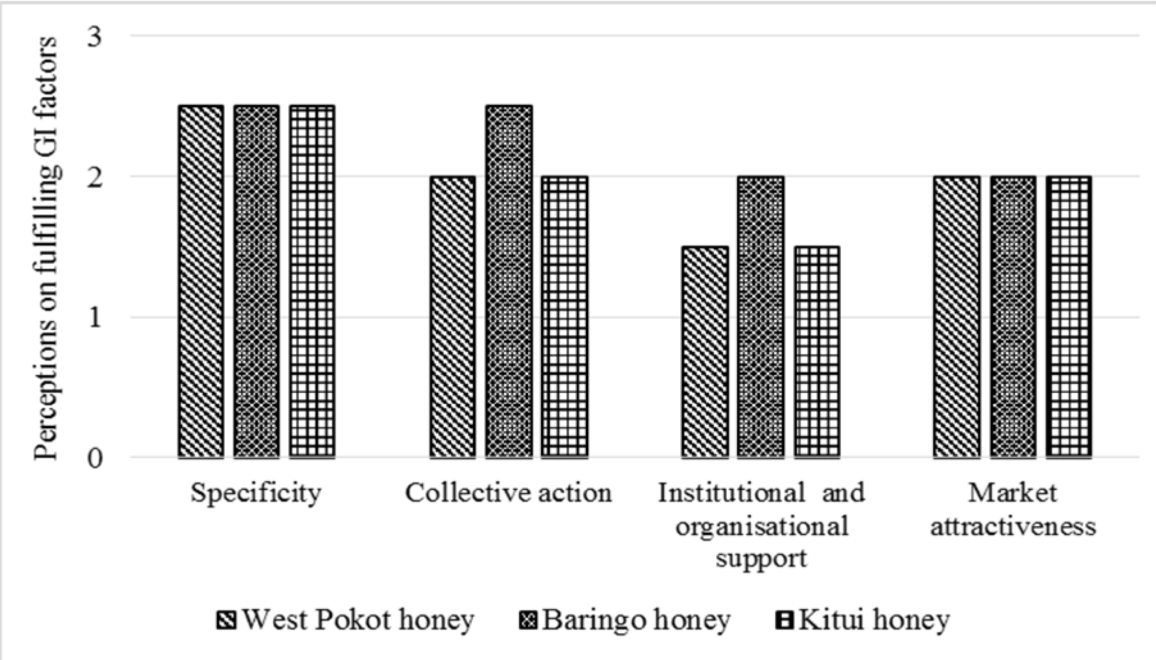

Figure 4.1: Perceptions on fulfilling factors of GI potential for Kenyan honey (Likert scale of 1-3, where 3 is the highly fulfilled)

In terms of collective action, honey producers in the three study areas are organized at different levels from beekeeper groups to honey producer cooperatives similarly to producer. Collective efforts as a factor enhancing GI potential of Rooibos tea in South Africa was also noted (Bienabe & Troskie, 2007) and Cotija Cheese (Pomeón, 2007). Cooperation of producers in production and processing of West Pokot, Baringo and Kitui honeys has enhanced consistent honey quality and implementation of quality assurance standards and product, which is a GI prerequisite. On the other hand, collective marketing has played a role in meeting market demand at the local level through bulk production, thus reputation of the honeys. Collective reputation of products can result in increased benefits to producers as a result of low transaction costs and economies of scale (Blakeney et al., 2012; Bramley & Biénabe, 2013).

However, there exist challenges which would hinder protection of West Pokot, Baringo and Kitui honeys with GI in relation to collective action. For instance, some honey producers do not belong to any honey group, thus they work individually despite the existence of honey groups and associations in the three areas. This was also observed in qualifying Oku white honey in Cameroon for GI labelling (Coulet & Mahop, 2012). In West Pokot and Kitui, honey producer groups are not fully engaged in collective marketing of their honeys, similarly to producers of honey bush tea in South Africa (Bramley & Biénabe, 2013). Also vertical integration of West Pokot and Kitui honey producers with other value chain actors is minimal. Additionally, the existing honey producer cooperatives in the study areas do not bring together honey producers from all honey producing areas within a region, similarly to what was also observed for silkmoth in Kakamega, Kenya (Egelyng et al., 2017). This would likely result in information asymmetry and increase in opportunistic behaviour (e.g. free riding, moral hazard and alteration of honey quality) among the value chain actors, thereby affecting GI potential.

Therefore, increased cooperation of producers and other stakeholders as well as collective efforts in marketing of the West Pokot, Baringo and Kitui honeys are needed to develop codes of practice for a potential GI product, conformity to product specification, access to relevant information and promotion of a product (Bramley & Biénabe, 2013). Building capacity of honey producers in the three regions would enhance cooperation and collective efforts among honey value chain actors. Formation of a regional honey association, which would bring together all honey producers from all locations within a particular region, would also be needed to drive forward the processes and legal frameworks required in development and registration of GI honeys.

Institutional and organizational support was identified as the weakest GI factor, thus it presents some constraints in protecting West Pokot, Baringo and Kitui honeys with GI. Similar challenges were identified in qualifying Zanzibar cloves and Kenyan tea as potential GIs (Blakeney et al., 2012). Existing honey standards i.e. East African Standards for honey have been implemented by a few processors/traders of the three honeys in this study. Instead, overreliance on informal institutions e.g. norms and taboos in governing honey production activities was demonstrated for the three honeys as compared to use of formal rules, similar to what was observed in the case study of Nguni hides in South Africa (Bramley & Biénabe, 2013). Use of informal rules may not suffice adherence and maintenance of quality needed in marketing the honeys beyond the local level and enhancing a wider recognition of a product (Egelyng et al., 2017), which is a requirement for GI registration. Other formal institutions which would govern production and marketing of origin honeys in Kenya are still in the process of development and/or enactment. These include the Beekeeping Industry Bill, National Beekeeping Policy and GI Bill. Enactment of these institutions would guide development of a honey monitoring plan which would enhance traceability, conformity of a product to GI specifications and registration of the honeys.

As noted during this study, production and marketing of the three honeys receive inadequate support from government organizations and this has been a hindrance in enhancing their recognition beyond the local level. Blakeney et al. (2012) identified similar challenges in GI registration of African products. Protection of the West Pokot, Baringo and Kitui honeys with GI would therefore need regulatory framework, financial, infrastructural development, and policy support. State intervention would be important in enforcement of existing policies and standards that enhance production of quality honey that meet the market requirements (Barjolle et al., 1998). Initiatives by the Ministry of Agriculture and other actors would be important in supporting enactment and implementation of beekeeping/honey policies and building capacity of honey producers and processors in order to enhance GI development for the three honeys.

Organic certification of West Pokot and Kitui honeys justify the quality of the honeys with reference to environmental quality resulting from honey producers´ efforts in biodiversity conservation, as noted by Allaire (2012). This has resulted in positive consumer perception about the honey, resulting to increased demand and premium prices as noted based purchases made during the data collection period. Benefits derived from a product based on environmental quality is expected to create some economic incentives to conserve the natural environment, as noted for Oku White honey in Cameroon (WIPO, 2014). This aspect of linking biodiversity conservation to product quality for economic development has been supported in other GI studies (Allaire, 2012; Blakeney et al., 2012; Marie-Vivien et al., 2014). Organic certification for the West Pokot and Kitui honeys was done once and there lacks capacity, facilitation and producer group´s commitment in renewing the organic certification. This is likely to influence reputation of a product over a period of time, thereby affecting the products´ GI potential.

Specificity of West Pokot, Baringo and Kitui honeys have enhanced their recognition and demand beyond the local market. Similarly, unique characteristics of Ethiopian Coffee (Blakeney et al., 2012) and Kalahari Melon seed oil in South Africa (Bramley & Biénabe,

2013) enhanced their reputation internationally and establishment of niche markets. Indicating the geographical area of production in the labels of West Pokot, Baringo and Kitui honeys as well their exhibition in conferences, agricultural shows and trade fairs, has provided information about product characteristics and region of production, thereby contributing to market attractiveness in different markets as noted for Mamou chilli in Guinea-Conakry (Camara & Haba, 2004). However, producers/processors of honey from the three study areas do not provide full and verified information about characteristics (organoleptic, physicochemical properties and pollen composition) of the honey and the region of production. Provision of such information would ensure that consumers are not misled with regards to quality of the honey and relation to its origin.

4.5 Conclusion

The factors used in assessing West Pokot, Baringo and Kitui honeys for revealed the potential of the three honeys for protection with GI. However, there exist factors which may hinder development of GI honeys despite their unique attributes, similar to other GI case studies in Africa. Although the three honey cases indicated that initiative by other actors in the honey sub-sector, have played an important role in enhancing GI potential of the honeys, institutional and organizational support was identified as the weakest factor in enhancing GI potential of the three honeys. With the growing interest in GI protection in Kenya, information provided in this study provided useful insights on prospects for Kenya to develop GI products and their markets. Results of this study were based on perceptions and observation, thus there is a need for product analysis in order to provide detailed information on the link between product quality and geographical origin. Therefore, capacity building of honey producers and processors at the local level, development, enactment and implementation of institutional frameworks are needed to enhance their GI protection. Also, development and enactment of policies and regulations which would support development of GI honeys in Kenya is needed.

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CHAPTER 5 : DETERMINING THE PHYSICOCHEMICAL AND MELISSOPALYNOLOGICAL PARAMETERS OF HONEY [3]

Abstract

Properties and composition of honeys are essential in providing information regarding their quality as well as in their differentiation based on production region characteristics. Honey composition and quality can be determined through melissopalynological and physicochemical analyses. There is inadequate knowledge on physicochemical properties and floral sources that can differentiate potential GI honeys (West Pokot, Baringo and Kitui honeys) from other honeys. The aim of this study was to i) assess the physicochemical properties of West Pokot, Baringo and Kitui honeys, ii) determine the floral sources of the honeys from the three regions; and iii) assess differences between honeys from the three study areas based on physicochemical properties and floral sources. Twenty one (21) honey samples were collected in lowlands of West Pokot, Baringo and Kitui for analysis. Melissopalynological analysis was carried out to determine honey floral sources while physicochemical analysis determined honey quality. Results showed a total of 29 pollen types in the honey samples analysed and *Acacia spp.* was the predominant pollen type in 4 of the 21 honey samples. The mean values of parameters analysed were: moisture, 16.34%; HMF, 23.28 mg/kg; diastase activity, 10.67 Schade units; free acidity, 22.95 meq/kg and electrical conductivity, 0.40 mS/cm. Free acidity and electrical conductivity values of honey samples obtained from West Pokot were significantly lower than the values of honeys from Baringo and Kitui. Eighteen (18) honey samples had all parameter values within the limits set in the East African Standards for honey, Codex Alimentarius Standards for honey and the European

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Union directive for honey. Results of this study suggest that honey producers have undertaken appropriate measures in honey harvesting, processing, handling and storage. However, there is need to build capacity of producers whose honey were of unacceptable quality. This would involve training on proper honey production, processing and handling practices as well establishment of honey collection and processing centres at the local level in order to improve honey quality. This will enhance access to existing honey markets. Conservation of bee floral sources is also needed to maintain honey quality.

Key Words: Honey, Melissopalynological analysis, Physico-chemical properties, Pollen type, West Pokot, Baringo and Kitui Counties

5.1 Introduction

Honey quality and characteristics are greatly influenced by natural factors (e.g. climatic conditions and floral sources which provide nectar and pollen) and human factors (e.g. traditions and know-how of producers in harvesting periods and methods, handling, processing and storage techniques) (Rekha et al., 1997; Bogdanov, et al., 1999; Küçük et al., 2007; Muli et al., 2007; Coulet & Mahop, 2012; WIPO, 2014; Yang et al., 2014; Diafat et al., 2017). Substances which determine honey quality include pollen, water content, sugar content, proteins, enzymes, phenolic compounds, flavonoids, vitamins, minerals, organics acids, solid particles and free amino acids (Martos et al., 2000; González-Miret et al., 2005). Honeys also have a specific flavour and aroma based on the floral source (Zhou et al., 2002). Composition and properties of honey are known to vary across different regions (Viuda-Martos et al., 2010; Silva et al., 2013).

The quality of honey can be determined through melissopalynological analysis, physicochemical analysis and sensory analysis (Cantarelli et al., 2008; Stolzenbach et al., 2011; Jones & Bryant, 2014). These analyses provide useful information which can be used to verify authenticity of honey as well as its botanical and geographical origin (Von der Ohe et al., 2004; Petersen & Bryant, 2011; Stolzenbach et al., 2011). Among the quality parameters considered in honey trade are physicochemical parameters (moisture, Hydroxymethylfurfural (HMF), diastase activity, electrical conductivity, free acid, sugars and water insoluble contents); organoleptic characteristics (colour, aroma, flavour and consistency); and pollen composition. Levels or values of these parameters in a honey indicate its relative quality.

Moisture is an important parameter in determining honey quality. Too high moisture content often causes fermentation of honey leading to low shelf life and unpleasant flavour

(Bogdanov & Martin, 2002). Climatic conditions, degree of honey maturity reached in the hive and handling during harvesting, processing and storage all determine the level of moisture content in honey (Silva et al., 2009; Yücel & Sultanoglu, 2013).

The level of HMF indicates freshness of honey and it is affected by the storage conditions/periods and the extent to which it is heated (White, 1994; Küçük, 2007; Mehryar & Esmaiili, 2011). HMF level in honey is also influenced by moisture content, presence of organic acids and sugars. High HMF levels in a honey sample suggest a possibility of adulteration, overheating or storage for a long period of time (Castro-Vázquez et al., 2008; Wang & Li, 2011).

Diastase is a natural enzyme which occurs in honey and is sensitive to heat. Low levels of the enzyme in the honey indicate excessive heating during processing and/or storage for too long or under high temperatures (Oddo et al., 1999; Bogdanov & Martin, 2002; Bogdanov et al., 2004). Diastase content in the honey also depends on floral sources, nectar collection period by a bee colony and its flow.

Acidity in the honey is influenced by organic acids, particularly gluconic acid which emerges from bacterial action and glucose activity during honey ripening (Ruiz-Argueso & Rodriquez-Navarra, 1973; White & Doner, 1980). Free acidity influences honey flavour, texture, shelf life and stability (Gomes et al., 2011).

The electrical conductivity in honey is linked to concentration of organic acids, mineral salts, ash, complex sugars and proteins (Chefrour et al., 2009). This honey parameter varies depending on floral origin and it is important in classifying honey as either from nectar or honeydew (Belay et al., 2013).

In Kenya, honey production is concentrated in Arid and Semi-arid Lands (ASALS) (GoK, 2013). Honeys from ASALs have been identified as having potential for protection with Geographical Indication (GI) (Blakeney et al., 2012) and among the identified honeys were Kitui, West Pokot and Baringo honeys. The Kenya Honey Council (KHC) in collaboration with other actors in the honey sub-sector envisions to use GI in enhancing market value for these honeys (KIPI, 2009). Labelling a product with GI adds its value and also enhances its access to niche markets where consumers are willing to pay a premium price for specific honey traits, thereby improving producersô livelihoods.

Oku white honey from Cameroon (WIPO, 2014) and other honeys from European Union (EU door database) are among the agricultural products protected with GI based on their characteristics which are attributed to geographical origin. To facilitate marketing and registration of these honeys with GI, their physicochemical properties and floral sources were described to demonstrate the link between honey quality and the human environment as well as geographical environment. Potential GI honeys in Kenya have not yet been described in a similar way in order to fulfil an important requirement for access to niche markets and for GI registration.

Previous studies on Kenyan honeys have assessed the physicochemical properties of the honeys sold in urban retail market (Ng´ang´a et al., 2013) and those processed through traditional methods (Muli et al., 2007). However, there is inadequate knowledge on physicochemical properties and floral sources of potential GI honeys from West Pokot, Baringo and Kitui. The aim of this study was therefore to i) assess the physicochemical properties of West Pokot, Baringo and Kitui honeys in order to determine if they fulfil the quality standards stated in the East African Standards (EAS) for honey, in the Codex Alimentarius standards for honey and in the European Union (EU) directive for honey ii) determine the floral sources of the honeys from the three regions; and iii) assess differences between the honeys from the three study areas based on their physicochemical properties and floral sources. The results of this study will provide information on the link between honey quality and composition with the natural environment and human factors in the three study areas. This information is essential in differentiating honey produced in a particular region from those produced in other regions, protecting the honeys with GI and maintenance of GI honey quality through the use of proper honey production and handling practises.

5.2 Materials and methods

5.2.1 Honey sample collection

Twenty one (21) honey samples (100g each), seven from each study area, were collected during the first honey harvesting season (February and May 2015). The number of honey samples collected was determined by availability of resources. However, the samples represented a large production area since they were collected from processing plants where producers collectively process and market the honeys. The honeys were collected from beekeepers in the lowlands of West Pokot, Baringo and Kitui Counties, Kenya (Figure 5.1). These areas are categorized as arid and semi-arid areas and rain-fed agriculture is unreliable thus, beekeeping is largely practised and a viable venture (Government of West Pokot, 2013; Government of Baringo, 2013; Government of Kitui, 2013). Honey production in the three study areas is an important source of livelihood for the community (ICIPE, 2009; Gloor, 2011; Berem, 2015). Vegetation in the three areas where the honey samples were collected is mainly natural forests comprising shrubs and woody or thorny trees, with Acacia flora dominating the regions (Beentje, 1994; Maundu & Tengnas, 2005).

After collection, the 21 honey samples were placed in a fresh, sterile, closely tightened food grade container. Containers with the honey samples were labelled with a number, place and date of collection for easy identification. The samples were stored at 25°C and kept away from direct sunlight and moisture in order to ensure that their quality was maintained. Analysis of the honey samples was conducted at Quality Services International (QSI) GmbH in Bremen, Germany.

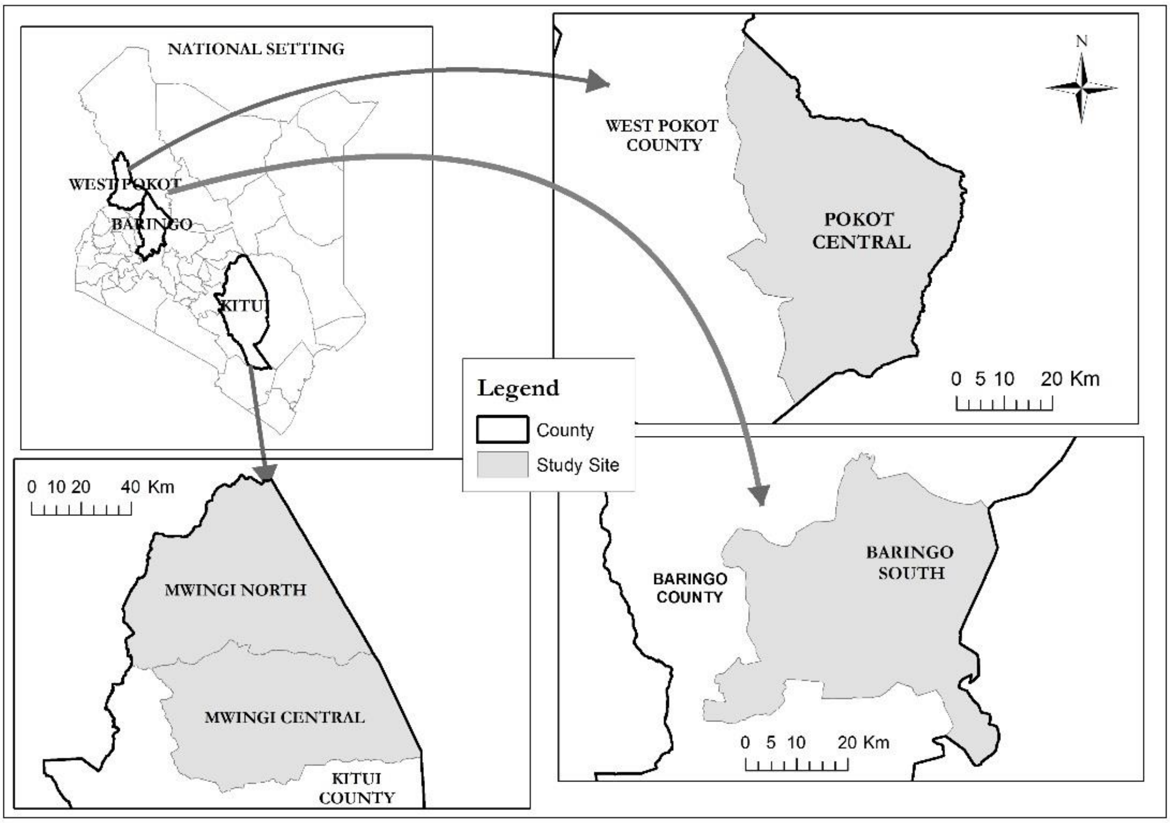

Figure 5.1: A Map showing areas where honey samples were obtained

5.2.2 Melissopalynological analysis

Identification of pollen types in honey samples and determination of their relative frequencies of pollen grains in each sample was done using the methods described by Louveaux et al. (1970), Louveaux et al. (1978), Feás et al. (2010), and Yang et al. (2012). Relative frequencies of identified pollen types were determined through grouping and counting pollen grains in the prepared sediment of each honey sample (Von der Ohe et al., 2004) using a microscope. Pollen analysis was used in determining floral sources and in establishing geographical origin of honeys. Confirmation of geographical origin of honey was based on the identified pollen spectrum being consistent with the flora of the particular region from where honey samples were obtained (Louveaux et al., 1978; Bogdanov & Martin, 2002; Jones & Bryant, 2014).

5.2.3 Physicochemical analysis

Physicochemical analysis including measurement of moisture content, HMF, diastase activity, free acidity and electrical conductivity in each honey sample was done based on methods described by the Association of the Official Analytical Chemists (AOAC, 1990) and harmonized methods of the International Honey Commission (Bogdanov et al., 1997; Bogdanov et al., 1999).

To ascertain if the physico-chemical parameter values obtained from the analysed honey samples were of acceptable quality as required in different markets, the parameter values were compared with the recommended levels as specified in the East African Standards (EAS) for honey (EAS 36:2000), Codex Alimentarius honey standards (CODEX STAN 12-1981) and the European Union (EU) directive for honey (2001/110/EC) (Appendix 1).

5.2.4 Statistical analysis

Means and standard deviation of the physicochemical property values for the honey samples collected in each study area were calculated. Analysis of Variance (ANOVA) was used to determine the differences in physicochemical properties parameters values of honeys obtained from the three study areas. Relative frequencies of each pollen type in each honey sample were calculated and expressed as percentages based on total number of pollen grains counted. Identified pollen types were categorized as predominant (>45%); secondary (16-

45%); important minor; (3-15%) and minor (<3%) (Louveaux et al., 1970; Louveaux et al., 1978; Jones & Bryant, 2014).

5.3 Results and discussion

5.3.1 Pollen composition

Results of melissopalynological analysis are summarised in Table 5.1. A total of 29 pollen types were identified from the 21 honey samples analysed. Based on the methods used in identification of pollen types, 11 were identified to family level, 17 to genus level and only one to species level. Overall, 21 pollen types were recorded in honey samples from West Pokot and Kitui and 20 pollen types in samples of Baringo honeys.

Table 5.1: Percentages of pollen types in West Pokot, Baringo and Kitui honey

Pollen type	**Pollen type percentage (%)**																				
	West Pokot **(n=7)**							Baringo **(n=7)**							Kitui **(n=7)**						
Honey Sample	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***	***14***	***15***	***16***	***17***	***18***	***19***	***20***	***21***
Acacia spp.	50	54	58	48	37	42	9	37	25	8	11	13	10	20	15	4	17	11	17	15	4
Euphorbiaceae	7	10	17	12	12	14	2	m	m	m	m	m	m	m	18	18	m	16	19	m	m
Combretaceae	m	7	5	7	9	10	18	m	21	35	26	35	27	m	17	23	6	20	26	11	32
Brachystegia spp.	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
Bidens spp.	16	20	12	16	10	6	19	13	m	7	3	m	8	4		20	3	m	8	3	36
Capparaceae	3	m	m	m	m	m	m	m	12	20	30	20	11	2	11	10	m	m		m	m
Poaceae	m	m	m	m	m	m		m	m	m	m	m	m	m	m	17		m	m	m	m
Caesalpinia spp.	m	m	m	m	m	m	m	m	m	m	m	m	m		m	6	m	m	3	m	m
Sapindaceae	m	m	3	4	m	m	m	m	m				m	m	m	m		m	m	m	m
Leucaena spp.	m	m	m	m	m	m	m	m	m	m	m	m	m	m				m	m	m	m
Julbernardia spp.	m	m	m	m	m	m	m	m	m	m	m	m	m	m							
Acanthaceae								m	m	13	18	11	m	18	9	m	m	m	m	m	m
Schefflera spp. (Ivy tree)	4	m	m	m	m	m	7	3	5	m	m	m									
Chenopodium spp. (black weed)	m	m	m	m	m	m	m	m	m	m	m	m									
Onobrychis spp.	m	m	m	m	m	m	m	m	m												
Triumfetta spp.					m	m	m	m	m	m	m	m								m	7

Pollen type	**Pollen type percentage (%)**																				
	West Pokot **(n=7)**							Baringo **(n=7)**							Kitui **(n=7)**						
Honey Sample	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***	***14***	***15***	***16***	***17***	***18***	***19***	***20***	***21***
Apiaceae															m	m	m	4	4	m	m
Brassicaceae (crucifers)			m	m	m	m	m	m													
Olea spp.															m		23	m		m	m
Coffea spp.					m	m												18		13	m
Vernonia spp.					m	m	m	m													
Taraxacum spp.																		m	m	m	m
Zea mays																		m	m	m	m
Rhizophoraceae													29	42						23	
Ebenaceae							35										16				
Prosopis spp.								21	24												
Myrtaceae							m														m
Eucalyptus spp.							m														
Trifolium spp. (clover types)																					m

Predominant (>45%), secondary pollen (16-45%), important minor pollen (3-15%) and minor pollen (m) (<3%)

The results of this study showed that naturally occurring plants e.g. *Acacia spp.* and *Brachystegia spp.* as well as introduced/cultivated plants e.g. *Trifolium spp., Bidens spp., Eucalyptus spp., Prosopis spp.*, Euphorbiaceae, Combretaceae, Brassicaceae, *Zea mays* and Coffea *spp.* are floral sources for bees. These observation agrees with findings of other plant-pollinator interaction studies where observations of bees foraging on multiple plant species from both natural and agricultural ecosystems were made (Waser et al., 1996; Gikungu, 2006) and different pollen spectrum observed in honeys (Aina et al., 2015; Gok et al., 2015).

Four honey samples (1-4) from West Pokot having *Acacia spp*. as a predominant pollen type could be classified as unifloral honeys. Similar findings have earlier been found by Gloor (2011). The predominance of Acacia pollen type in the four honeys is likely attributed to honey beesô preference for *Acacia spp.,* the floral rewards by the preferred plant (Gikungu, 2006) as well as its massive flowering in West Pokot during the study season. *Acacia spp*. has numerous flowers per inflorescence (Stone et al., 2003), which provide great floral reward (pollen/nectar) to its visitors. The results showed that other 17 samples had a combination of secondary pollen, important minor pollen or minor pollen and therefore could be classified as multifloral honeys. This result could be attributed to honey bee preference for specific flora based on its availability in a specific region, as well as limited/less frequency of honey bee visits to flowering plant species in a particular region (Aina et al., 2015).

Some pollen types were recorded in all or most honey samples obtained from West Pokot, Baringo and Kitui despite the differences in geographical location of the three areas. This is an indication of similarities of vegetation types in the study areas based on agro-ecological zonation. The common pollen types included; *Acacia spp.,* Euphorbiaceae, Combretaceae, *Brachystegia spp., Bidens spp.,* Capparaceae, Poaceae (grasses), *Caesalpinia spp.,* Sapindaceae, *Leucaena spp*. and *Triumfetta spp.*. Four of these pollen types *(Acacia spp.,* Euphorbiaceae, Combretaceae and *Brachystegia spp.)* were recorded in all honey samples in varying quantities. Some pollen types were observed in honey samples obtained from specific areas and they included; *Prosopis spp*. in Baringo, *Eucalyptus spp.* in West Pokot, *Olea spp.*, Apiceae, *Taraxacum spp., Zea mays* and *Trifolium spp.* in Kitui. Representation of specific and common pollen types in the honey samples analysed is attributed to distribution and diversity of plants in particular area depending on the ecological/eco-climatic zone of an area (Beentje, 1994; Maundu & Tengnas, 2005).

Presence of pollen types of cultivated plants i.e. *Coffea spp.* and *Zea mays* in the honey samples implied that agroecosystems provide bee floral sources. Plants from such ecosystems can be useful in supporting bees especially when the natural flowering plants are not blooming. Similar observations were noted in studies conducted by Gikungu (2006) and Karanja et al. (2010). More so, some cultivated crops which are specific in particular regions have been noted to yield unique honeys in EU whose attributes have facilitated its protection with GI. Therefore, management of agroecosystem in the study areas can support survival of bees and yield honey with characteristics which can enhance their GI potential and sustainable production.

The results further showed pollen types of vegetation present in the three study areas, including those dominant in arid and semi-arid areas (Ngethe, 1985; Gichora, 2005; Gloor, 2011; Wanzala et al., 2016). These results confirm the geographical origin of the honeys, differences in honey pollen composition across regions and the natural link to honey characteristics, thus this can form a basis for protection of the three honeys with GI.

5.3.2 Physicochemical properties

The physiochemical parameter values of the honey samples from the three study areas, their mean and standard deviation are summarized in Table 5.2. Mean values of physicochemical parameters are compared across the three study areas. Details of physicochemical values of the analysed honey samples are provided in Appendix 2.

The moisture content of honey samples from the three study areas ranged from 14.20 to 17.40 %, with an overall mean of 16.34±0.88 %. These values were below the maximum limit of 22% as recommended by EAS and 20% as recommended by Codex and EU directive for honey. The results indicated that the honey producers in the study areas harvested ripe and capped honey and that they stored honeys under suitable condition where moisture could not be absorbed. There was no significant difference in moisture content percentage between honey samples obtained from the three areas. However, moisture content of honey samples from Kitui was higher than that of honeys from West Pokot and Baringo. Variation in moisture content was likely attributed to botanical origin of the honeys (Yücel & Sultanoglu, 2013) and humidity in the areas.

Hydroxymethylfurfural (HMF) of the honey samples analyzed ranged between 11.00-120.00 mg/kg. The HMF value of one honey sample which had 120 mg/kg was marked as an outlier, thus, was not used in calculation of Mean±SE as well as statistical differences for the honey parameter values. The high HMF value of this honey sample exceeded the maximum limit of HMF value as specified by EAS, Codex standard and EU directive for honey. This result suggest faulty processing and storage conditions. The overall HMF Mean±SE for the honey samples was 23.28±9.10 mg/kg and there was no significant difference in HMF content between the three study areas.

Diastase activity values of the honeys analysed ranged between 2.70-17.50 Schade units (10.67±3.34 Schade units). Although there was no significant difference in diastase activity value between honeys from the three areas, honeys obtained from Kitui had a lower mean diastase activity as compared to the other two areas (Table 5.2). Diastase activity values of three honey samples from Kitui (sample 17, 20 and 21) were below the minimum limit of 8 Schade units as specified by Codex and EU directive for honey, while only one honey sample (21) was below the minimum limit of 3 Schade units as specified by EAS. This explains the lower diastase activity mean for honey samples from Kitui. These results indicate that the three honey samples had low enzyme content resulting from either overheating of the honey beyond the recommended temperature of 40^{o}C or storing them under high temperatures beyond 25^{o}C (Bogdanov, 2002).

Free acidity of the honeys ranged between 17.00-29.00 meq/kg (22.95±4.33 meq/kg) and these values were below the maximum limit of 40 meq/kg as stipulated by EAS and 50 meq/kg as specified by Codex and EU directive for honey. These results indicated the honeys were ripe during harvesting and they had low water content thus absence of fermentation (Gomes et al., 2010). Free acidity values of honey samples obtained from West Pokot were significantly lower than the values of honeys from Baringo and Kitui and this could be attributed to differences in sugar concentration of the nectar (Ruiz-Argueso and Rodriquez-Navarra, 1973) based on flower types. This is associated with variation of floral sources between the three areas. Similar results have been observed by Sahinler & Gul (2004), Williams et al. (2009) and Babarinde et al. (2011).

Table 5.2: Means of composition of 21 honey samples obtained from West Pokot, Baringo and Kitui

Study Area	Moisture content (%)	HMF (mg/kg)	Diastase activity (Schade units)	Free acidity (meq/kg)	Electrical conductivity (mS/cm)
West Pokot	15.94±0.42 a	26.11±8.52 a	10.83±3.23 a	18.29±1.04 a	0.30±0.06 a
Baringo	16.16±1.29 a	22.67±7.15 a	11.39±1.63 a	26.93±2.70 b	0.49±0.07 b
Kitui	16.93±0.30 a	20.68±12.10 a	9.79±4.74 a	23.64±3.12 b	0.42±0.06 b
Bonferroni p-value	***0.081***	***0.575***	***0.683***	***0.004***	***0.000***

Means with same letters within a column are not significantly different (P<0.05)

Electrical conductivity of the honey samples ranged between 0.26-0.59 mS/cm (0.40±0.10 mS/cm). These values were below the maximum value of 0.8 mS/cm as specified in Codex and EC directive. These results indicated that the honeys were either blossom honeys or blends of blossom and honey dew honeys (Bogdanov et al., 1999; Chefrour et al., 2009; Belay et al., 2013), an indication that honey is not adulterated. EAS does not specify the required level of electrical conductivity in honeys. Electrical conductivity values of honey samples derived from Baringo and Kitui were significantly higher as compared to electrical conductivity values of those obtained from West Pokot. These results can be attributed to high acidity values of Baringo and Kitui honeys (Bogdanov, 2002; Kirs et al., 2011) or the variation in geographical origin/floral sources of the honeys.

In summary, 18 honey samples (all samples from West Pokot and Baringo and 4 from Kitui) out of 21 samples analysed had all physicochemical parameter values within the acceptable limits as stipulated in the EAS, Codex and the EU directive for honey. The 18 honeys were classified as table honeys (i.e. honeys whose quality is fit for direct human consumption). Results of the 18 samples indicated that producers and processors of these honeys take appropriate measures to safeguard its quality. These measures include harvesting mature/ripe honey, use of appropriate temperatures while processing honeys and storing honeys under favourable conditions (i.e. areas free from moisture and high temperatures. Results of the 18 honey samples indicated that the honeys were acceptable and could gain reputation and access market in local, regional and international markets, including the EU. Honey from Tanzania and Ghana have met local and international standards and this has enhanced their access to EU market (SCF & Traidcraft, 2007; Akpabli-Tsigbe, 2015).

Results of the other 3 honey samples from Kitui, with unacceptable HMF and diastase activity levels, were classified as industrial honeys (i.e. honey of lower quality, thus suitable for industrial use). This was an indication that some producers/processors did not take deliberate measures when processing/handling/storing honey. The low quality of the honeys can negatively influence their authentication and reputation, thereby affecting their demand and market scope. Production of low quality honeys in Kitui could be as a result of limited capacity and lack of implementation of regulations governing honey production, processing, packaging and storage. Also, findings from a study conducted at a honey processing and marketing centre in Kitui i.e. Mwingi honey market place, where the three honey samples were collected revealed that honeys of uncertain quality was sourced from brokers and other individual producers outside the production region. This sourcing was due to low production of honeys by the authorized producers within the study region (Musinguzi, 2016). Since results of this study showed that some of the honey samples from Kitui were of good quality, it could be likely that the problem in the low quality honeys was as a result of poor processing, handling or storage by producers and brokers where the honeys were sourced by the processing centre. Similar findings were noted for some honeys produced through traditional methods and those sold in retail market (Muli et al., 2007; Ng´ang´a et al., 2013).

Proper post- harvest handling and traceability of the low quality honey is needed to facilitate its GI labelling.

5.4 Conclusion

Results of this study showed that honeys from West Pokot, Baringo and Kitui are of good quality and they generally meet the standards for local, regional international market, particularly EU. Melissopalynological analysis showed differences of the pollen spectrum between honeys from the different study areas based on geographical zones. Pollen types represented in the honeys were typical to vegetation of the study areas. Compliance of the honeys to the existing honey standards as well as the natural link to honey quality can form a basis for selling the product in niche market and in its protection with GI. To improve the low quality honeys and maintain the ones with good quality as well as enhance their link to natural and human factors, there is need for development of the honey value chain. Activities/initiatives which can facilitate this include; training of honey producers and processors on best production practices and conservation of bee flora, quality assurance of honeys at the local level, establishment of local infrastructure (e.g. honey processing and marketing centres and road). To improve the quality of Kitui honey, development of a monitoring plan would be necessary. This tool would enhance honey traceability, control of the honey value chain. Also, capacity building of producers and processors on appropriate production, handling, processing and storage techniques as well as establishment of collection centres and other infrastructure e.g. roads, would be needed. Development and implementation of other institutions to support honey production and marketing is also needed.

CHAPTER 6 : DETERMINING THE DIVERSITY AND FREQUENCY OF VISITORS OF *Acacia brevispica* AND EXTENT OF POLLINATION BY HONEY BEES IN KITUI COUNTY [4]

Abstract

Acacia species dominate arid and semi-arid areas across the world and are an important source of livelihood supporting activities. This is also the case in Kenya, where the Acacia woodlands are under pressure, partly due to the extractive activities that generate household income, such as collection of fuelwood, building poles, charcoal burning and livestock fodder. There is an apparent dilemma between the extractive and non-extractive use of the Acacia woodlands, and a need to develop income generating activities that also conserve and support the natural basis. Honey production is a widespread activity in Kenyan arid and semi-arid areas where Acacia species dominate, but information on pollination of the species in relation to livelihood sustenance and natural resource conservation is scarce. Therefore, this study investigated to what extent honey bees (*Apis mellifera*) visit and pollinate *Acacia brevispica* in Kitui County, Kenya. The study also assessed the occurrence of Acacia pollen types in honeys produced within the study area. Results showed that honey bees were the most numerous flower visitor and pollinator of *A. brevispica*, while Acacia pollen was the predominant pollen type in the sampled honeys. This shows that *A. brevispica* benefit from pollination by honey bees in exchange for pollen and nectar which they use in production of honey, which is a source of income for local households. Understanding this mutual relationship between honey bees and *A. brevispica* is key for survival of both in that, honey bees need plants for production of honey and habitat while plants require bees to provide

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pollination service. Honey bees are equally important in pollination of agricultural crops and are therefore the interaction can ensure food security, community livelihoods and biodiversity conservation.

Key Words: Acacia, Conservation, Honey bee, Honey Production, Livelihoods, Pollination, Kitui County

6.1 Introduction

Plant-pollinator interactions contribute to biological diversity, maintenance of ecosystem functions, agricultural productivity, food security and livelihoods (Potts et al., 2003; Potts et al., 2010). Unfortunately, this interaction is threatened by human induced factors, such as urbanization (Potts et al., 2010), intensification of agricultural land use, intensive use of chemicals, and the introduction of genetically modified and alien species (Krebs et al., 1999; Richards, 2001; Ricketts, 2004; Tscharntke et al., 2005). Habitat loss and fragmentation may result in reduced pollinator diversity (Vazquez & Simberloff, 2002) and lower number of pollinators (Lennartsson, 2002; Potts et al., 2003), pollination deficits and low seed output due to pollen limitation (Jennersten, 1988) all of which negatively affect plant populations as well as agricultural production (Foley et al., 2005). However, human activities may also have a positive role in the plant-pollinator interaction, such as pollination services of managed bees in natural environments (Chamberlain & Schlising, 2008).

Mutual interactions between plants and pollinators can be complex and is associated with a number of factors. For instance, visitation rates of a plant by pollinators can be influenced by factors, such as climatic conditions, pollinator type and characteristics, and flower morphology and physiology (Conner & Rush, 1996; Ushimaru et al., 2007). Previous studies have shown that there is a relationship between pollination limitation, visitation rate and abundance of pollinators (Larson & Barrett, 1999; Herrera, 2000). Pollinators can be specialists, i.e. pollinators visiting one or specific plant species, but generalists that visit and pollinate many and diverse plant species are more common (Johnson & Steiner, 2000; Ghazoul, 2006). The honey bee is an example of a generalist pollinator (Olesen & Jordano, 2002; .Aslan et al., 2016).

Forests surrounding agricultural farms have been found to have a positive impact on abundance and diversity of pollinators (Ricketts, 2004; Klein et al., 2008; Karanja et al., 2010) and survival of the plants (Kolehmainen & Mutikainen, 2006) as well as the survival of the plants (Kolehmainen & Mutikainen, 2006). This has also been indicated in studies conducted in Kenya (Karanja et al., 2010). Forests provide important foraging, nesting, roosting and mating sites for most pollinators (Roubik, 1995; Ricketts, 2004). Absence or change in natural habitats/forests interrupts plant-pollinator relationships (Richards, 2001; Winfree et al., 2009; Goulson et al., 2015) and may lead to depressed agricultural output and loss of livelihoods (Karanja et al., 2010). Besides creating a habitat for pollinators, forested areas also play an important role for many rural communities, especially in areas with widespread poverty and subsistence agriculture where collection of non-timber forest products is undertaken as an important livelihood activity (Wunder et al., 2014). Such activities are undertaken in dry forests and woodlands in Kenya where trees in the natural environment have a supporting role for rural livelihoods. However, these areas may come under pressure from the very same activities (Barrow & Mlenge, 2003; Kiage et al., 2007; Mureithi et al., 2016).

As such, maintenance of pollination services and pollinator populations is a significant task, not only geared towards conservation of natural resources (Stone et al., 2003), but also for the sake of maintaining or enhancing agricultural productivity, food security and rural livelihoods. In order to understand the importance of pollination services for the regeneration and production of different plant species, natural and managed, information on the flower visitors and their importance for seed or fruit set is required (Stone et al., 2003; Martins, 2008).

Acacias spp. are thorny plant species in the Fabaceae family, which thrive well in tropical and subtropical habitats, particularly in arid and semi-arid regions (Ross, 1981; Stone et al., 2003; Marshall et al., 2012). The genera includes woody shrubs and trees, which can translate to bushlands and forests (Ross & Gordon-Gray, 1966). The growth form of the plant species are attributed to climatic and edaphic conditions in the growing area. Acacia plants are self-incompatible and exhibit little or no self-fertilization (Muona et al., 1991) and rely on insects for pollination (Tybirk, 1993; Tandon & Shivanna, 2001; Stone et al., 2003). Floral rewards of Acacia plants to their visitors are nectar and pollen (Stone et al., 1998; Stone et al., 2003;), and they are important food resources to a variety of insects (Martins, 2014; Adgaba et al., 2017). Bees, wasps, flies and butterflies have been documented as flower visitors of most *Acacia spp*. (Tybirk, 1993; Stone et al., 2003).

Acacia trees also constitute an important wild resource for rural communities in dry zone areas across the world (Moncur et al., 1995). The trees are used for medicine (Ibrahim & Ibrahim, 1998; Wanzala et al., 2016) livestock fodder (Nyambati et al., 2006), timber, poles, charcoal and fuel wood (Stone et al., 1998; Stone et al., 2003; Dlamini & Geldenhuys, 2009). Acacia plants also supports life forms as well as provide pollen and nectar for production of honey (Martins, 2014). This is the case in the Arid and Semi-arid Lands (ASAL) of Kenya, where a number of *Acacia spp*. are important sources for livelihood. In Kitui County, Kenya, Acacia woodlands are known as sources of nectar and pollen for bees which enhance production of a unique quality honey, which has a high demand and good reputation in the region of production as well as at a national level (Egelyng et al., 2017). Honey production in the area forms an important source of livelihoods for the local communities where several beekeeping groups have been established.

Acacia woodlands in Kitui have been under pressure, due to extractive activities which are undertaken by local households for income generation (ICIPE, 2009). These activities include collection of fuel-wood, building poles, charcoal burning, and livestock fodder. The Ministry of Agriculture in Kitui County, Kenya has emphasized the need to develop non-extractive and woodland 'friendly' income generating activities. Therefore, the local communities in the area have been supported in undertaking honey production activities for income generation. However, little is known on the relationship between pollination of *Acacia spp.* in Kitui and livelihood sustenance as well as conservation of natural resources. Furthermore, information on the utilization of *Acacia spp.* and other surrounding vegetation by honey bees, in production of honey has not been documented. Understanding the link between visitation and pollination of *Acacia spp.* by honey bees, and the production of good quality honey can increase the awareness of the double role of beekeeping for income generation and pollination services to a woodland species under pressure. Therefore, this study investigated the diversity and frequency of visitors of *Acacia brevispica* and extent of pollination by honey bees in Kitui County. This plant is known for production of quality honey and it was the key flowering plant species in Kitui County during the study season, thus selected for this study.

6.2 Methodology

6.2.1 Study area

This study was carried out between January-May, 2016 in Kitui, Kenya, which falls within the semi-arid zone in Kenya (Figure 6.1). The County is located between latitudes 0^0 10 and 3^0 0 South and longitudes 37^0 50 and 39^0 0 East (Government of Kitui, 2013). Kitui is home to the Mumoni tropical forest reserve, which is adjacent to communal and private lands. Beekeepers place their hives in the forest, communal and private lands. Small scale agriculture, pastoralism, and beekeeping are the main sources of livelihoods in the study area (ICIPE, 2009; Ayuya et al., 2015).

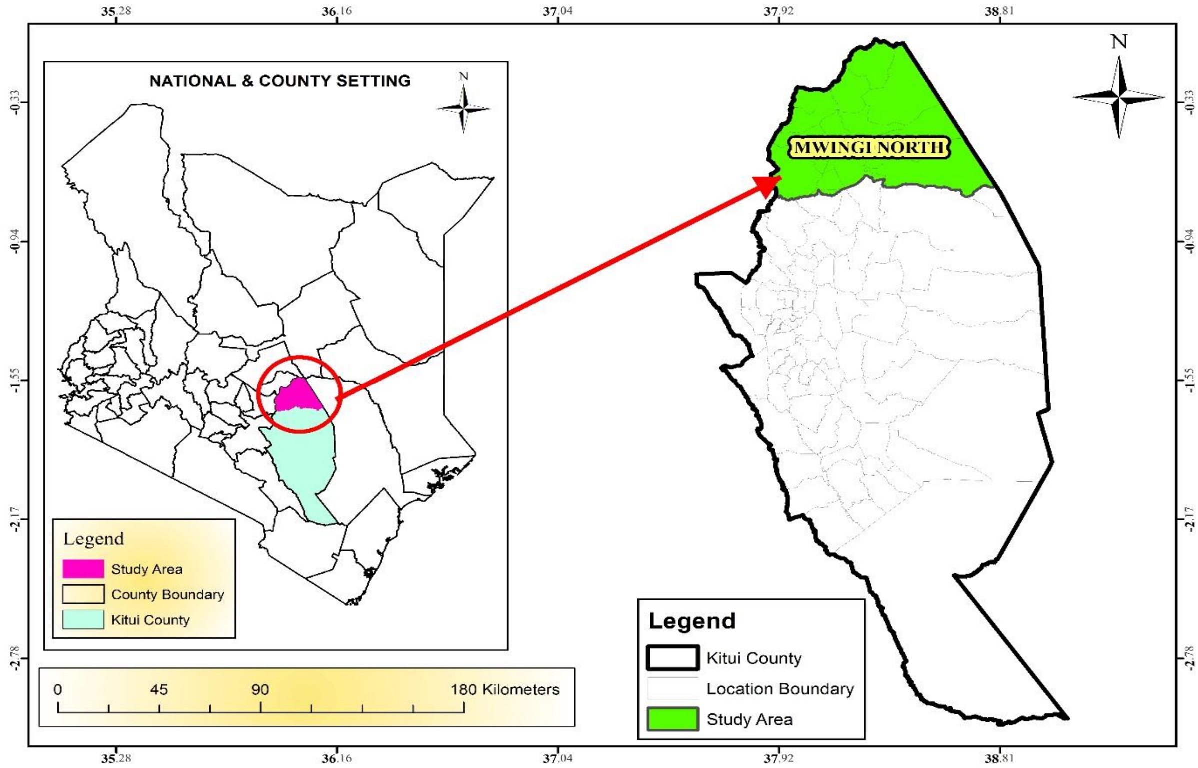

Figure 6.1: A Map of Kenya showing the study area and sampling site

Acacia and *Commiphora spp.* are the most dominant and widespread vegetation types in the study area (ICIPE, 2009). Various Acacia plants flower at different times during the rainy season. During the studied season, *A. brevispica* was the only flowering *Acacia* spp. *A. brevispica* was also the dominant flowering plant with conspicuous white flowers that could be observed throughout the study area. A smaller part of the study area was covered with small-scale agricultural farms where crops, such as mangoes, cassava, sorghum, millet, beans, and maize were grown. Temperatures in the study area range between 14^0C and 34^0C, with September being the hottest month when most bee flora dries up. The area experiences frequent droughts due to erratic and unreliable rainfall, ranging between 500-700mm annually.

6.2.2 Data collection

6.2.2.1 Abundance and diversity of flower visitors and pollinators of *Acacia brevispica*

To determine diversity, abundance of flower visitors, their frequency, pollinators of *A. brevispica* and seed set, on-farm experiments were carried and this was guided by study design used in pollination observations on some plants (Martins, 2008; Karanja et al., 2010; Hansted et al., 2012). Four farms (2 ha each) located 2 km from the Mumoni forest in Mwingi North, Kitui were selected for this study and the distance between the farms was 1 km. Each of the four farms had similar plant species belonging to different families, including Acacia trees. In each farm, 14 Acacia trees were selected based on their form and structure. In each of the tree, five branches with similar form, size, and shape were selected in the middle of the crown for observation. Each branch had an average of five flowers. Pollinator exclusion bags (nylon mesh of 10μm hole size) were placed around the selected branches when flowers were at bud stage to prevent unobserved flower visitors (Martins, 2008; Martins & Johnson, 2009; Hansted et al., 2012). Flower visitor observations were carried out between 8 a.m. to 4 p.m. on sunny days when flower visitors were active. The exclusion bags were opened once and each flower was observed until it had been visited by a single visitor. Flower visitors were observed for a maximum of 10 minutes once a day after which re-bagging was done to ensure that no other pollinator visited the flowers. *A. brevispica* has a short flowering cycle, thus observation of flower visitors were done for two days in each farm. Flower visitors, their abundance and behaviour on the flowers were recorded. Visited flowers were marked using a ribbon tape and numbered differently for easy monitoring. The pollinator exclusion bags were removed after fading of the visited and bagged flowers. The mature pods on the marked branches were harvested, opened and the number of seeds counted. To investigate if *A. brevispica* would set seed after self-pollination, 20 branches from the trees were selected and bagged for observation of flower visitors. Additional 20 branches were marked and left uncovered to allow for open pollination. Selection of these branches for the experiment was based on previous studies (Martins, 2008; Hansted et al., 2012). Seed set (the proportion of flowers that developed seeds) was calculated as the number of seeds counted/potential ovules.

6.2.2.2 Collection of honey samples for pollen analysis

To assess the occurrence of Acacia pollen in honey produced within the study area, eight unprocessed honey samples were collected from hives placed in areas surrounding the four test farms. The eight honey samples were harvested and collected during the study season. Each sample was placed in a clean and closely tight container to avoid contamination. Containers with the honey samples were labelled and stored under room temperature (25°C).

Pollen analysis was carried out in Palynology section at the National Museums of Kenya. The analysis was executed based on methods of melissopalynology described by Louveaux et al. (1978) &Von Der Ohe et al. (2004). Pollen grains were extracted from collected honey samples and identified using a collection of reference pollen slides and photographic atlas. Pollen types found in the honey were recorded and occurrence percentages in each honey sample were calculated. All of the honey samples were analysed during the same time period to ensure uniform conditions and comparability.

6.3 Results

6.3.1 Flower visitors of *A. brevispica* and seed set

Flowers of *A. brevispica* were visited by different insect groups belonging to three orders; Hymenoptera (bees and wasps), Diptera (flies), and Lepidoptera (butterflies) (Table 6.1). Bees were the most diverse groups of insects visiting *A. brevispica* (Table 6.1), with honey bees being the most frequent visitors. Aggression of honey bees was observed on occasions where other visitors made an effort to land on flowers in which honey bees were foraging.

Table 6.1: Composition of flower visitors and abundance

		Number of visitors on observed flowers				
Visitor/Study Site	**Insect group**	**Farm 1**	**Farm 2**	**Farm 3**	**Farm 4**	**Total number of visits on flowers**
Apis mellifera	Honey bee	109	126	148	159	**542**
Lipotriches spp.	Bee			8		**8**
Lasioglossum spp.	Bee		11			**11**
Braunsapis spp.	Bee	1	10			**11**
Belenois aurota	Butterfly	16	31	9	9	**65**
Polistes spp.	Wasp	1				**1**
Calliphora spp.	Fly	1	6			**7**
Syrphus spp.	Fly			5		**5**

Seed set in *A. brevispica* was only recorded in the flowers visited by honey bees and those left for open pollination throughout the flowering period. No seed set was found in flowers excluded from visitors, or flowers visited by other insects, such as solitary bees (i.e. *Lipotriches spp*., *Lasioglossum spp*. and *Braunsapis spp*.), butterflies, wasps, and flies. On average, flowers visited by honey bees only had a seed set of 33.9% (n= 280), while flowers left for open pollination, and thus possibly visited by any local pollinator had a 56.0% (n=20) seed set (Table 6.2).

Table 6.2: Seed set (%) for *A. brevispica* flowers exposed to different visitors (open pollinated) and those visited once by honey bees

	Seed set (%)	
Site	**Flowers pollinated by honey bees**	**Flowers open to other pollinators**
Farm 1	29.56	50.47
Farm 2	34.66	63.28
Farm 3	30.60	49.56
Farm 4	40.83	60.75
Mean	**33.91 (±0.33)**	**56.01 (±0.19)**

6.3.2 Pollen types found in honey samples

A total of 22 pollen types, belonging to 14 plant families were observed in the honey 8 samples collected during on-farm experiment. Of these, 21 were identified to genus level and only one to species level (Table 6.3). Of the pollen type identified, two were from agricultural crops, namely Sorghum and *Zea mays*. Acacia pollen was the predominant pollen type (>45%) in all of the honey samples, thus the most important floral resource for honey bees in this study. The Acacia pollen were certainly from *A. brevispica* since it was the only flowering *Acacia spp.* in the study area during the studied season. Other pollen types were represented as secondary pollen (16-45%), important minor pollen (3-15%), and minor pollen (<3%) (Louveaux et al., 1978; Jones & Bryant, 2014).

Table 6.3: Pollen types found in the honey collected from the study site

Pollen Type	Family	Pollen Type Percentage							
		HS1	HS2	HS3	HS4	HS5	HS6	HS7	HS8
Acacia spp.	Fabaceae	64	62	48	69	55	65	53	46
Justicia spp.	Acanthaceae	1		5	1	3		2	3
Leucas spp.	Lamiaceae	10	2		2	6	4	3	3
Ocimum spp.	Lamiaceae	17		13	10	5	8	4	7
Maesa spp.	Myrsinaceae	1		5		6		1	2
Sorghum spp.	Poaceae		2					1	
Cyphostemma spp.	Vitaceae	1							1
Euphorbia spp.	Euphorbiaceae	1	6	4	6	10	1	3	4
Allophylus spp.	Sapindaceae	1						1	1
Vernonia spp.	Asteraceae	3	18	10	2	3	8	10	7
Ageratum spp.	Asteraceae		1					1	
Solanum spp.	Solanaceae		2						1
Aspilia spp.	Asteraceae		4	10				3	5
Cucumis spp.	Cucurbitaceae			5		3	3	2	
Leonotis spp.	Lamiaceae				5			4	2
Ipomoea spp.	Convolvulaceae				1	3	2	2	3
Maerua spp.	Capparaceae				1				
Ricinus spp.	Euphorbiaceae					5	2		2
Commelina spp.	Commelinaceae						2	1	
Acalypha spp.	Euphorbiaceae						1	2	1
Zea mays	Poaceae	1			2				2
Bidens spp.	Asteraceae		2				4	3	

Key: HS= Honey Sample

6.4 Discussion

Honey bees were the most abundant insects visiting *A. brevispica*. Similar observations were made in other *Acacia* visitation studies in India (Tandon & Shivanna, 2001); Mexico (Raine et al., 2002; Raine et al., 2007) and Hawaii (Aslan et al., 2016). The abundance of honey bees visiting A. *brevispica* in Kitui was attributed to the presence of colonized bee hives, which results from beekeeping activities within the study area as well as the presence of wild honey bees in tree hollows within the natural environment of the study site. Honey bees also have a good communication system (waggle dance) and they take advantage of flowers with promising floral rewards which can be foraged on with minimal cost (time and energy) (Couvillon et al., 2012).

The results of this study also show that visitation of *A. brevispica* by honey bees contributed to the reproduction of the plant. Recorded seed set from flowers visited by honey bees, unlike those visited by other insects, was attributed to aggression of honey bees during foraging (Martins, 2004; Vergara & Badano, 2009; Badano & Vergara, 2011), where honey bees were observed chasing away other visitors who tried to forage on the flowers of *A. brevispica*. Reproduction success was also attributed to contact of honey bees with stamens and pistil of flowers during foraging. This result concurs with findings of other studies which noted that honey bees competes with other pollinators for floral resources (Schaffer et al., 1983; Steffan-Dewenter & Tscharntke, 2000; Thomson, 2006). Furthermore, their presence in agricultural fields may decrease the diversity of other floral visitors who are likely to be efficient pollinators (Badano & Vergara, 2011). Zero seed set in flowers visited by solitary bees, butterflies, wasps and flies suggest that organisms visiting plants may not necessarily pollinate the flower, even though they collect the floral rewards (Spears, 1983; Stone et al., 2003). Higher seed set in flowers open for pollination (not bagged) may be as a result of the flowers being exposed to more visits or by diverse visitors. Previous studies note that visitation frequency of plants by pollinators (Benachour & Louadi, 2013; Couvillon et al., 2015; Aslan et al., 2016) and diversity of visitors (Stone et al., 2003; Winfree et al., 2009) enhance successful pollination. Lack of seed set on flowers that were excluded from pollinators implies that *A. brevispica* requires pollination for reproductive success (Harsh, 2000).

Occurrence of Acacia pollen types in the honeys collected from the study area confirm that Acacia plants are an important floral resource for bees, as also noted by Martins (2014). Results also indicated that honey bees have the ability to forage on a great diversity of flowering plants, including agricultural crops (Roubik, 1992; Waser et al., 1996; Villanueva-G & Roubik, 2004; Martins, 2004) for their survival and reproduction (Roubik, 1992). Higher pollen percentages of Acacia pollen types, as compared to other pollen types (Table 6.3), could be attributed to honey bees preferences for *A. brevispica* as well as their availability and floral rewards offered by the plants (Roubik, 1993; Fidalgo & Kleinert, 2010).

The results of this study represent an opportunity to link pollination of Acacia woodlands, in this case *A. brevispica*, to both an income generating activity as well as to the contribution of the regeneration of the woodlands through pollination services by the honey bees. Mutual interaction between honey bees and *A. brevispica* is key for survival of both in that, honey bees need plants for production of honey and habitat while plants require bees to provide pollination service. This service contributes to food security, biodiversity and environmental productivity. Given the current focus on sustainable development of arid and semi-arid areas by the GoK (2010), benefits derived from interactions between honey bees and Acacia woodlands could form an example of the necessity for sustainable utilization and conservation of dry land forests ecosystems in Kenya.

All of the honeys sampled were classified as unifloral honey (i.e. Acacia honey), based on the predominant Acacia pollen type. Acacia honey from Kitui has a high reputation and demand as well as price premium in the market, which is attributed to the quality of the honey based on its link to origin (Egelyng et al., 2017). Fetching premium prices from Acacia honey can form an incentive for producers to conserve Acacia woodlands and other bee floral resources in order to enhance sustainable production. This has been the case for Oku white honey from Cameroon, which fetches premium prices based on its acidic flavour and unique white colour; characteristics which are attributed to two dominant white flower plants, namely *Nuxia congesta* and *Schefflera abyssinica,* present in the Oku forest (WIPO, 2014). To sustain production of Oku honey, producers and other actors within its production region have made efforts in enhancing regeneration and conservation of bee floral sources (WIPO, 2014). Increased benefits from honey production are likely to increase honey production activities, and to some extent, this may result in environmental pressure. There is, therefore, a need for policy support in beekeeping for honey production and pollination.

6.5 Conclusion

Findings of this study indicate that honey bees are important pollinators of a natural woody plant, *A. brevispica,* which is an important floral source in honey production. Encouraging beekeeping in the study area for honey production can lead to pollination of the woodlands, thereby facilitating conservation of bees, their food resources and other biodiversity as well as local livelihoods. Therefore, this study suggests that conservation initiatives in the study area need to incorporate sustainable beekeeping practices. The results of this study also creates an opportunity to market honeys produced in the study area using labels which indicate a link of a product to the geographical origin, such as floral sources, for the honeys. This is anticipated to enhance product premium prices, which would create incentives for natural resource conservation and sustained production.

CHAPTER 7 : DETERMINING THE FACTORS INFLUENCING COLLECTIVE ACTION AMONG PRODUCERS OF HONEY [5]

Abstract

Collective action plays a critical role in GI labelling of origin products since it enhances and maintains productœs reputation. Origin honeys protected with Denomination of Origin and Geographical Indication (GI) has added billions of Euros to European agriculture. Some African countries have potential to create additional monetary value from their origin honeys. Tapping this potential would enhance rural development while stewarding natural environment. Kenya has identified honeys with unique characteristics which are attributed to origin, thus the country can benefit from the honeys if protected with GI. However, there is low participation of honey producers in groups. Using semi-structured questionnaires, data was collected from 318 honey producers in Kitui, Baringo and West Pokot Counties, Kenya in order to assess the factors determining membership to honey groups, a proxy for collective action. From a logit regression, factors determining collective action among producer of origin honeys include; experience in beekeeping, distance from farms to the honey processing centre, education level, number of hives owned, use of modern hives, awareness on GI, production of honeys with origin linked attributes and access to information on production and value addition of honey. This paper concludes that strengthening the capacity of honey producers in Kenya through provision of information and infrastructural development is important in enhancing collective action for development of GI honeys.

Key words: Collective action, Geographical Indication, Group membership, Origin honey, West Pokot, Baringo and Kitui Counties

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[5] *Paper submitted to Alanya Academic Review Journal as: Warui, M.W., Mburu, J., Kironchi, G., & Gikungu, M. Factors influencing collective action among producers of origin honeys in Kenya—under review*

7.1 Introduction

Collective action which involves producer cooperation and collective efforts among other actors working within and /or outside a products´ geographical origin, is increasingly becoming important in GI development (Vandecandelaere et al., 2010; Blakeney et al., 2012; Bramley & Biénabe, 2013). This is because some important factors considered in protection of origin products can only be addressed at collective level. For instance producers need to work collectively with relevant actors in defining GI product, setting up and implementing production and marketing rules (Giovannucci, 2009; Blakeney et. al., 2012) as well as code of practice (Belletti & Marescoti, 2011; Belletti et al., 2012). Development and implementation of rules governing a product can enhance its collective reputation and traceability (Winfree & McCluskey, 2005) as well as management and conservation of natural resources (Larson Guerra, 2004; Baker & Eric, 2008; Marie-Vivien et al., 2014; WIPO, 2014). This can result to increased product premium prices (Moschini et al., 2008), thus enhanced producer livelihoods.

Origin honeys i.e. honeys with quality traits essentially attributed to their area of production (geographical origin), have enhanced positive economic, social and environmental development in countries where they are protected and marketed under Geographical Indication (GI). GI - a form of ´branding from below` (Mancini, 2013) identifies a product whose quality characteristics are linked to geographical origin, cultural and physical environment (landscape, people, and place) (Vandecandelaere et al., 2010). Among the factors considered in registering origin honeys with GI include product specificity and reputation, institutional environment and collective action (Coulet & Mahop, 2012; WIPO, 2014; Egelyng et al., 2017).

Producer cooperation can facilitate overall success and sustainability of origin products (Vandecandelaere et al., 2010; Bramley & Biénabe, 2013) due to benefits associated with economies of scale (Barjolle et al., 2005), access to improved agricultural technologies (Gibson et al., 2008) and infrastructure (Mwaura et al., 2012). Producers working collectively also create avenues to advocate for support and formulation of policies to address production and marketing issues (EPRC, 2012). Therefore, opportunistic behavior (e.g. fraudulent imitation) is reduced and collective decision making enhanced (Mburu & Wale, 2006). This can facilitate producer access to better and niche markets (Blakeney et al., 2012), thus addressing issues of market failures.

Some Kenyan origin honeys have been identified to have potential for GI protection (KIPI, 2009; Blakeney et al., 2012). However, the market potential of these honeys has not been fully exploited. This is associated with low production volumes and inadequate value addition of the commodity which influence its quality (Muli et al., 2007; Berem, 2015; Egelyng et al., 2017). Establishment of honey groups in production region among other initiatives has been undertaken to mitigate these problems (Gichora, 2003; ICIPE, 2009; Berem, 2015). These initiatives aim to improve the value of honeys and increase their market access, thereby enhancing development of arid and semi-arid areas (GoK, 2010). Despite establishment of honey groups, participation of producers in the groups is still low (GoK, 2013). This study therefore analysed the factors determining producer membership to honey groups.

Findings of this study will inform actors in the Kenyan honey sub-sector who are involved in development of programmes, policies and institutional frameworks that enhance cooperation of producers in production, value addition and marketing of honeys. Results of this study will also inform policy makers involved in strengthening capacity, opening up, expanding and creating niche markets for Kenyan honeys, as well as those involved in development of GI regulatory framework.

7.2 Methodology

7.2.1 Study areas

This study was carried out in lowlands of West Pokot, Baringo and Kitui Counties, Kenya (Figure 7.1). The three study areas are characterized by low, unreliable and poorly distributed rainfall, high temperatures and frequent droughts which is associated with variations in weather patterns as a result of climate change (Schreck et al., 2004; Government of West Pokot, 2013; Government of Baringo, 2013; Government of Kitui, 2013). Beekeeping is more prevalent in the three study areas and honeys produced in the regions have potential for protection with GI (KIPI, 2009).

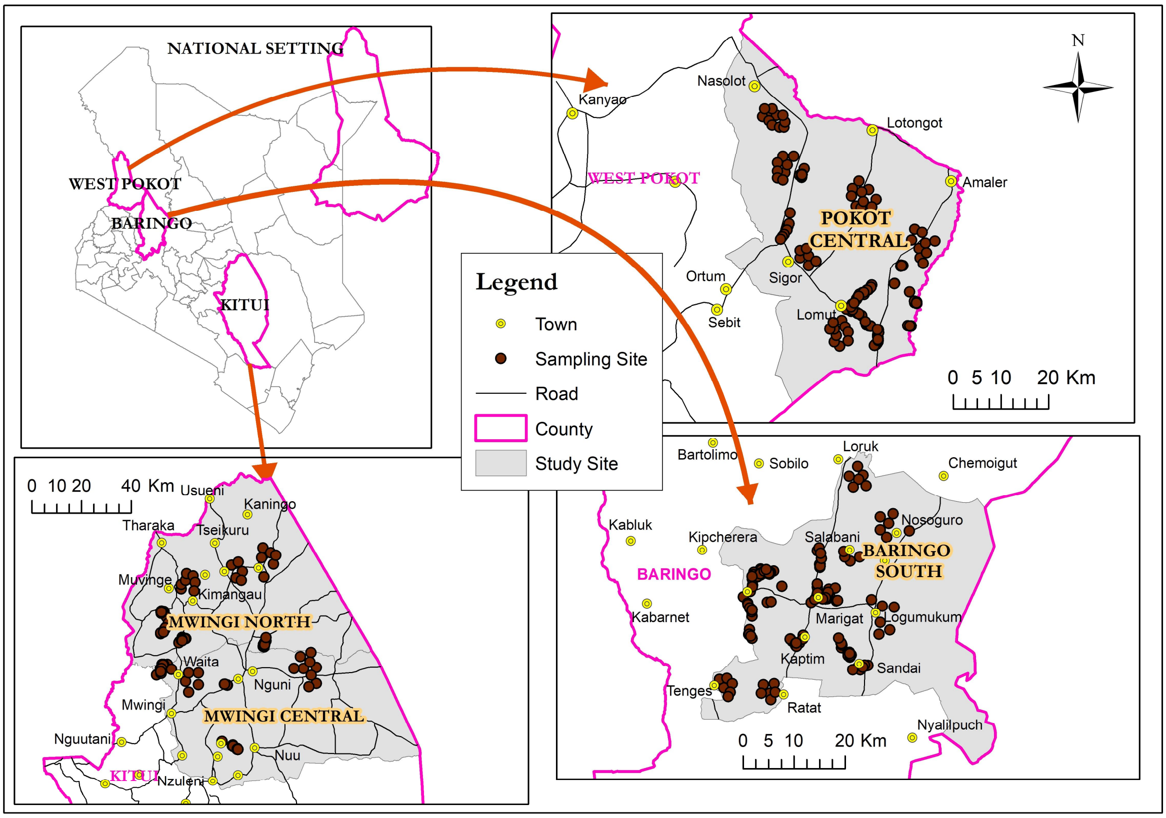

Figure 7.1: Map of Kenya showing the three study areas and sampled household areas

7.2.2 Hypothesized factors influencing collective action among producers of honey

Factors likely to influence membership in a farmerõs group/cooperative were identified from literature (Karli et al., 2006; Etwire et al., 2013; Issa & Chrysostome, 2015), for consideration in this study. These factors include; beekeeping experience, use of modern hives, distance from farms to processing plant, education, age and gender of household, access to information and credit, number of hives, land size and income (Table 7.1). Additional factors likely to influence collective action among producers of honey which were considered in this study included GI awareness (awareness of link between product quality and production region) and production of honey with origin linked attributes (honey whose attributes can be differentiated from those of similar products produced in other regions). Therefore, this study hypothesized that GI awareness and production of honey with origin linked attributes are likely to positively influence membership to honey group.

Experience in beekeeping was expected to positively influence membership in honey group. This is because experience over years can enhance a farmer to make appropriate decisions (Affognon et al., 2015) to join group based on knowledge on the existing opportunities and benefits associated with honey groups. The expected influence of use of modern hives was positive based on the claims that use of modern hives would yield more honey (Affognon et al., 2015), which would be cumbersome to extract manually. Modern hive also have special honey combs in which would need advanced equipment for extraction (Carroll & Kinsella, 2013). Most of the specialized equipment are commonly owned at the group level, thus a producer would need to become a member of a group to access such facilities.

Distance from farms to the processing plant was expected to positively influence membership in honey group. Honey production in the study areas is practised farther from processing plants thus producers would opt to become members of a group in order to share transport costs and get access to market as observed by Davis et al. (2010). GI awareness and production of honey with origin linked attributes were expected to positively influence group membership, as a strategy to protect the quality of product from adulteration and imitation. Producers of honeys with unique attributes would become members of a group in order to gain more prices for their products based on findings reported by Musinguzi et al. (2018).

Education level of the household head was expected to have both positive and negative influence on group membership. This is because educated household heads are likely get access and understand group membership and associated benefits more than those with a lower education level or no education (Affognon et al., 2015). Age of the household head was expected to have both positive and negative influence on group membership. Whereas younger farmers would participate in groups (Davis et al., 2010) in order to adopt new technology and explore innovations, older farmers would also become members based on their networks, experience and an understanding benefits associated with groups. Also, younger farmers may be resource constrained to participate in group while older people may not (Morgan, 1988). Ability for older farmers to participate in group can be limited by physical weakness associated with old age (Khan et al., 2012).

Gender was expected to positively and negatively influence membership in honey group. Due to culture and traditions in honey production areas of this study, women were expected to participate less in groups compared to men. Also, male farmers are more networked socially due to their participation in informal meetings (´barazas´) where they are likely to get agricultural information. Women are less sensitized due to domestic workload which make it difficult for them to participate in forums/meeting where they can access information. Males are decision makers in households and are able to attend group meetings without objections unlike female who have to get permission from their husbands.

Access to production and value addition information was expected to positively influence membership to group. Access to information has a positive effect on farmersô decision to participate in a group since they can make informed choices. Also informed farmers are more likely to participate in groups in order to put into practice the knowledge acquired (Nnadi Akwiwu, 2008). Influence of number of hive to group membership was expected to be positive. Farmers with less hives would be expected to join groups in order to get access to more and subsidized hives. On the other hand, those with more hives would have high production levels thus, they would need advanced equipment to process honey (Carroll & Kinsella, 2013) and this are mostly available at the group level.

Land size and group membership was expected to positively and negatively influence group membership. Increase in farm size would mean more farm yields thus more income. Such farmers would be less willing to be members of a honey group due to diversified farming options. Farmers with less land sizes would participate in group in order to access inputs and technology in order to maximize benefits from honey production which does not require little land area (Carroll & Kinsella, 2013).

Influence of income on group membership was expected to be positive as well as negative. Higher income would be a resource to invest in honey production/processing equipment. A farmers with high income would therefore acquire equipment and other resources needed without joining a group. On the other hand, in cases where members of a group contribute to invest in equipment, high income would encourage a farmer to join a group (Carroll and Kinsella, 2013). Low income also on one hand limit participation in group in a case where farmers are required to make contributions in group investment. On the other households with low income would become members of an existing group in order to benefit from communal equipment provided to the groups by government and development partners. Access to credit by the household head was expected to positively influence membership to group since is important for the improvement of small holder farming as shown by Otieno et al. (2010).

Table 7.1: Variables likely to influence collective action among producers of honey

Variable Description	Nature of Variable	Expected Sign
Dependent Variable		
Household (HH) head membership in honey group	Dummy (1=Yes 0=No)	
Independent Variables		
Experience in beekeeping	Continuous	+
Use modern hives	Dummy (1=Yes, 0=No)	+
Distance from farms to the processing plant	Continuous	+
GI awareness	Dummy (1=Yes, 0=No)	+
Education level of HH head	Ordinal (0=None, 1=Primary education, 2= Secondary education, 3= Tertiary education)	+/-
Age of HH head	Continuous	+/-
Gender	Nominal (1=Male, 2=Female)	+/-
Produce honeys with origin linked attributes	Dummy (1=Yes, 0=No)	+
Access to production info	Dummy (1=Yes, 0=No)	+
Number of hives per HH	Continuous	+
Land size	Continuous	+/-
Log HH income	Continuous	+/-
Access to credit	Dummy (1=Yes, 0=No)	+

The dependent variable used in this study has binary values, 1=yes or 0=no. Therefore, logit model was used to analyse factors determining the likelihood of becoming a member of a honey group, which is a proxy to collective action. The model helps in predicting the outcome from a number of independent variables and it expresses the probability of an event occurring to probability of an event not occurring.

7.2.3 Data collection and analysis

The study was carried out in 2015 and both primary and secondary data were collected. To collect data, semi- structured questionnaires were administered to a stratified random sample of 318 honey producers (103, 110 and 105) in Kitui, Baringo and West Pokot respectively). In each selected household, the head/spouse was interviewed. Data gathered from the households included; household socio-economic characteristics, farm characteristics and practises in honey production. Researcher´s own observations and insights were used to verify information provided by respondents where possible. Data was analysed using STATA statistical software version 13.0. Descriptive analyses were used to summarize demographics and socio-economic characteristics of respondents. Logit regression analyses were performed to determine factors influencing honey producer membership in honey group, a proxy for collective action.

7.3 Results and discussion

7.3.1 Socio-economic characteristics

Summary statistics of socio-economic characteristics of the sampled population are provided in Table 7.2. Results on producer membership in honey groups indicated a low level of participation in honey groups by producers in Baringo and West Pokot as compared to Kitui. High number of membership in groups among producers in Kitui was attributed to an NGO led programme which enhanced collective value addition and marketing of honeys produced in the region (ICIPE, 2009; Affognon et al., 2015).

Table 7.2: Socio- economic characteristics of the households

Variables	West Pokot (n=105)	Baringo (n=110)	Kitui (n=103)	Overall
Mean experience in beekeeping (years)	13.95 (13.21)	19.03 (13.57)	28.49 (17.05)	20.41 (15.80)
Mean distance (farms to processing centres (Kms)	10.21 (7.44)	14.31 (8.13)	33.22 (24.01)	19.08 (18.04)
Mean education level of HH head	0.44 (0.69)	1.48 (0.89)	1.02 (0.83)	0.99 (0.91)
Mean age of HH head (years)	43.60 (14.42)	46.44 (14.23)	54.72 (14.56)	48.18 (15.10)
Mean number of hives	26.21 (34.78)	23.00 (28.08)	31.37 (39.08)	26.77 (34.23)
Mean land size (Acres)	3.92 (7.80)	6.06 (10.13)	6.87 (6.09)	5.62 (8.29)
Mean HH income per year (Kshs)	133096.19 (173407.40)	290922.00 (529208.24)	124731.71 (177903.34)	184980.77 (349733.46)
Participation in honey group (%)	19.05	43.64	64.08	42.14
Use modern hives (%)	2.86	21.82	30.10	18.24
GI awareness (%)	78.10	94.55	79.61	84.28
Gender (% Male)	100	92.73	84.47	92.45
Produce honeys with origin linked attributes	86.67	95.45	83.50	88.68
Access to production and value addition information (%)	95.24	78.18	82.52	85.22
Access to credit (%)	0.95	15.45	3.88	6.92

Figures enclosed in parentheses represent the standard deviation of the mean (Source: authors' survey, 2015).

Although the overall mean education level of the respondents was low, household heads in Baringo had a relatively higher education level compared to the other two study areas. West Pokot recorded the highest percentage (64.76%) of respondents without any formal education. Respondentsô ages ranged from 19 to 90 years and the highest average age was reported in Kitui. Age of the population sampled indicated that honey production was undertaken by all age groups ranging from the youth to aging population. Results showed some disparity in income levels between households in the study areas. The highest income was reported in Baringo and this was attributed to favourable climatic conditions which favour production of farm crops with market value (Gichora, 2003).

Use of modern hives was not a common practice in the study areas. The low use of modern hives was attributed to beliefs, traditions and cultures on use of traditional hives (e.g. log hives) and lack of access to modern hives as well as inadequate producer skills on use and management of modern hives due to lack of training. Most respondents in the study areas were aware of GI (awareness of the link between product qualities to production region) and they produced honeys with origin linked attributes (honey whose attributes can be differentiated from those of similar products produced in other regions). Results on gender of respondents indicated that majority of the households in the study areas were headed by males. More respondents in this study had access to information on production and value addition of honeys as compared to those who had access to credit for honey production

7.3.2 Results of factors influencing collective action among producers of honey

Factors influencing membership of producers in honey groups from the logit model are summarized in Table 7.3. Determinants of membership to honey groups included experience in beekeeping, distance from farms to processing centre, education level of HHH, number of hives owned, use of modern hives, GI awareness, production of honeys with origin linked attributes and access to information on honey production and value addition.

Experience in beekeeping had a positive and significant influence on honey producer membership in a honey group, particularly in West Pokot. Household heads with more years of experience in beekeeping were more likely to become members of a honey group compared to those who had less experience. Experience gained by farmers over years can enable farmers to venture into opportunities which can make them create more income for future success and sustainability in their activities (ICIPE, 2009). This result is in agreement with findings from a study by Muiruri (2015) who reported that beekeepers with more experience in beekeeping had a higher likelihood of participating in beekeeping programs and initiatives as compared to their counterparts. Affognon et al. (2015) also noted that farmers with more experience in their farming activities can make decisions that would benefit them based on past experiences

Households whose honey production farms were farther from the honey processing centres/market had a higher likelihood of participating in the groups. Some respondents in this study live in remote areas and getting honey to the processing centres/market is difficult and expensive as high transport costs are involved (Berem, 2015). Such producers are more likely to become members of a honey group in order to minimize transaction costs through collective transportation of honey to the processing centres/market. This finding concurs with that of Ngaruko & Lwezaula (2013) who found out that longer distance from household to group convening centres influences farmer´s decision to participate in a group.

Table 7.3: Logit regression estimates for the determinants of membership in honey groups

Variables	West Pokot Coefficient(SE)	Baringo Coefficient(SE)	Kitui Coefficient(SE)	Combined Coefficient(SE)
Experience in beekeeping	0.052(0.022)**	0.040(0.025)	0.024(0.025)	0.037(0.012) ***
Distance from farms to the processing plant	-0.001(0.050)	0.070(0.066)	0.028(0.022)	0.051(0.013) ***
Education level of HHH	0.221(0.440)	0.658(0.379)*	0.351(0.456)	0.503(0.189) ***
Age of HHH	-0.006(0.023)	0.028(0.027)	0.023(0.029)	0.018(0.013)
Number of hives	0.012(0.008)	0.013(0.010)	0.015(0.011)	0.013(0.005) ***
Land size	0.119(0.073)	0.014(0.024)	0.056(0.082)	0.029(0.018)
Log HH income	0.274(0.618)	0.420(0.527)	-0.157(0.573)	0.177(0.307)
Use modern hives	1.548(1.557)	1.291(0.618) **	2.111(0.904) **	1.413(0.438) ***
GI awareness	-0.582(0785)	1.033(1.266)	1.689(0.865) **	0.978(0.482) **
Gender		0.611(0.918)	0.982(0.908)	0.881(0.569)
Produce honey with origin linked quality	-1.124(0.852)	0.349(1.345)	2.505(0.876) ***	0.926(0.526) *
Access to production and value addition information		2.197(0.772) ***	3.606(0.971) ***	2.654(0.582) ***
Access to credit		0.451(0.719)	0.423(2.091)	0.549(0.609)
Log-Likelihood	-39.373047	-55.692867	-36.399364	-138.66431
Psuedo-R^2	0.1867	0.2609	0.4588	0.3594
ɢ(ɟ -value)	18.07 (0.05)	39.32(0.00)	61.71(0.00)	155.62 (0.000)

*Notes: the level of significance is represented by stars i.e. ***significant at 1 percent, ** significant at 5 percent and * significant at 10 percent.*

Education level positively and significantly influenced membership in honey group particularly in Baringo. Household heads with a higher education level were more likely to join honey groups. The possible explanation of this result is that higher level of education provides a pathway for more information (Faturoti et al., 2006; Kasina et al., 2009; Wiles et al., 2009), thereby enabling a producer to acquire knowledge and understand the benefits/gains associated with producer groups. Similar findings were reported by Karli et al. (2006), Etwire et al. (2013) and Issa & Chrysostome (2015).

Households with more hives and those who used modern hives particularly in Baringo and Kitui had a higher likelihood to participate in a honey groups. This was attributable to the fact that producers with more hives and those who use modern hives are more likely to produce more honey (Affognon et al., 2015; Muiruri, 2015). Such producers are likely to become members of a honey group in order to overcome problems of price uncertainties and high transaction costs associated with individual marketing (Berem, 2015). Also, extraction of honey from combs from modern hives require specialized equipment (centrifugal honey extractors) in order to avoid destruction of the combs (Carroll & Kinsella, 2013). Members of honey groups invest in such equipment and they are placed at centralized locations for use by producers who are members of the groups. Honey producers using the modern hives are therefore likely to become members of a group in order to gain access to collective honey processing equipment.

GI awareness and production of honeys with origin linked attributes positively influenced membership in a honey group particularly in Kitui. Household heads who were aware of GI and those who produced honeys with origin linked attributes had higher likelihood of becoming members of a honey group. An explanation of these results is that producers who are aware of GI are conversant with the collective nature of GI and associated benefits

(Bramley & Bienabe, 2013), thus are likely to become members of a group, in order to gain benefits. On the other hand, those who produce honeys with origin linked quality would become members of honey groups so as to; gain access to better markets, maintain product position in the market, benefit from premium prices and better bargaining power from collective reputation (ICIPE, 2009); Blakeney et al., 2012) and avoid risk of product disappearance and exploitation by buyers (Vandecandelaere et al., 2010; Blakeney et al., 2012). These findings are supported by the case study of Cotija Cheese (cheese with unique characteristics attributed to origin) in Mexico where awareness on GI and production of unique cheese whose quality was recognized in the market resulted to collective action (Pomeón, 2007). Producers of Cotija origin Cheese became members of a regional producer association in order to enhance preservation of product quality as well as its reputation with an aim to maintain income from the product (Vandecandelaere et al., 2010).

Results of this study also showed that access to information on production and value addition is a significant determinant of membership in honey group, particularly in Baringo and Kitui. Producers who had access to information on honey production and value addition were more likely to become members of a honey group unlike their counterparts. This is possibly because such producers would easily acquire information related to honey production activities e.g. existing groups, requirements for becoming a member, associated benefits, thus make informed choices. This result concurs with findings by Bhusal & Thapa (2005), Karli et al., (2006), Kasina et al. (2009), Carroll & Kinsella (2013) and Etwire et al. (2013), who found out that access to information influence farmersô undertakings, practises, developments, engagements and future plans.

7.4 Conclusion and policy implications

Results of this study have revealed that farm characteristics, household characteristics and producer characteristics can influence collective action. Awareness on GI and production of honeys with origin linked attributes have emerged as important determinants of producer membership in honey groups, despite the fact that GI is still a new concept in Kenya. Collective action among producers of origin honeys could be enhanced through strengthening capacity of producers and this can be achieved through trainings, infrastructural development and dissemination of information (especially information on origin honeys) through extension services and other awareness programmes. Results from this study suggests a need to encourage policies and extension programs which bring information on production and value addition of honeys as well as those that encourage farmers to improve their education. GI awareness on origin products and GI concept, requirements and benefits should also be created. While use of modern hives can be encouraged and promoted in potential areas, capacity building is also needed for producers using the traditional hives. Results also suggest the need to develop infrastructure e.g. roads and appropriate technologies to enhance honey production.

CHAPTER 8 : EVALUATION OF EXISTING VALUE ADDITION INITIATIVES THAT ENHANCE RECOGNITION OF TERRITORIAL TRAITS OF HONEY[6]

Abstract

Recognition of honeys with specific characteristics attributed to their territory (geographical origin) can enhance increased incomes to households in rural areas of Kenya, if protected and sold under Geographical Indications (GI) labels. This is mainly because product recognition can result in its demand, reputation, access to market and its protection from imitation and disappearance from the market. Initiatives undertaken by actors in the honey sub-sector and other sectors to promote recognition of Kenyan honeys and their territorial and local traits have not been documented. This study evaluated the existing value addition initiatives enhancing recognition of territorial or local traits of the three Kenyan honeys i.e. Kitui, West Pokot and Baringo honeys. Data collection methods used included literature review as well as interviews with relevant stakeholders in the honey sub-sector and other relevant sectors. Results showed that development of honey value chains, product certification, product promotional and marketing activities and awareness on the link between product quality and geographical origin have greatly contributed to recognition of West Pokot, Baringo and Kitui honey as well as their territorial traits. Findings of this study will inform programs and policies which aim to improve the honey sub-sector in Kenya.

Key Words: Geographical Indications, Honey, territorial traits, Value addition initiatives, West Pokot, Baringo and Kitui Counties

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8.1 Introduction

Products with territorial traits i.e. products with specific attributes that are linked to their geographical origin/area of production can create additional value through market/consumer recognition (Vandecandelaere et al., 2010). Recognition of a product is based on its specificity (unique characteristics which can be differentiated from other similar products based on their territory characteristics) packaging, labelling and marketing (Vandecandelaere et al., 2010). Classification of a product by consumers based on its attributes reinforces the identity of the product itself and the community in its region of production (Blakeney et al., 2012). Thus, this results in demand, reputation, access to market and its protection from imitation and disappearance from the market (Giovannucci et al., 2009; Bramley & Biénabe, 2013). Uniqueness of a product is a critical factor in gaining and justifying market recognition (Bramley & Biénabe, 2013). The stronger a product is characterized based on its territorial traits, the easier it is to prove that the product is distinct thus its recognition. Legal instruments play a great role in protecting unique characteristics of a product and its recognition (Giovannucci et al., 2009; Bramley & Biénabe, 2013).

Products with characteristics linked to territory can be protected and marketed with Geographical Indications (GI) (ARIPO & EU, 2012; Blakeney et al., 2012). GI links products to geographical origin, traditions and typicity by indicating their unique characteristics, thereby protecting the products from fraud, availing consumers with information about a product and increasing premium prices (Vandecandelaere et al., 2010; Blakeney et al., 2012).

Kenya is among the African countries seeking for more value for their origin products in order to meet consumer preferences, access niche markets and obtain higher product prices (Blakeney et al., 2012). Although some origin Kenyan honeys have been identified for protection with GI (KIPI, 2009; Blakeney et al., 2012; Egelyng et al., 2017), there is still unexploited potential for creating additional market value from these honeys. This has been brought about by inadequate product specifications, poor infrastructure, poor knowledge on products with territorial traits, inadequate and unoperationalized institutional environment, financial constraints, poor access to market, low human capacity, collective action and honey adulteration (Nyaga, 2004; GoK, 2013). Addressing this challenges can enhance recognition of Kenyan honeys. Value addition initiatives undertaken by actors in the honey sub-sector and other sectors to promote recognition of territorial traits of Kenyan honeys has not been documented. This study evaluated existing value addition initiatives enhancing recognition of territorial or local traits initiatives of the three Kenyan honeys. Findings of this study will inform policy makers and actors in the honey sub-sector on appropriate policies and programs, which can advance the honey sub-sector through recognition of honeys with territorial or local traits in order to add their market value. This will thus present an agenda for actions that need to be undertaken to overcome the barriers which can hinder marketing and development of GI honeys in Kenya.

8.2 Theoretical framework

Protection of products based on their geographical origin, is founded on the economic theories of information and reputation (Bramley et al., 2003). These theories explain the need for avoiding market distortions/failures that occur as a result of information asymmetry between producers and consumers of a product (Bramley et al., 2003). Recognition of a product by consumers enhances its reputation and this can help overcome the market failure associated with asymmetry of information (Bramley et al., 2003). Product recognition can be protected through ´institutionalization of reputation´ in order to prevent consequences of information asymmetries.

GI which links product characteristics to its origin has been described as institutionalization of reputation as it reduces problems of information asymmetry and free riding on product territorial attributes which enhance product reputation (Belletti, 2000; Aprile et al., 2012) This would reduce information costs for consumers sourcing their preferred products. Successful GI labelling of origin products requires consideration of a number of factors, which include an appropriate institutional framework. Interaction between formal and informal institutions can influence recognition of an origin product and its characteristics (Vandecandelaere et al., 2010), thus reduce likelihood of fraud that can compromise product recognition and validity.

Product recognition can be derived from actions of different actors within and outside the area of production (Marty, 1998). Organization of producers and collective efforts in production of an origin-linked product can enhance its collective reputation (Blakeney et al., 2012; Bramley & Biénabe, 2013) and recognition. Existence and sustenance of collective efforts is enhanced by transparency, accountability and equity in the institutional environment (Bramley et al., 2003).

Marketing structures are also important in ensuring consistent market positioning and effective commercialization of a product (Giovannucci et al., 2009). This can result to product recognition and enforcement of regulations which ensure its quality and this can lead producer access to market as well as high product demand and premium prices (Vandecandelaere et al., 2010).

In Kenyan honey sub-sector, information asymmetry has resulted in lack of market access for honey producers, high consumer prices, unethical marketing practices and poor market organization (GoK, 2013). This has led to increased transaction costs due to search for information, increased costs of production and supply thus influencing recognition of Kenyan origin honeys. Based on the theories of information and reputation, this study discusses how existing value adding initiatives in the Kenya´s honey sub-sector have enhanced recognition of West Pokot, Baringo and Kitui honey and their territorial traits.

8.3 Methodology

8.3.1 Study area

This study was carried out in Kitui, Baringo and West Pokot Counties, Kenya, in the period 2014-2015. Both primary and secondary data collection methods were used. Primary data involved in-depth interviews with actors at the national and local honey sub-sector as well as with representatives from other organizations supporting the honey sub-sector. In each of the study areas the following respondents were interviewed; 5 honey producers, 3 honey processors, 3 honey traders/marketing agents, and 3 representatives from Ministry of Agriculture (MoA), Ministry of Trade Industry and Enterprise (MTIE) and Agriculture Sector Development Support Programme (ASDSP). Two focus group discussions were also conducted with honey producers in each of the three study areas. At the national level, in-depth interviews were conducted with one representative from each of the following organizations; Kenya Organic Agricultural Network (KOAN), National Beekeeping Institute (NBI), Kenya Industrial Property Institute (KIPI), Kenya Bureau of Standards (KEBS), International Centre of Insect Physiology and Ecology (ICIPE) and Kenya Honey Council (KHC).

Secondary data was gathered from study and reports on honey related initiatives. The researcher also collected data through participation and observations during honey market days, honey processing activities, honey conferences, meetings, trainings, trade and marketing related activities organized by organizations supporting honey production at the local and national level.

8.3.2 Data analysis

Contextual analysis was used to analyse information gathered from the interviews with actors supporting the honey sector. The statements provided by the respondents were analyzed in relation to economic theories of information and reputation (Bramley et al., 2003) and case studies.

8.4 Results and discussion

Interviews and discussions of this study revealed that a number of value addition initiatives are undertaken by actors in governmental, non-governmental organizations and producers (Figure 8.1) at the national and local level in order to enhance recognition of West Pokot, Baringo and Kitui and their territorial traits.

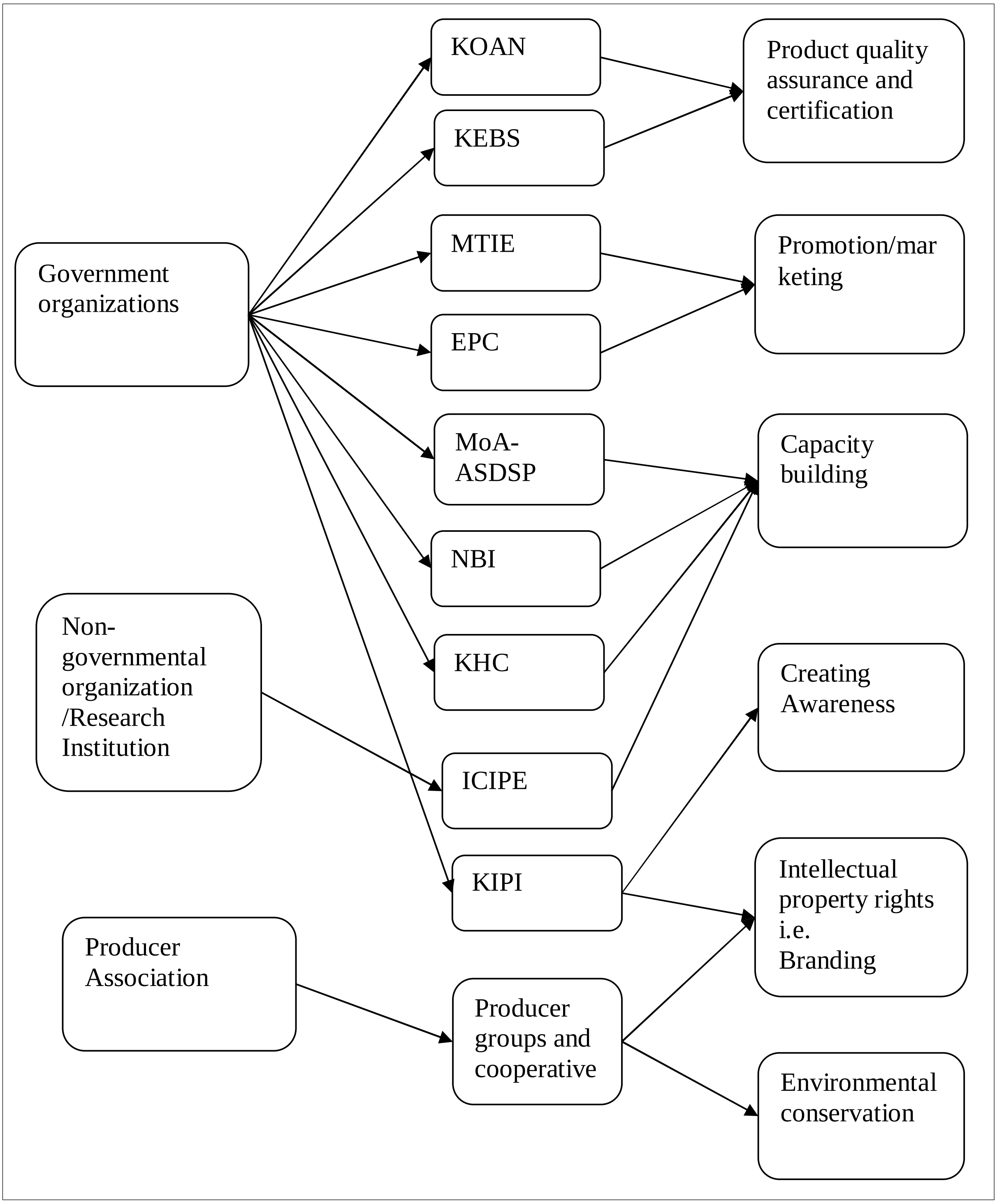

Figure 8.1: An illustration of value addition initiatives by actors supporting the honey sector *(Source: own schematic based on interviews)*

Development of honey value chain by the ASDSP, programme under Ministry of Agriculture (MoA) was ongoing at the county level during the study period. Specific activities that were carried out included development of honey processing and marketing centres, organization of honey producers, processors and traders into groups, associations and cooperatives; input supply e.g. beehives; organizing honey conferences in collaboration with other organizations training on best practices in hive management, honey harvesting, post-harvest handling, processing and storage; conservation and regeneration of bee flora linking producers, processors and traders to financial institutions which offer interest free loans and linking honey traders to the market and consumers. ICIPE and the NBI were also actively involved in the honey value chain development. These initiatives have enhanced consistent production and supply of quality honey, thus preventing products from disappearing in the market, differentiation of products in the market and protection of product quality/characteristics from imitation. Also, unscrupulous traders and free riding activities have been controlled through exchange of information, collective marketing thus reducing market distortions which can hinder recognition of honeys and their territorial traits in the market. Honey producer groups in the study areas conduct exchange visits and field days where they learn best practices on honey production. Also, larger honey groups have supported the smaller groups in processing and marketing of honeys through provision of equipment. Through this initiative, the small scale producers have a direct link to consumers and access to market through reducing distortion of information and exposure to middlemen. Similarly, previous studies have noted that strengthening and vertical and horizontal collaboration of actors within the value chain contributes greatly in enhancing product quality value addition of a product thereby enhancing its recognition (Marescotti, 2003; Pomeón, 2007; Bienabe & Troskie, 2007; Vandecandelaere & Mery, 2008; Sereyvath, 2009).

Honey traders in the three study areas receive support from the MTIE and the EPC in marketing their honeys. Discussions revealed that traders do participate in product promotional/marketing events which are organized and facilitated by EPC. These events include trade fairs, honey conferences, exhibitions and agricultural shows at the local and national level. Such marketing activities have connected producers and consumers. Producers get the opportunity to give information to consumers on honey characteristics, quality and their production processes. On the other hand, consumers get first-hand and additional information about a product and this avoids loss of information which is of importance to honey users. Provision of information to consumers about a product has reduced transaction costs in search of information, thereby addressing issues of market failure for the honeys. Producers in the study areas understand and implement marketing rules and other particular requirements that enhance market entry and product promotion. This has resulted in development of regional partnerships and strategic alliances with other marketing companies thereby enhancing a wider recognition of the honeys beyond the local markets. In addition the products are availed to consumers in areas where they not penetrated before. Marketing activities of a product have been deemed important in addressing information asymmetry, thereby enhancing its reputation in the market (Garcin & Carral, 2007; Gallego Gómez, 2007)

Honey quality assurance and control is undertaken by KEBS in accordance with honey specification as stipulated in the East African Standards (EAS 36:2000). Honey testing is carried out using accredited equipment. In addition to honey tests, inspection of hives, harvesting, processing, handling, packaging and storage equipment and techniques are also carried out. During the fieldwork, KEBS certification mark was observed in honey labels used by most processors/traders who have complied with the existing standards. The quality assurance body also conducts regular inspection of honeys sold in supermarket and other trading centres/markets. This initiative has helped in removing inferior honey products and those that imitate quality honeys in the market, thereby enhancing recognition of origin and genuine products. Some honey producers in the study areas have been certified as organic producers by the KOAN in collaboration with the MoA and ICIPE in accordance with the East African Organic Standards. This kind of certification involves inspection of honey production inputs, bee foraging areas, processing and handling techniques. According to producers, quality assurance and organic certification have increased demand of the honeys in the market as indicated by producers. Compliance to East African honey standards and conformity to other product specifications have removed trade barriers thereby enhancing a wider recognition of the honeys at the local, national and regional markets. On the other hand, organic certification of honeys which signify environmental quality based on biodiversity conservation initiatives and informal institutions has created a positive image of production region thus increased demand and appreciation of honeys produced in the regions based on their traits. In a similar way, case studies of products have reported that quality assurance and certification of a product builds confidence and acceptance of the product by consumers, thereby increasing its demand and reputation (Gerz & Fournier, 2006; SINER-GI, 2006; Gallego Gómez, 2007; Mawardi, 2009).

Kenya Industrial Property Institute and the KHC have created awareness on GI and honey branding using collective marks (marks distinguishing the geographical origin or other common characteristics of goods from others). This has enhanced producer knowledge on use of labels to protect and market their honeys. Some honey producers/traders use a common label for their honeys. These labels provide a brief description of the honey, its origin and brand name as well as contact information of producers/processors/traders. Product labelling has provided useful information about the product e.g. quality, content and origin to consumers who also can source for more information about a product using the provided contact details. This initiative enhances product traceability thus reducing fraudulent and free riding activities, thus meeting consumer needs and enhancing a positive perception about a product. Case studies conducted by Mawardi (2009) and Sereyvath (2009) have reported that use of logos and labels in a product provides useful information to consumers as well as enhancing interaction between producers and consumers, thereby enhacing product reputation and market.

Honey processors and trader groups have established honey shops along major roads, tourist attraction sites, local hotels and main markets in production regions. This has ensured availability and access of the honey to consumers who are not conversant with location of honey markets within production regions e.g. travellers, tourists, local visitors and other traders. Establishment of honey market places in tourist attraction sites and at consumer´s convenience has enhanced accessibility of honey, thus its reputation. In a similar way, establishment of niche markets through tourism related activities have enhanced reputation and market of some products (Camara & Haba, 2004; FAO, 2006; Pomeón, 2007).

8.5 Conclusion and policy implications

The honey case studies in Kitui, Baringo and West Pokot revealed that different forms of initiatives undertaken by actors within and outside the honey sub-sector play a great role in adding market value to the honeys. Honey producers and traders within the study regions have seized the opportunities brought about by these initiatives. This has enhanced recognition and reputation of their products at local, national and regional market. Findings of this study indicate prospects for Kenyan origin honeys to be protected with GI establish niche markets through recognition of their territorial traits. However, to register these honeys with GI, there is need for development and implementation of honey policies at the county level as well as in development of monitoring plans that can enhance traceability and accreditation of honeys. Also, capacity development (e.g. trainings, development of infrastructure etc.) and awareness creation programs should target all producers in a particular region since they are required to work collectively in safeguarding origin product for maintenance of product quality and sustainable production. Use of a common standard label for honeys originating in the same geographical area would also enhance recognition of the honeys and their territorial traits as well as reputation which is a prerequisite in development of GI products. Recognition and reputation of a product stems from a collective process thus coordination of involved actors in their value addition initiatives would be necessary.

CHAPTER 9 : SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

9.1 Summary

This study sought to analyse the quality and origin attributes of Kenyan honey for Geographical Indication (GI) labelling. Explicitly, the study sought to (1) assess the suitability of honey from West Pokot, Baringo and Kitui Counties for GI labelling; (2) determine the physicochemical and melissopalynological parameters of honey from West Pokot, Baringo and Kitui Counties; (3) determine the diversity and frequency of visitors of *Acacia brevispica* and extent of pollination by honey bees in Kitui County; (4) determine factors influencing collective action among producers of honey from West Pokot, Baringo and Kitui Counties; and (5) evaluate existing value addition initiatives enhancing recognition of territorial traits of honey from West Pokot, Baringo and Kitui Counties.

The study was conducted in lowlands of West Pokot, Baringo and Kitui Counties. The study sites were chosen because they are known for production of unique honeys which can be differentiated from those producer regions. The study adopted a research design that involved field surveys (interviews and questionnaire administration), on-farm experiment and laboratory experiment.

The study found that West Pokot, Baringo and Kitui honey are suitable for GI labelling mainly based on specificity which can be linked to the natural environment and human factors. This study identified gaps which are hindrances for GI labelling of Kenyan honeys. Further, the institutional and organizational support represented

This study also found out that there is a mutual interaction between honeybees and *Acacia brevispica*. Honey bees obtain nectar and pollen from the plant while the plant benefit from pollination service for the bee. The mutual relationship is important in maintaining honey quality for GI labelling. The study also found a positive relationship between household and farm characteristics with collective action. Factors that positively influence producer membership to honey group (proxy for collective action included experience in beekeeping, distance from farms to the honey processing centre, education level, number of hives owned, use of modern hives, GI awareness (awareness of link between product quality and production region), production of honeys with origin linked attributes and access to information on production and value addition of honey.

Initiatives by different actors supporting the honey sub sector enhance recognition of territorial traits of West Pokot, Baringo and Kitui honey through addressing issues of information asymmetry and product reputation. The initiatives include; product quality assurance and certification, promotion and marketing, capacity building, awareness creation on GI, branding and environmental conservation initiatives.

9.2 Conclusion

Based on the results of this study, West Pokot, Baringo and Kitui honey exhibited unique quality characteristics which demonstrated a link with the natural environment (i.e. floral sources and pollination service) and human factors (culture, traditions and know-how). This can enhance marketing of these honeys in reference to this link for increased premium prices for the producers. Therefore, these results lead to a conclusion that the three honeys have potential for GI labelling.

Initiatives by a wide range of actors within and outside the honey sector contribute significantly to recognition of West Pokot, Kitui and Baringo honeys and their territorial traits. These initiatives can form an opportunity for honey value chain to exploit benefits associated with geographical-linked product quality. However, honey value addition initiatives mostly benefits honey producer/processors/traders who are organized in groups. This is a drawback to recognition of origin honeys beyond the local level. Therefore honey producers who operate as individuals need to be encouraged to become members of the existing groups. This can be enhanced through addressing identified factors which influence membership to honey group. Also proper coordination among organizations involved in honey value addition activities need to be enhanced.

Findings of this study showed a weak institutional environment and inadequate organizational support in production and marketing of the three honeys. This is a hindrance for GI protection of the potential products. The results highlight the need for policies and laws supporting registration of potential GI products for enhanced community livelihoods, social inclusion and biodiversity conservation

Overall, the study findings indicate that there exists an opportunity for producers of West Pokot, Baringo and Kitui honeys to gain additional benefits from their products, similarly to how other countries across the world have benefited from their origin products which are protected with PGI/PDO.

9.3 Policy recommendations

Findings of this study showed that there are weaknesses in enactment and enforcement of policies, standards and regulations which influence product quality. Existing honey standards need to be enforced at the local level for quality assurance of honey. Enactment of relevant policy instrument is also needed to guide in development of a honey monitoring plan to enhance traceability of honey from the origin.

The study found out that access to information on production and value addition of honey, thus, government and other actors working in the honey sector need to encourage policies that bring awareness and information to honey producers e.g. extension officers, exchange visits and pamphlets.

REFERENCES

Adgaba, N., Al-Ghamdi, A., Tadesse, Y., Getachew, A., Awad, A. M., Ansari, M. J., Owayss, A. A., Mohammed, S. E. A., & Alqarni, A. S. (2017). Nectar secretion dynamics and honey production potentials of some major honey plants in Saudi Arabia. *Saudi Journal of Biological Sciences*, *24*, 180ï 191.

Affognon, H. D., Kingori, W. S., Omondi, A. I., Diiro, M. G., Muriithi, B. W., Makau, S., & Raina, S. K. (2015). Adoption of modern beekeeping and its impact on honey production in the former Mwingi District of Kenya: assessment using theory-based impact evaluation approach. *International Journal of Tropical Insect Science*, *35*(2), 96-102.

Aina, D. O., Enefola, J. O., & Agwu, C. O. C. (2015). Palynological Study of Honey Samples from Four Localities in Kogi East, Nigeria. *Journal of Biology and Life Science*, *6*(1), 29-36.

Akpabli-Tsigbe, N. D. K. (2015). Quality evaluation of Artisanally produced honey sold on Ghanaian markets. University of Ghana, Legon, college of basic and applied sciences.

Alda-Garcilope, C., Gallego-Picó, A., Bravo-Yagüe, J.C., Garcinuño-Martínez, R.M., Fernández-Hernando, P. (2012). Characterization of Spanish honeys with protected designation of origin óñ Miel de Granada òô according to their mineral content. *Food Chemistry*, *135*, 1785ï 1788.

Allaire, G. (2012). The Multidimensional Definition of Quality. In L. Augustin-Jean, H. Ilbert, & N. Saavedra-Rivano (Eds.), *Geographical Indications and International Agricultural Trade: The Challenge for Asia*. Palgrave-Macmillan, London.

AOAC. (1990). *Official methods of analysis, (15th ed)*. Association of Official Analytical Chemists, Washington, Arlington, VA. USA.

Aprile, M. C., Caputo, V., & Nayga, R. M. (2012). Consumersô valuation of food quality labels: The case of the European geographic indication and organic farming labels. *International Journal of Consumer Studies*, *36*(2), 158ï 165.

ARIPO, & EU. (2012). *Administrative Memorandum of Understanding on co-operation between the African Regional Intellectual Property Organization and the Directorate General for Agriculture and Rural Development of the European Commission*. Zanzibar, Tanzania. Retrieved from https://ec.europa.eu/agriculture/sites/agriculture/files/developing-countries/partners/gi/stonetown-memorandum_en.pdf

Aslan, C. E., Liang, C. T., Galindo, B., Hill, K., & Topete, W. (2016). The role of honey bees as pollinators in natural areas. *Natural Areas Journal*, *36*(4), 478ï 488.

Atrott, J., & Henle, T. (2009). Methylglyoxal in Manuka Honey ï Correlation with Antibacterial Properties. *Czech Journal of Food Science, 27,* S163ï S165.

Augustin-Jean, L., Ilbert, H., & Saavedra-Rivano, N. (2012). *Geographical Indications and International Agricultural Trade: The Challenge for Asia*. Palgrave-Macmillan.

Ayuya, O. I., Gido, E. O., Bett, H. K., Lagat, J. K., Kahi, A. K., & Bauer, S. (2015). Effect of certified organic production systems on poverty among smallholder farmers: Empirical evidence from Kenya. *World Development*, *67,* 27ï 37.

Babarinde, G. O., Babarinde, S. A., Adegbola D. O., & Ajayeoba S. I. (2011). Effects of harvesting methods on physicochemical and microbial qualities of honey. J*ournal of Food Science and Technology*, *48(*5), 628ï 634.

Badano, E. I., & Vergara, C. H. (2011). Potential negative effects of exotic honey bees on the diversity of native pollinators and yield of highland coffee plantations. *Agricultural and Forest Entomology*, *13*, 365ï 372.

Bagal, M. N., & Vittori, M. (2011). *Practical Manual on Geographical Indications for ACP countries*. CTA and oriGin, Agridea, Switzerland.

Baker, N. J., & Eric, E. (2008). Integrating wildlife in natural resources management for tourism and community livelihoods in Lake Victoria basin: East Africa. *African Journal of Environmental Science and Technology, 2*(10): 287-295.

Barham, E., Sylvander, B. (2011). *Label of Origin for Food. Local Development, Global Recognition.* CAB International, Cambridge, MA.

Barjolle, D., & Sylvander, B. (2002). Some Factors of Success for " Origin Labelled Products " in Agri-Food Supply Chains in Europe¿ Market , Internal Resources and Institutions. *Économies et Sociétés*, *25*, 1441ï 1462.

Barjolle, D., Boisseaux, S., & Dufour, M. (1998). *Le lien au terroir. Bilan des travaux de recherche*. Institute of Agricultural Economics, Lausanne.

Barjolle, D., Réviron, S., & Chappuis, J. M. (2005). Organization and Performance of Origin Labelled Food Alliances. In A.R. Bellows (Eds.) *Focus on Agricultural Economics.* Nova Science, .New York.

Barrow, E., & Mlenge, W. (2003). Trees as key to pastoralist risk management in semi-arid landscapes in Shinyanga, Tanzania and Turkana, Kenya. *Paper presented at The International Conference on Rural Livelihoods, Forests and Biodiversity,* Bonn, Germany.

Beentje, H. J. (1994). *Kenya Trees, Shrubs and Lianas*. National Museums of Kenya, Nairobi, Kenya.

Belay, A., Solomon, W. K, Bultossa, G., Adgaba, N., & Melaku, S. (2013). Physicochemical properties of the Harenna forest honey, Bale, Ethiopia. *Food Chemistry, 141,* 3386 ï 3392.

Belletti, G. (2000). Origin labelled products, reputation, and etherogeneity of firms. In B. Sylvander, D. Barjolle & F. Arfini (Eds.), *The Socio-Economics of Origin Labelled Products: Spatial, Institutional and Co-ordination Aspects* (pp. 240ï 259). PARIS:

INRA.

Belletti, G., & Marescotti, A. (2011). Origin Products, geographical indications and rural development. In E. Barham, & B. Sylvander, B. (Eds.), *Labels of origin for food: local development, global recognition*. CABI, Wallingford.

Belletti, G., Casabianca, F., & Marescotti, A. (2012). Local food quality and local resources. In F. Arfini, M. C. Mancini, & M. Donati (Eds.), *Local agri-food systemsin a global world: market, social and environmental challenges*. Cambridge scholars publishing, Cambridge, London.

Benachour, K., & Louadi, K. (2013). Inventory of insect visitors, foraging behaviour and pollination efficiency of honeybees (*Apis mellifera L*) (*Hymenpoptera: Apidae*) on plum (*Prunus salicina Lindl.*) (*Rosaceae*) in the Constantine area, Algeria. *African Entomology*, *21*(2), 354ï 361.

Berem, R. M. (2015). Economic analysis of honey production and marketing in Baringo County , Kenya¡ An application of the institutional analysis and development framework. *Journal of Natural Sciences Research*, *5*(10), 34ï 41.

Bhusal, S. J., & Thapa, R. B. (2005). Comparative study on the adoption of improved beekeeping technology for poverty alleviation. *Journal of the Institute of Agriculture and Animal Science, 26,* 117-125.

Bienabe, E., & Troskie, D. (2007). *GI Case Studies: Rooibos*. Retrieved from https://food.origin-for-sustainability.org/2005/upload/SINERGI%20Rooibos%20report%20draft4%20_4_.pdf.

Blakeney, M., Coulet, T., Mengistie, G., & Mahop, M. T. (2012). *Extending the Protection of Geographical Indications: Case Studies of Agricultural Products in Africa*. EARTHSCAN, Routledge, New York.

Bogdanov, S. (2002). *Harmonized methods of the International Honey Commission.* Swiss Bee Research Centre, Switzerland.

Bogdanov, S., & Martin, P. (2002). Honey authenticity. *Mitteilungen aus dem Gebiete der Lebensmitteluntersuchung und Hygiene, 93*(3), 232-254.

Bogdanov, S., Lüllmann, C., Martin, P., Von der Ohe, W., Russmann, H., Vorwohl, G., & Flamini, C. (1999). Honey quality and international regulatory standards: review by the International Honey Commission. *Bee world, 80*(2), 61-69.

Bogdanov, S., Martin, P., Lüllmann, C., Borneck, R., & Flamini, T. (1997). Harmonised methods of the European honey commission. *Apidologie,* (extra issue) 1-59.

Bogdanov, S., Ruoff, K., & Persano Oddo, L. (2004). Physico-chemical methods for the characterisation of unifloral honeys: a review. *Apidologie*, *35*(1), 4-17.

Boussaid, A., Chouaibi, M., Rezig, L., Hellal, R., Donsȩ̄ F., Ferrari, G., & Hamdi, S. (2018). Physicochemical and bioactive properties of six honey samples from various floral origins from Tunisia. *Arabian Journal of Chemistry*, *11*(2), 265-274.

Bramley, C., & Biénabe, E. (2013). Guidelines for Selecting Successful GI Products. In C. Bramley, E. Biénabe & J. Kirsten (Eds.), *Developing Geographical Indications in the South: The Southern African Experience*. Springer, London.

Bramley, C., Biénabe, E., & Kirsten, J. (2003). The Economic of Geographical Indications: Towards a conceptual framework for geographical indication research in Developing Countries. In *The Economics of Intellectual Property* (pp. 109ï 149). World Intellectual Property Organisation (WIPO), Geneva.

Buba, F., Gidado, A., & Shugaba, A. (2013). Analysis of Biochemical Composition of Honey Samples from North-East Nigeria. *Biochemistry & Analytical Biochemistry*, *2*(3), 139-159.

Camara, T. H., & Haba, M. (2004). Mamou pepper. Simplified form for the identification of products likely to be recognized in geographical indications. African Property Organization Intellectual. Yaoundé.

Cantarelli, M. A., Pellerano, R. G., Marchevsky, E. J., & Camina, J. M. (2008). Quality of honey from Argentina: Study of chemical composition and trace elements. *Journal of the Argentine Chemical Society, 96,* 33ï 41.

Carroll, T., & Kinsella, J. (2013). Livelihood improvement and smallholder beekeeping in Kenya: the unrealised potential. *Development in Practice*, *23*(3), 332ï 345.

Castro Vàzquez, L., Díaz Maroto, M. C., & Gonzàlez Vinas, M. A. (2008). Influence of storage conditions on chemical composition and sensory properties of citrus honey. *Journal of Agricultural and Food Chemistry*, *56,* 1999-2006.

Chabrol, D., Mariani, M., & Sautier, D. (2017). Establishing Geographical Indications without State Involvement? Learning from Case Studies in Central and West Africa. *World Development*, *98*, 68ï 81.

Chamberlain, S. A., & Schlising, R. A. (2008). Role of honey bees (*Hymenoptera: Apidae*) in the pollination biology of a California native plant, *triteleia laxa* (*Asparagales: Themidaceae*). *Environmental Entomology*, *37*(3), 808ï 816.

Chefrour, A., Draiaia, R., Tahar, A., Ait, K. Y., Bennadja, S., & Battesti, M. J. (2009). Physicochemical characteristics and pollen spectrum of some north-eastern Algerian honeys. *African Journal of Food, Agriculture, Nutrition and Development 9,* 1276 ï 1293.

Chever, T., Renault, C., Renault, S., & Romieu, V. (2012). Value of production of agricultural products and foodstuffs , wines , aromatised wines and spirits protected by a geographical indication (GI). Retrieved from https://ec.europa.eu/agriculture/sites/agriculture/files/.../value-gi/final-report_en.pdf.

Conner, J. K., & Rush, S. (1996). Effects of flower size and number on pollinator visitation to wild radish, Raphanus raphanistrum. *Oecologia*, *105*(4), 509ï 516.

Coulet, T., & Mahop, M. T. (2012). Cameroon: Oku White Honey. In M. Blakeney, T. Coulet, G. Mengistie, & M. T. Mahop (Eds.), *Extending the Protection of Geographical Indications. Case studies of Agricultural Products in Africa*. EARTHSCAN, Routledge, New York.

Couvillon, M. J., Pearce, F. C. R., Harris-Jones, E. L., Kuepfer, A. M., Mackenzie-Smith, S. J., Rozario, L. A., Schurch, R., & Ratnieks, F. L. W. (2012). Intra-dance variation among waggle runs and the design of efficient protocols for honey bee dance decoding. *Biology Open, 1,* 467ï 472.

Couvillon, M. J., Riddell Pearce, Fiona, C., Acceleton, C., Fensome, K. A., Quah, S. K. L., Taylor, E. L., & Ratnieks, F. L. W. (2015). Honey bee foraging distance depends on month and forage type. *Apidologie, 46*(1)*,* 61ï 70.

Davis, K., Nkonya,E., Kato, E., Mekonnen, D.A, Odendo, M., Miiro, R., & Nkuba, J. (2010). *Impact of Farmer Field Schools on Agricultural Productivity and Poverty in Uganda*. IFPRI. Discussion Paper 00992. Retrieved from https://pdfs.semanticscholar.org/d0c7/9ae04439217101c80170383c2375976ee1f1.pdf.

Diafat, A. E. O., Benouadah, A., Bahloul, A., Meribai, A., Mekhalfi, H., Bouaziz,F., Techache, D., Laabachi, H., & Arrar, L. (2017). Physicochemical properties and pollen analyzes of some Algerian honeys. *International Food Research Journal, 24*(4), 1453-1459.

Dlamini, C. S., & Geldenhuys, C. J. (2009). The socioeconomic status of the non-timber forest product subsector in Swaziland. *Southern Forests: A Journal of Forest Science*, *71*(4), 311ï 318.

Egelyng, H., Bosselmann, A. S., Warui, M., Maina, F., Mburu, J., & Gyau, A. (2017). Origin products from African forests: A Kenyan pathway to prosperity and green inclusive growth? *Forest Policy and Economics*, *84*, 38ï 46.

EPRC. (2012). What factors determine membership to farmer groups in Uganda? Evidence from the Uganda Census of Agriculture 2008/9. *Research series number*, *98,* 1-42.

Etwire, P. M., Dogbe, W., Wiredu, A. N., Martey, E., Etwire, E., Robert, K., & Wahaga, E. (2013). Factors Influencing Farmer´s Participation in Agricultural Projects¿ The case of the Agricultural Value Chain Mentorship Project in the Northern Region of Ghana. . *Journal of Economics and Sustainable Development*, *4*(10), 36ï 44.

FAO. (2006). Migrations & Développement Study on rural tourism and agricultural sectors in the province of Taroudant: argan oil, olive oil and safra. In *Migrations & Développement*. Organisation des Nations Unis pour l´Alimentation et l´Agriculture FAO.

Faturoti, O., Emah, N., Isife, I., Tenkouano, A., & Lemchi, J. (2006). Prospects and determinants of adoption of IITA platain and banana based technologies in three Niger Delta states of Nigeria. *African Journal of Biotechnology*, *5*(14), 1319-1323.

Feás, X., Pires, J., Estevinho, M. L., Iglesias, A., & Pinto de Araujo, J. P. (2010). Palynological and physicochemical data characterisation of honeys produced in the Entre-Douro e Minho region of Portugal. *International Journal of Food Science and Technology*, *45,* 1255ï 1262.

Fidalgo, A. O., & Kleinert, A. M. P. (2010). Floral preferences and climate influence in nectar and pollen foraging by melipona rufiventris lepeletier (*Hymenoptera: Meliponini*) in Ubatuba, São Paulo State, Brazil. *Neotropical Entomology*, *39*(6), 879ï 884.

Foley, J. A., Defries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., Chapin, F. S., Coe, M. T., Daily, G. C., Gibbs, H. K., Helkowski, J. H., Holloway, T., Howard, E. A., Kucharik, C. J., Monfreda, C., Patz, J. A., Prentice, C., Ramankutty, N., & Snyder, P. K.

(2005). Global consequences of land use. *Science, 309,* 570ï 574.

Gachimbi, L. (2002). *Participatory diagnosis of soil nutrient depletion in semi-arid areas of Kenya.* Managing African soils no.26 .

Gallego Gómez, J. (2007). Coffee from Colombia. In H. Riveros, E. Vandecandelaere, & T. Florence (Eds.), *Quality of food linked to the origin and traditions in Latin America: case studies.* Rome, Italy: FAO-IICA. Retrieved from www.cafedecolombia.com/particulares/en/el_cafe_de_colombia/

Garcin, D. G., & Carral, S. (2007). *Moroccan saffron between tradition and market: Study of the sector of saffron in Morocco, in the region of Taliouine, province of Taroudant*.

Gerz, A., & Fournier, S. (2006). Gerz A. Fournier, S.Gari Missè in Benin: a local, premium-quality staple. In P. Vande Kop, D. Sautier, & A. Gerz (Eds.), *Origin-based products : Lessons for pro-poor market development*. Amsterdam: KIT / CIRAD.

Getachew, A., Gizaw, H., Assefa, D., & Tajebe, Z. (2014). Physico-chemical properties of honey produced in Masha, Gesha, and Sheko Districts in Southwestern Ethiopia. *Current Research in Agricultural Sciences, 1*(4),110 ï 116.

Ghazoul, J. (2006). Floral diversity and the facilitation of pollination. *Journal of Ecology, 94,* 295ï 304.

Gibson, R. W., Byamukama, E., Mpembe, I., Kayongo, J., & Mwanga, R. O. (2008). Working with farmer groups in Uganda to develop new sweet potato cultivars: decentralisation and building on traditional approaches. *Euphytica*, *159,* 217ï 228.

Gichora, M. (2003). *Towards Realization of Kenya's Full Beekeeping Potential: A Case Study of Baringo District*. *Ecology and Development Series 6*. University of Bonn, Germany.

Gikungu, M. W. (2006). *Bee Diversity and some Aspects of their Ecological Interactions with Plants in a Successional Tropical Community*. Bonn University, Germany.

Giovannucci, D., Josling, T., Kerr, W., OöConnor, B., & Yeung, M. T. (2009). *Guide to geographical indications. Linking products and their origins*. International Trade Centre. Geneva.

Gloor, R. (2011). *Bees and their products: A Cabesl Project Report*. ICIPE, Nairobi, Kenya

Gok, S., Severcan, M., Goormaghtigh, E., Kandemir, I., & Severcan, F. (2015). Differentiation of Anatolian honey samples from different botanical origins by ATR-FTIR spectroscopy using multivariate analysis. *Food Chemistry*, *170,* 234ï 240.

GoK. (2010). *Agricultural sector development strategy 2010–2020*. Nairobi, Kenya. Retrieved from http://www.gafspfund.org/sites/gafspfund.org/files/Documents/5.Kenya_strategy.pdf

GoK. (2013). *Sessional paper No. 7 on National Beekeeping Policy. Enhancing the contribution of the beekeeping sector to food security, agribusiness, employment creation and environmental conservation towards Vision 2030*. Ministry of Agriculture, Livestock and Fisheries State Department, Nairobi, Kenya

Gomes, S., Dias, L. G., Moreira, L. L., Rodrigues, P., & Estevinho, L. (2010). Physicochemical, microbiological and antimicrobial properties of commercial honeys from Portugal. *Food and Chemical Toxicology*, *48,* 544-548.

Gomes, T., Feaçs, X., Iglesias, A., & Estevinho, L. M. (2011). Study of organic honey from the Northeast of Portugal. *Molecules*, *16,* 5374ï 5386.

González-Miret, M. L., Terrab, A., Hernanz, D., Fernández- Recamales, M. A., & Heredia, F. J. (2005). Multivariate correlation between color and mineral composition of honeys and by their botanical origin. *Journal of Agricultural and Food Chemistry, 53,* 2574ï 2580.

Goulson, D., Nicholls, E., & Rotheray, E. L. (2015). Bee declines driven by combined stress from parasites, pesticides, and lack of flowers. *Science*, *347*(6229), 1435ï 1444.

Government of Baringo. (2013). *First County Integrated Development Plan (2013-2017*), Kenya

Government of Kitui. (2013). *First County Integrated Development Plan (2013-2017*), Kenya

Government of West Pokot. (2013). *First County Integrated Development Plan (2013-2017*), Kenya

Grote, U. (2009). Environmental Labeling, Protected Geographical Indications and the Interests of Developing Countries. *The Estey Centre Journal of International Law and Trade Policy*, *10*(1), 94ï 110.

Hansted, L., Grout, B. W. W., Eilenberg, J., Dencker, I. B., & Toldam-Andersen, T. B. (2012). The importance of bee pollination of the sour cherry (*Prunus cerasus*) cultivar óstevnsbaerô in Denmark. *Journal of Pollination Ecology*, *10*(16), 124ï 129.

Harsh, J. (2000). Population genetic structure of *Acacia Brevispica* from East Africa. *Undergraduate Research Journal, 3,* 39ï 42.

Hermitte, M. (2001). Les appellations d ô origine dans la genèse des droits de propriété intellectuelle. *Études Recherche Systèmes Agraires Développement*, *32*, 195ï 207.

Herrera, C. M. (2000). Measuring the effects of pollinators and herbivores: Evidence for non-additivity in a perennial herb. *Ecology*, *81*(8), 2170ï 2176.

Ibrahim, F., & Ibrahim, B. (1998). The Maasai herbalists in Arusha Town, Tanzania. *GeoJournal*, *46*(2), 141ï 154.

ICIPE. (2009). *Improving Forest Conservation and Community Livelihoods through Income Generation from Commercial Insects in Three Kenyan Forests*. Nairobi, Kenya.

Israel, G. D. (2009). *Determining sample size. Program Evaluation and Organizational Development (PEOD)*. Institute of Food and Agricultural Sciences (IFAS), University of Florida, Gainesville.

Issa, N., & Chrysostome, N. J. (2015). Determinants of farmer participation in the vertical integration of the Rwandan coffee value chain¿ Results from Huye District. *Journal of Agricultural Science*, *7*(9), 197ï 211.

Izac, A.-M., Egelyng, H., Ferreira, G., Duthie, D., Hubert, B., Louwaars, N., & et al., (2009). Options for enabling policies and regulatory environments. In B. D. McIntyre, H. Herren & R. T. Watson (Eds.), *Agriculture at a Crossroads- Volume 1: The Global Report. IAASTD*. Island Press.

JAICAF. (2009). Development of Beekeeping in Developing Countries and Practical Procedures. Case Study in Africa. Japan Association for International Collaboration of Agriculture and Forestry. Retrieved from http://www.jaicaf.or.jp/English/bee_en.pdf.

Jennersten, O. (1988). Pollination in Dianthus deltoides (*Caryophyllaceae*): Effects of habitat fragmentation on visitation and seed set pollination in dianthus deltoides (*Caryophyllaceae*): Effects of habitat fragmentation on visitation and seed set. *Conservation Biology*, *2*(4), 359ï 366.

Johnson, S. D., & Steiner, K. E. (2000). Generalization versus specialization in plant pollination systems. *TREE*, *15*(4), 140ï 143.

Jones, G. D., & Bryant, V. M. (2014). Pollen Studies of East Texas Honey. *Palynology*, *38*(2), 242ï 258.

Juma, C. E. N. (2017). *Economic analysis of consumers' awareness and willingness to pay for geographical indicators and other quality attributes of honey in Kenya*. University of Nairobi, Kenya.

Karanja, R. H. N., Njoroge, G. N., Gikungu, M. W., & Newton, L. E. (2010). Bee interactions with wild flora around organic and conventional coffee farms in Kiambu District , Central Kenya. *Journal of Pollination Ecology*, *1*(2), 7ï 12.

Karli, A., Bilgic, A., & Celik, Y. (2006). Factors Affecting Farmersô Decision to Enter Agricultural Cooperatives Using Random Utility Model in the South Eastern Anatolian

Region of Turkey. *Journal of Agricultural and Rural Development in the Tropics and Subtropics*, *107(*2), 115-127.

Kasina, M., Kraemer, M., Martius, C., & Wittmann, D. (2009). Farmersô knowledge of bees and their natural history in Kakamega District, Kenya. *Journal of Apicultural Research and Bee World*, *48* (2): 126-133.

Khan, M., Sajjad, M., Hameed, B., Khan M. N., & Jan, A. U (2012). Participation of Women in Agriculture Activities in District Peshawar. *Sarhad Journal of Agriculture, 28*(1), 121-127.

Kiage, L. M., Liu, K.-B., Walker, N. D., Lam, N., & Huh, O. K. (2007). Recent land-cover/use change associated with land degradation in the Lake Baringo catchment, Kenya, East Africa: evidence from landsat TM and ETM+. *International Journal of Remote Sensing*, *28*(19), 4285ï 4309.

KIPI. (2009). MoU Swiss - Kenya Project on Geographical Indications (SKGI). Kenya Intellectual Property Institute, Nairobi. Retrieved from https://www.ige.ch/fileadmin/user_upload/%0AJuristische_Infos/e/MoU_swiss_kenya_e.pdf.

Kirs, E., Pall, R., Martverk, K., & Laos, K. (2011). Physicochemical and melissopalynological characterization of Estonian summer honeys. *Procedia Food Science*, *1,* 616 ï 624.

Klein, A.-M., Cunningham, S. A., Bos, M., & Steffan-Dewenter, I. (2008). Advances in pollination ecology from tropical plantation crops. *Ecology*, *89*(4), 935ï 943.

Kolehmainen, J. K., & Mutikainen, P. (2006). Reproductive ecology of three endangered African violet (*Saintpaulia H. Wendl.*) species in the East Usambara Mountains, Tanzania. *African Journal of Ecology, 44,* 219ï 227.

Krebs, J. R., Wilson, J. D., Bradbury, R. B., & Siriwardena, G. M. (1999). The second silent spring? *Nature, 400,* 611ï 612.

Küçük, M., Kolailē S., Karaoĵ lu, ķ., Ulusoy, E., Baltacē C., & Candan, F. (2007). Biological activities and chemical composition of three honeys of different types from Anatolia. *Food Chemistry*, *100,* 526ï 534.

Larson Guerra, J. (2004). Geographical Indications and Biodiversity¿ Bridges Joining Distant Territories. *Bridges*, *8*(2), 17ï 18.

Larson, B. M. H., & Barrett, S. C. H. (1999). The ecology of pollen limitation in buzz-pollinated Rhexia virginica (*Melastomataceae*). *Journal of Ecology, 87,* 371ï 381.

Larson, J. (2007). *Relevance of geographical indications and designations of origin for the sustainable use of genetic resources*. Rome, Italy. Retrieved from http://underutilized-species.org/Documents/PUBLICATIONS/gi_larson_lr.pdf.

Lennartsson, T. (2002). Extinction thresholds and disrupted plant-pollinator interactions in fragmented plant populations. *Ecology*, *83*(11), 3060ï 3072.

Louveaux, J., Maurizio, A., & Vorwohl, G. (1970). Methods of melissopalynology. *Bee World, 51,* 125ï 131.

Louveaux, J., Maurizio, A., & Vorwohl, G. (1978). Methods of Melissopalynology. *Bee World*, *59*, 139ï 157.

Mancini, M. C. (2013). Geographical Indications in Latin America Value Chains¿ A ñ branding from below ò strategy or a mechanism excluding the poorest*?* *Journal of Rural Studies*, *32*, 295ï 306.

Marescotti, A. (2003). Typical products and rural development: who benefits from PDO/PGI recognition? In K. Mattas & E. Tsakiridou (Eds.), *Food Quality Products in the Advent of the 21st Century: Production, Demand and Public Policy*. Chania, Greece: CIHEAM. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Typical+products+and+rural+development+:+Who+benefits+from+PDO+/+PGI+recognition+?#0

Marie-vivien, D., Garcia, C. A., Kushalappa, C. G., & Vaast, P. (2014). Trademarks , Geographical Indications and Environmental Labelling to Promote Biodiversity¿ The Case of Agroforestry Coffee in India. *Development Policy Review*, *32*(4), 379ï 398.

Marshall, A. R., Platts, P. J., Gereau, R. E., Kindeketa, W., Kangœthe, S., & Marchant, R. (2012). The genus acacia (*Fabaceae*) in East Africa: distribution, diversity and the protected area network. *Plant Ecology and Evolution, 145*(3), 289ï 301.

Martins, D. J. (2004). Foraging patterns of managed honeybees and wild bee species in an arid African environment: Ecology, biodiversity and competition. *International Journal of Tropical Insect Science*, *1,* 105ï 115.

Martins, D. J. (2008). Pollination observations of the African violet in the Taita Hills, Kenya. *Journal of East African Natural History*, *97*(1), 33ï 42.

Martins, D. J. (2014). *Our Friends the Pollinators: A Handbook of Pollinator Diversity and Conservation in East Africa*. Nature Kenya - The East Africa Natural History Society, Nairobi, Kenya.

Martins, D. J., & Johnson, S. D. (2009). Distance and quality of natural habitat influence hawkmoth pollination of cultivated papaya. *International Journal of Tropical Insect Science*, *29*(3), 114ï 123.

Martos, I., Ferreres, F., & Tomas-Barberan, F. A. (2000). Identification of flavonoid markers for the botanical origin of Eucalyptus honey. *Journal of Agricultural and Food Chemistry, 48,* 1498ï 1502.

Marty, F. (1998). Which are the ways of innovation in PDO and PGI products. In F. Arfini & C. Mora (Eds.), *Typical and Traditional Products: Rural Effect and Agro-Industrial Problems*. Parma, Italy.

Maundu, P., & Tengnas, B. (2005). Useful Trees and Shrubs for Kenya. World Agroforestry Centre, Nairobi, Kenya.

Mawardi, S. (2009). *Advantages , Constraints And Key Success Factors In Establishing Origin- and Tradition-Linked Quality Signs : Kintamani Bali Arabica coffee geographical indication, Indonesia*. *Case study on quality products linked to geographical origin in Asia*.

Mburu, J., & Wale, E. (2006). Local organizations involved in the conservation of crop genetic resources: conditions for their emergence and success in Ethiopia and Kenya. *Genetic Resources and Crop Evolution*, *53,* 613ï 629.

Mehryar, L., & Esmaiili, M. (2011). *Honey and Honey Adulteration Detection: A Review. In Proceedings of 11th International Congress on Engineering and Food*, Athens, Greece.

Moncur, M. W., Mitchell, A., Fripp, Y., & Kleinschmidt, G. J. (1995). The role of honey bees (*Apis mellifera*) in eucalypt and acacia seed production areas. *The Commonwealth Forestry Association*, *74*(4), 350ï 354.

Morgan, D. L. (1988). Age Differences in Social Network Participation. *Journal of Gerontology: Social sciences, 43*(4), 129-137.

Moschini, G., Menapace, L., & Pick, D. (2008). Geographical indications and the provision of quality in agricultural markets. *American Journal of Agricultural Economics*, *90,* 794ï 812.

Muiruri, M.P.D. (2015). *Mapping of the honey value chain and analysis of changes in gender roles and factors influencing women empowerment among beekeepers in Kitui County*. University of Nairobi, Kenya.

Muli, E., Munguti, A., & Raina, S. K. (2007). Quality of Honey Harvested and Processed Using Traditional Methods in Rural Areas of Kenya. *Acta Veterinaria Brno*, *76*(2), 315ï 320.

Muona, O., Morant, G. F., & Bell, J. C. (1991). Hierarchical patterns of correlated mating in acacia melanoxylon. *Genetics, 127,* 619ï 626.

Mupangavanhu, Y. Y. (2013). *The regional integration of African trade mark laws: challenges and possibilities.* University of the Western Cape. Retrieved from http://etd.uwc.ac.za/xmlui/.

Mureithi, S. M., Verdoodt, A., Njoka, J. T., Gachene, C. K. K., & Ranst, E. Van. (2016). Benefits derived from rehabilitating a degraded semi-arid rangeland in communal enclosures, Kenya. *Land Degradation and Development, 27,* 1853ï 1862.

Musinguzi, P. (2016). *Livelihoods and local certified organic niche markets: A case study of local certified organic smallholder bee keepers in Mwingi, Eastern Kenya*. University of Copenhagen, Denmark.

Musinguzi, P., Skovmand, A., & Pouliot, M. (2018). Livelihoods-conservation initiatives¿ Evidence of socio-economic impacts from organic honey production in Mwingi , Eastern Kenya. *Forest Policy and Economics*, *97*, 132ï 145.

Musungu, S. F. (2008). *The protection of Geographical Indications and the Doha round: strategic and policy considerations for Africa*. Geneva, Switzerland. Retrieved from http://www.quno.org/resource/2008/12/protection-geographical-indications-and-doha-round-strategic-and-policy.

Mwaura, F.M., Tungani, J. O., Sikuku, D., & Woomer, P. L. (2012). Acceptability of cereal banks as a marketing intervention among small holder farmers in Western Kenya. *Outlook on Agriculture, 41*(1), 35-40.

Ngöangöa, F., Onditi, A., Gachanja, A., & Ngumba, E. (2013). Physicochemical Analysis of Honey in the Kenyan Retail Market. *Food Science and Quality Management, 12,* 30-36.

Ngaruko, D. D., & Lwezaula, D. D. (2013). Determinants of Farmersô Group Membership Satisfaction in Mbozi Distict, Tanzania: Exploring Farmersô Options. *International Journal of Economics & Management Sciences, 2* (11), 919-923.

Ngethe, J. C. (1985). *Honey production from natural vegetation in Kitui, Kenya. Proceeding of the international Conference of Apicultural Tropical Climates*. IBRA, London, UK.

Nnadi, F. N., & Akwiwu, C. D. (2008). Determinants of Youthsô Participation in Rural Agriculture in Imo State, Nigeria. *Journal of Applied Sciences, 8*(2), 328-333.

Nyaga, A. (2004). The Geographical Indication Protection Africa Perspective. In *WTO Round Table on Geographic Indications aromatized wines and spirits protected by a geographical indication (GI)*. Retrieved from https://www.wto.org/english/tratop_e/dda _e/symp04_paper_nyaga_e.doc

Nyambati, E. M., Sollenberger, L. E., Karue, C. N., & Musimba, N. K. R. (2006). The value of A*cacia brevispica* and *Leucaena leucocephala* Seedpods as dry season supplements for calves in dry areas of Kenya. *African Journal of Agricultural Research*, *1*(4), 118ï 124.

Oddo, L. P., Piazza, M. G., & Pulcini, P. (1999). Invertase activity in honey. *Apidologie, 30,* 57-65.

Olesen, J. M., & Jordano, P. (2002). Geographic patterns in plant-pollinator mutualistic networks. *Ecology*, *83*(9), 2416ï 2424.

Opiyo, E. B. (2014). *Protection of Geographical Indications in Kenya*. Africa University, Kenya.

Otieno, P. S., Nyikal, R. A., & Mugivane, F. I. (2010). Non-credit services of group-based financial institutions: Implications for smallholder women's honey income in arid and semi arid lands of Kenya. *African Journal of Agricultural Research*, *5*(5), 344-347.

Petersen, S., & Bryant V. (2011). The study of pollen and its role in the honey market. *American Bee Journal 151*(6), 591-594.

Pomeón, T. (2007). *Cheese Cotija, Mexico: A product with collective brand "Cotija Region of origin", in the process of acquiring a Designation of Origin*. *FAO-IICA*. Mexico.

Retrieved from http://www.fao.org/fileadmin/templates/olq/documents/Santiago/Documentos/Estudios%20de%20caso/Cotija/Queso_COTIJA_Mexico.pdf

Potts, S. G., Biesmeijer, J. C., Kremen, C., Neumann, P., Schweiger, O., & Kunin, W. E. (2010). Global pollinator declines: trends, impacts and drivers. *Trends in Ecology & Evolution*, *25*(6), 345ï 353.

Potts, S. G., Vulliamy, B., Dafni, A., Neœman, G., OôToole, C., Roberts, S., & Willmer, P. (2003). Response of plant-pollinator communities to fire: changes in diversity, abundance and floral reward structure. *OIKOS, 101,* 103ï 112.

Raine, N. E., Pierson, A. S., & Stone, G. N. (2007). Plantï pollinator interactions in a Mexican acacia community. *Arthropod-Plant Interactions, 1,* 101ï 117.

Raine, N. E., Willmer, P., & Stone, G. N. (2002). Spatial structuring and floral avoidance behavior prevent ant-pollinator conflict in a Mexican ant-acacia. *Ecology, 83*(11), 3086ï 3096.

Rekha, S. S., Pushpa, R. K., & Dinanath, V. R. (1997). *Honey: Quality Criteria. Handbook of indices of Food Quality*. Woodhead Publishing Limited, Cambridge, England.

Richards, A. J. (2001). Does low biodiversity resulting from modern agricultural practice affect crop pollination and yield? *Annals of Botany, 88,* 165ï 172.

Ricketts, T. H. (2004). Tropical forest fragments enhance pollinator activity in nearby coffee crops. *Conservation Biology, 18*(5), 1262ï 1271.

Ross, J. H. (1981). An analysis of the African acacia species: Their distribution, possible origins and relationships. *Bothalia, 13*(3), 389ï 413.

Ross, J. H., & Gordon-Gray, K. D. (1966). *Acacia brevispica* and *Acacia schweinfurthii* in Africa, with particular reference to Natal. *Brittonia*, *18*(1), 44ï 63.

Roubik, D. W. (1992). *Ecology and natural history of tropical bees*. New York: Cambridge University Press.

Roubik, D. W. (1993). Tropical pollinators in the canopy and understory: Field data and theory for stratum "preferences". *Journal of Insect Behavior, 6*(6), 659-673.

Roubik, D. W. (1995). *Pollination of cultivated plants in the tropics*. FAO Agricultural Services Bulletin 118. Retrieved from http://www.fao.org/3/a-v5040e.pdf.

Ruiz-Argueso, T., & Rodriquez-Navarra, A. (1973). Gluconic acid-producing bacteria from honey bees and ripening honey. *Journal of General Microbiology, 76,* 211-216.

Sahinler, N., & Gul, A. (2004). Chemical composition and physical properties of honey produced in Turkey from sunflower, cotton, orange and pine. In I. Bernardinelli, & N. Milani (Eds.). *Proceeding of the first European Conference of Apidology*. Udine, Italy.

Schaffer, W. M., Zeh, D. W., Buchmann, S. L., Kleinhans, S., Schaffer, V. M., & Antrim, J. (1983). Competition for nectar between introduced honey bees and native North American bees and ants. *Ecology, 64*(3), 564ï 577.

Schreck, C. J., & Semazzi, F. H. (2004). Variability of the recent climate of eastern Africa. *International Journal of Climatology*, *24*(6), 681-701.

Sereyvath, P. (2009). Kampong Speu Palm sugar, Cambodia. In FAO (Ed.), *Rural development and agrifood product quality linked to geographical origin in Asia*. Bangkok: FAO.

Shenkute, A. G., Getachew, Y., Assefa, D., Adgaba, N., Ganga, G., & Abebe, W. (2012). Honey production systems (Apis Mellifera L.) in Kaffa, Sheka and Bench-Maji zones of Ethiopia. *Journal of Agriculture Extension and Rural Development, 4,* 528 ï 541.

Silva, L. R., Andreia, P. R. V., Valentão, M. P., & Andrade, P. B. (2009). Honey from Luso region (Portugal): Physicochemical characteristics and mineral contents. *Microchemica l Journal*, *93* (1), 73ï 77.

Silva, T. M. S., Santos, F. P., Evangelista-Rodrigues, A., Silva, E. M. S., Silva, G. S., Novais, J. S. Santos, F. A. R., & Camara, C. A. (2013). Phenolic compounds, melissopalynological, physicochemical analysis and antioxidant activity of jandaēra (*Melipona subnitida*) honey. *Journal of Food Composition and Analysis*, 29, 10ï 18.

SINER-GI. (2006). *WP1 Report. Legal and Institutional issues related to GIs*. Retrieved from www.origin-food.%0Aorg/2005/upload/SIN-WP1-report-131006.pdf%0A

Spears, E. E. (1983). A direct measure of pollinator effectiveness. *Oecologia, 57*(1), 196ï 199.

Steffan-Dewenter, I., & Tscharntke, T. (2000). Resource overlap and possible competition between honey bees and wild bees in Central Europe. *Oecologia, 122*(2), 288ï 296.

Stolzenbach, S., Byrne, D.V., & Bredie, W. L. P. (2011). Sensory local uniqueness of Danish honeys. *Food Research International*, *44,* 2766-2774.

Stone, G. N., Raine, N. E., Prescott, M., & Willmer, P. G. (2003). Pollination ecology of acacias (*Fabaceae, Mimosoideae*). *Australian Systematic Botany, 16,* 103ï 118.

Stone, G. N., Willmer, P., & Rowe, J. A. (1998). Partitioning of pollinators during flowering in an African acacia community. *Ecology, 79*(8), 2808ï 2827.

Tandon, R., & Shivanna, K. R. (2001). Pollination biology and breeding system of *Acacia senegal. Botanical Journal of the Linnean Society, 135,* 251ï 262.

Thomson, D. M. (2006). Detecting the effects of introduced species: A case study of competition between Apis and Bombus. *OIKOS, 114,* 407ï 418.

Tscharntke, T., Klein, A. M., Kruess, A., Steffan-Dewenter, I., & Thies, C. (2005). Landscape perspectives on agricultural intensification and biodiversity ï ecosystem service management. *Ecology Letters, 8,* 857ï 874.

Tybirk, K. (1993). Pollination, breeding system and seed abortion in some African acacias. *Botanical Journal of the Linnean Society, 112,* 107ï 137.

Ushimaru, A., Watanabe, T., & Nakata, K. (2007). Colored floral organs influence pollinator behavior and pollen transfer in commelina communis (*Commelinaceae*). *American*

Journal of Botany, 94(2), 249ï 258.

Vandecandelaere, E., & Mery, J. (2008). Limón de Pica, Chile. In H. Riveros, E. Vandecandelaere, & T. Florence (Eds.), *Quality of food linked to the origin and traditions in Latin America: case studies*. Rome, Italy: FAO-IICA.

Vandecandelaere, E., Arfini, F., Belletti, G., & Marescotti, A. (2010). *Linking people, places and products: A guide for promoting quality linked to geographical origin and sustainable geographical indications* (2nd ed.). FAO and SINER-GI, Rome.

VanEngelsdorp, D., & Meixner, M. D. (2010). A historical review of managed honey bee populations in Europe and the United States and the factors that may affect them. *Journal of Invertebrate Pathology, 103*, S80 ï S95.

Vazquez, D. P., & Simberloff, D. (2002). Ecological specialization and susceptibility to disturbance: Conjectures and refutations. *The American Naturalist, 159*(6), 606ï 623.

Vergara, C. H., & Badano, E. I. (2009). Pollinator diversity increases fruit production in Mexican coffee plantations: The importance of rustic management systems. *Agriculture, Ecosystems and Environment, 129,* 117ï 123.

Villanueva-G, R., & Roubik, D. W. (2004). Why are African honey bees and not European bees invasive? Pollen diet diversity in community experiments. *Apidologie, 35,* 481ï 491.

Viuda-Martos, M., Riuz-Navajas, Y., Zaldivar-Cruz, J. M., Kuri, V., Fernández-López, J., Carbonell-Barrachina, A. A., & PérezÁlvarez, J. A. (2010). Aroma profile and physico-chemical properties of artisanal honey from Tabasco, Mexoco. *International Journal of Food Science and Technology, 45,* 1111-1118.

Von Der Ohe, W., Oddo, L. P., Piana, M. L., Morlot, M., & Martin, P. (2004). Harmonized methods of melissopalynology. *Apidologie*, *35*, S18ï S25.

Wang, J., & Li, Q. X. (2011). Chemical composition, characterization and differentiation of honey botanical and geographical origins. *Advances in food nutrition research*, *62,* 89-137.

Wanzala, W., Syombua, S. M., & Alwala, J. O. (2016). A survey of the applications and use of ethnomedicinal plants and plant products for healthcare from the Ukambani region in Eastern Kenya. *Indian Journal of Ethnophytopharmaceuticals*, *2*(2), 6ï 58.

Warui, M., Gikungu, M., Bosselmann, A., Hansted, L., & Mburu, J. (2014). An assessment of high quality honeys with a potential for Geographical Indication (GI) labeling and initiatives that add value to the honey sector in Kenya.

Waser, N. M., Chittka, L., Prince, M. V, Williams, N. M., & Ollerton, J. (1996). Generalization in pollination systems, and why it matters. *Ecology, 77*(4), 1043ï 1060.

White, J. W. (1994). The role of HMF and diastase assays in honey quality evaluation. *Bee World*, *75,*104-117.

White, J. W., & Doner, L. W. (1980). Honey composition and properties: Beekeeping in the United States. *Agric Handbook*, *335,* 82-91.

Wiles, N. L., Paterson, M., & Meaker, J. L. (2009). What factors determine the use of the nutrition information on the food label when female consumers from Pietermaritzburg select and purchase fat spreads? *South African Journal of Clinical Nutrition, 22*(2), 69-73.

Williams, E. T., Jeffrey, J., Barminas, J. T., & Toma, I. (2009). Studies on the effects of the honey of two floral types (*Ziziphus* spp. and *Acelia* spp.) on organism associated with burn wound infections. *African Journal of Pure and Applied Chemistry*, *3*(5), 98ï 101.

Williamson, M. (2012). Geographical Indications , Biodiversity and Traditional Knowledge ;
Obligations and Opportunities for the Kingdom of Saudi Arabia. *Arab Law Quarterly*, *26*(1), 99ï 119.

Winfree, J. A., & McCluskey, J. (2005). Collective reputation and quality. *American Journal of Agricultural Economics*, *87*(1), 206ï 213.

Winfree, R., Aguilar, R., Vazquez, D. P., Lebuhn, G., & Aizen, M. A. (2009). A meta-analysis of beesô responses to anthropogenic disturbance. *Ecology, 90*(8), 2068ï 2076.

WIPO. (2014). Bees, geographical indications, and development. Oku white honey, cameroon. Case study by World Intellectual Property Organization, Geneva. Retrieved from http://www.wipo.int/ipadvantage/en/details.jsp?id=5554.

Wunder, S., Angelsen, A., & Belcher, B. (2014). Forests, livelihoods, and conservation: Broadening the empirical base. *World Development, 64,* S1ï S11.

Yang, Y., Battesti, M. J., Costa, J., & Paolini, J. (2014). Characterization of Botanical and Geographical Origin of Corsican ñSpringò Honeys by Melissopalynological and Volatile Analysis. *Foods*, *3*(1), 128ï 148.

Yang, Y., Battesti, M. J., Paolini, J., Muselli, A., Tomi, P., & Costa, J. (2012). Melissopalynological origin determination and volatile composition analysis of Corsican ñErica arborea spring maquisò honeys. *Food Chemistry*, *134,* 37ï 47.

Yucel, Y., & Sultanoglu, P. (2013). Characterization of honeys from Hatay Region by their physicochemical properties combined with chemometrics. *Food Bioscience*, 1, 16ï 25.

Zhou, Q. X., Wintersteen, C. L., & Cadwallader, K. R. (2002). Identification and quantification of aroma-active components that contribute to the distinct malty flavor of buckwheat honey. *Journal of Agricultural and Food Chemistry,* 50, 2016-2021.

APPENDICES

Appendix 1: Recommended physicochemical parameter values based on East African Standards (EAS) for honey (EAS 36:2000), Codex Alimentarius honey standards (CODEX STAN 12-1981) and the European Union (EU) directive for honey (2001/110/EC)

Honey standards	Moisture content (%)	HMF (mg/kg)	Diastase (Schade units)	Free acidity (meq/kg)	Electrical conductivity (mS/cm)
EAS	Ò22	Ò80	Ó3	Ò40	np
Codex	Ò20	Ò40	Ó8	Ò50	Ò0.8
EC Directive	Ò20	Ò40	Ó8	Ò50	Ò0.8

Np=not specified

Appendix 2: Physicochemical parameter values of West Pokot, Baringo and Kitui honey

Study Area	Honey Sample No.	Moisture content (%)	HMF (mg/kg)	Diastase activity (Schade units)	Free acidity (meq/kg)	Electrical conductivity (mS/cm)
West Pokot	1	15.70	19.00	8.90	18.50	0.30
	2	15.80	19.30	9.60	18.50	0.31
	3	15.80	27.30	8.80	17.00	0.26
	4	15.80	26.80	8.60	17.00	0.26
	5	15.80	23.30	12.50	18.50	0.28
	6	15.80	23.10	9.90	18.50	0.28
	7	16.90	44.00	17.50	20.00	0.44
	Mean±SE	15.94±0.42 a	26.11±8.52 a	10.83±3.23 a	18.29±1.04 a	0.30±0.06 a
Baringo	8	15.00	11.00	12.60	25.50	0.56
	9	14.20	23.90	9.50	25.50	0.54
	10	17.40	28.90	9.30	28.50	0.44
	11	17.40	28.90	11.70	29.00	0.44
	12	17.40	28.40	10.60	29.00	0.44
	13	15.70	22.60	13.60	29.00	0.59
	14	16.00	15.00	12.40	22.00	0.42
	Mean±SE	16.16±1.29 a	22.67±7.15 a	11.39±1.63 a	26.93±2.70 b	0.49±0.07 b

Study Area	Honey Sample No.	Moisture content (%)	HMF (mg/kg)	Diastase activity (Schade units)	Free acidity (meq/kg)	Electrical conductivity (mS/cm)
Kitui	15	17.10	17.10	8.60	24.00	0.38
	16	16.80	11.30	14.50	25.00	0.44
	17	16.60	35.50	7.50	20.50	0.39
	18	17.40	11.80	16.20	29.00	0.52
	19	16.70	11.80	12.20	25.00	0.45
	20	16.70	36.60	6.80	20.00	0.38
	21	17.20	120.00*	2.70	22.00	0.35
	Mean±SE	16.93±0.30 a	34.87±39.13 a	9.79±4.74 a	23.64±3.12 b	0.42±0.06 b
P value		*0.081*	*0.614*	*0.683*	*0.004*	*0.000*

Mean±SE with the same letters (column) are not significantly different (P<0.05)

**HMF value was not used in determining Mean and statistical differences for the honey sample parameter values since it is an outlier*

Appendix 3: Household survey questionnaire

HOUSEHOLD SURVEY QUESTIONNAIRE

SECTION A: Questionnaire Identification

Serial no. of Questionnaire_________Date of survey (dd/mm/yyyy) ___/____/2015 **Start Time** ________________

Enumerator (*Full Name*):____

County: 1=Kitui 2=Baringo 3=West Pokot

Sub-County ___________________________

Location: ____________________________

Sub-Location: _______________________

Respondent(s) Name: ____(*Should be the household head or spouse*)

Position in the household: 1=Head 2=Spouse

GPS coordinates: GPS No________________Way Point_______________________

Latitude: (North/South) (________________________________)

Longitude: East (________________________________)

Elevation/Altitude________________________

SECTION B: Farm Characteristics and Beekeeping

1. Farm Characteristics

1.1. Average size of owned land _______________________ acres

1.2. Land tenure type: 1=Own with title 2=Own with no title 3= Rented 4=Communal land 5=Other (*please specify)*

1.3. How many years have you practiced farming in this region? ______________years

1.4. Is your household involved in beekeeping? 0=No 1=Yes *(If no ask question 1.5, if yes, proceed with question 1.6)*

1.5 What are the reasons for not keeping bees?____________________________

1= Lack of interest 2=No land to practise beekeeping 3=Fear of bees 4=Old age 5=Others (specify)

1.6 Who did you learn from about beekeeping?

1= Parents 2=Friends 3=Neighbours 4=Extension officers 5=Other Relatives 6=Internet 7=Others___________

1.7 What motivated you into beekeeping? 1=Honey production 2=Lack of an alternative agricultural activity 3=Hereditary 4=Conservation aspect 5=Lack/scarcity of other sources of foods 6=Culture/tradition 7=Pollination 8=Other (specify)

1.8 How many years have you been practicing beekeeping?____

1.9 What types of beehives do you have, how many for each type?

Type of bee hive	**Possessed or owned** 0=No 1=Yes	**Type of wood they are made up of (local name)**	**Number of hives**	**Of total number of hives, how many hives have bee colonies**
Langstroth hive				
Kenya Top Bar hive				
Log hive				
Super log hive				
Box hive				

1.10 Which is the most common practice to ensure bees are not affected by temperatures and rains in your hives?

Type of bee hive	**Most common practice to ensure bees are not affected by heat, rains and other harsh weather** 0-None 1=Placing some materials in the opening or on top of the hives 2=Placing bee hives under the shade 3=Placing bee hives in a closed room 4=Other (specify)	**Of the total number of hives how many are under this practice**
Langstroth hives		
Kenya Top Bar hives		
Log hives		
Super log hive		
Box hive		

1.11 Do you rent land for beekeeping? 0=No 1=Yes

1.12 If yes, how much land is rented? ________________________________acres

1.13 Crops grown by the household, list them according to priority

No.	**Crop**	**Acreage (Acres)**	**Main Purpose:** 1=Commercial-cash 2=Household use 3=Subsistence (combination of 1&2)
1			
2			
3			

1.14 Type of livestock kept by household in order of priority (***Bees are under livestock***)

No.	**Type of livestock**	**Number**	**Main Purpose:** 1=Commercial-cash 2=Household use 3=Subsistence (combination of 1&2)
1			
2			

1.15 Including honey production, which are the five **<u>agricultural enterprises</u>** that you practice and what is the average income you receive from each of them per year? (*if honey is not among five, continue until it is mentioned)*

No	**Enterprises**	**Average income from enterprise in a normal year**
1		
2		

SECTION C: Honey production and Pollination

2 Honey Production

2.1 Do you produce honey? 0=No 1=Yes

2.2 If yes, what are your main seasons (indicate months in a normal year)____

2.3 If no, why? 1=Absconding/migration of bees 2=Bees attack by pests and diseases 3=Poor hive management 4=Lack of enough food for bees 5=Other (specify)

2.4 For a single hive, what amount of honey is produced per season?

Type of bee hive	**Is honey produced honey in all hives all seasons** 0=No 1=Yes	**Amount of honey per hive per year (litres or kg)**	**Constraint to honey production *in all* seasons**1=Absconding/migration of bees 2=Bees attack by pests and diseases 3=Poor hive management 4=Lack of enough food 5=Other (specify)
Langstroth hive			
Kenya Top Bar hive			
Log hive			
Super log hive			
Box hive			

2.5 If there is a difference in amount of honey harvested between different hive types in the different seasons, what is the main reason for this?

1=Diversity of the flowering plants near the hive 2=Water availability 3=Hive management (cleaning, inspection, repair) 4=Size of the hive 5=Habitat where the bee hives have been placed 6=Other_______________

2.6 Where do you place your hives, what are the reasons and what is the proximate distances to the following the ecosystem characteristics?

Area	**Placement Placed** 0=No 1=Yes	**Proximate distance from other areas in metres (***Area where hives are placed is the central point)*	**Number of hives placed there**
Near Farm crops			
Water Sources			

Area	**Placement Placed** 0=No 1=Yes	**Proximate distance from other areas in metres (***Area where hives are placed is the central point)*	**Number of hives placed there**
Open area			
Forest/Natural vegetation			
Homesteads			
Road			
Topographical features e.g. hills, mountains			
Protected areas			
Other (specify)			

2.7 What inputs (type, quantity and price) do you apply in your farms and bee hives in a normal year?

Inputs: **(*excluding labour)***	**Use** 0=No 1=Yes	**Quantity in a year (Kgs)**	**Stage of plant when used** 1= After preparing land for planting 2=When planting crops 3=During early stages before weeds appear 4=Any stage of plant growth 5=When the plants are flowering 6=Any other (specify)
Inorganic fertilizer			
Organic fertilizer			
Pesticide			
Herbicide			

2.8 Do you know that fertilizers/ pesticides/herbicides and other chemicals kill bees? 0=No 1=Yes

2.9 If yes, what are you doing about it? 0=Nothing 1=Apply when plants/crops are not flowering 2=Do not use them 3= Other (specify)

2.10 Which honey do you like most in terms of its characteristics

Honey produced from below areas	**0=No 1=Yes**	**Rank its quality** *1 being the most prefferred*	**Special characteristics (Only one)** 1=Sweet Taste 2=Aroma 3=Viscocity 4=Colour 5=Staying for long without changing form/spoiling 6=Other (Specify)
Near farm crops			
In the forest			
Near the rivers			
Around the homestead			
In an open area			
Near topographical features e.g. hills, valleys			

2.11 Do you feed bees with the following?

Feed bees with	**0= No** **1=Yes**	**When** 1=During the dry season 2=Before harvesting honey 3=After harvesting honey 4= Everyday 5=Other	**Qty(Kgs)**	**Cost per kg (Ksh)**
Sugar				
Molasses				
Glucose				
Bananas				
Water				
Other (specify)				

2.12 Has bees population around your farms changed?

How	**0= No** **1=Yes**	**Reasons** 1= Drought 2=Noise 3=Habitat disturbance 4=Pests and diseases 5=Excessive heat 6=Other (specify)
Increased		
Decreased		
Remained the same		
I donÕt know		

3 Pollination

3.1 Which kinds of bees do you have around your farms and what are their importance?______________

Bee type	**0=No** **1=Yes**	**Approx no. of (colonies)**	**Where live/are kept** 1=In hives 2=In tree trunks 3=Under the soil 4=Any other (specify)	**Their main product/use** 1=Honey production 2=Wax production 3=Propolis production 4=Pollination 5=Royal jelly production
Honey bee				
Stingless bee				
Carpenter bees				
Other				

3.2 Are you aware that bees are useful in pollination? 0= No 1=Yes

3.3 If yes, what do you do to encourage their pollination services?

0=Nothing 1= Plant vegetation and other vegetation in farms so as they do not go away 2=Do not spray any chemicals to them or vegetation the forage on 3=Spray crops before they flower 4=Any Other______________________

3.4 Which main five natural plants do your bees visit?

Natural plants/trees visited (English or local name)	**Main Use** **1=Commercial-cash 2=Household use 3=Subsistence (combination)**	**Months they flower**	**What type of bees visit** 1=Honey bee 2=Carpenter Bees 3=Stingless bees 4=Other
1.			
2.			

3.5 Which main five farm crops do your bees visit?

Farm Crops visited (English or local name)	**Main Use** **1=Commercial-cash 2=Household use 3=Subsistence (combination)**	**Months they flower**	**What type of bees visit** 1=Honey bee 2=Carpenter Bees 3=Stingless bees 4=Other
1.			
2.			

SECTION D: Collective action and initiatives that add value to honey

4. Group Membership

4.1 Are you a member of any association or group? 0=No 1=Yes

4.2 If yes, state the number of groups you are in **Formal (registered)__________ Informal (non-registered)__________**

4.3 Do you belong to a group related to honey production 0=No 1=Yes

4.4 If yes, what benefits do you get?

1=Production information 2=Marketing information 3=Value addition information 4=Quality assurance
5=Loan for input access 6=Beekeeping equipment provision 7=Marketing services 8=Table Banking
9=Welfare 10=Other (Specify)

4.5 For honey producer group, how many members are you and do you own communal hives

No of members	**Communal Hives** 1=Yes 0=No	**Main Type of hive** 1=Langstroth 2=Kenya Top Bar hive 3=Log hive 4=Box hive 5=Super log hive	**Number of hives**

4.6 If not a member of any honey producer related group, what are the reasons?

1=There are no producer groups in the region 2= Not interested in joining groups 3=No perceived benefits

4=Other reason (*please specify)*

5 Access to extension services (e.g training)

5.1 Do you access any extension services? 0=No 1=Yes,

5.2 If yes, do you get those related to beekeeping and honey production 0=No 1=Yes

5.3 What services/support do you get to improve beekeeping and honey production?

Services/Support	**Do you get support** 0=No 1=Yes	**By who (main actor)** 1=Government organizations 2= NGOs 3=Private Companies, 4=Individual	**How often do they give support** (CODE E below)	**How often do you seek support from them** (CODE E below)
Information on Production, harvesting,				
Information on value addition				
Information on and quality assurance				
Marketing				

Services/Support	**Do you get support** 0=No 1=Yes	**By who (main actor)** 1=Government organizations 2= NGOs 3=Private Companies, 4=Individual	**How often do they give support** (CODE E below)	**How often do you seek support from them** **(**CODE E below)
Equipment for beekeeping				
Protection of the brand				

(**CODE E**: 0=Never 1=Daily 2=Weekly 3=Monthly 4=Quarterly 5=Semi-annually 6=Yearly 7=Other (specify)

5.4 What are your other sources of information on beekeeping and honey production?

Source of information	**0=No** **1=Yes**	**Order of important source (1-5) 1- most important and 5-least important**
Radio/Television		
Newspaper		
Internet		
Mobile phone service		
Traders/processors/other producers		
Apiculture/Honey congress, conference, shows, exhibitions, fairs, symposiums, competitions, honey days, forums		
Other (please specify)		

6 Use of credit and other financial support

6.1 Do you use credit for your agricultural activities? 0=No 1=Yes

6.2 If yes, is the credit for beekeeping and honey production? 0=No (*go to 6.5)* 1=Yes (*proceed with 6.3*)

6.3 Do you receive specified credit and if yes, from who?

Type	**0=No 1=Yes**	**Source of credit** 1=Bank 2=Micro-finance institution 3=Farmer cooperative/association 4=Other (non-farmer) cooperative 5=Farmer group
Inputs/equipment (to be recovered/returned at selling)		
Cash to purchase own bee equipment and other inputs		
In kind support		
Other (*please specify)*		

6.4 What were the challenges associated using or borrowing credit?

0=None 1=Insufficient 2=Other urgent needs arose 3=High interest rate

4=Other (*please specify*)____

6.5 If you have not borrowed/used credit, what are the reasons?

1=Cannot meet the requirements to access credit 2=Does not have need for credit 3=No place to access credit

4= Other (*please specify*) ___________________________

SECTION E: Honey harvesting activities

7 Honey harvesting methods

7.1 Which months do you harvest your honey?____

7.2 How do you tell that your honey is ready for harvesting

Method	**0=No 1=Yes**	**Frequency of use 1=Most frequently 2=Sometimes 3=Undecided 4=Rarely 5=Never**
Checking the flowers to see whether they have dried		
Checking the combs		
Checking the behaviour of bees		
Smelling the hives		
Other (specify)		

7.3 If checking the combs, which combs do you take home to extract honey?

1=Those that are less than a quarter sealed 2=Those that are a quarter sealed 3=Those that are half sealed

4=Fully capped combs 5=Any Other (Specify)__________ __________________

7.4 What common time of the day do you harvest your honey? 1=Morning 2=Mid-day 3=Evening 4=Night 5=Any time of the day

7.5 What are the reasons for 7.4 above? 1=Culture 2=To ensure bees do not harm people 3=Convenience 4=Availability 5=Other

7.6 Under what common weather do you harvest your honey? 1=Sunny 2=Rainy 3=Windy 4=Dry 5=Any kind of weather

7.7 What are the reasons for 7.6 above? 1=Culture 2=To ensure honey is protected from contamination

3=Convenience 4=Recommended weather 5=Other______________________

7.8 What equipment do you use when harvesting honey and how is it cleaned (***that which comes into contact with honey***)?

Equipment	**What you do to ensure it is kept clean** 0=Not using for any other activity so not washed 1=Washing with water and soap and drying 2=Washing with water only and drying 3=Wiping with a cloth without washing 5=Other (Specify)
Buckets	
Knives	
Harvesting clothes	
Other (specify)	

7.9 How do you avoid bee stings when harvesting honey?

1=Use of chemicals 2=Use of bee repellants 3=Killing bees 4=Smoking bees

5=Producing noise so that bees can leave the hive 6=Talking to bees politely 7=Any other (specify)

7.10 If the bees are calmed by smoke what is the source of smoke and what is the frequency of applications?

Source of smoke	**Use 0=No 1=Yes**	**Frequency of use 1=Most frequently 2=Sometimes 3=Undecided 4=Rarely 5=Never**
Cow dung		
Plant leaves		
Tree trunks		
Plant barks		

7.11 How do you dress when harvesting honey?

1= Honey harvesting gear (overall, gloves, boots, veil) 2=Normal Clothes 3=No clothes 4=Other

7.12 What other bee products do you harvest as you harvest your honey

Product	**Products Harvested** 0=No 1=Yes	**Amount harvested per year in (Kgs)**
Beeswax		
Propolis		
Pollen		
Royal Jelly		
Other		

Section F: Honey processing and storing

8 **Honey handling and processing**

8.1 Where (place) do you store your honey after harvesting?

1=In a dark room 2=In a room full of light 3=At room temperature 4=In the fridge 5=In a hot room

8.2 How long do you store your honey before you Process or take it for processing?

1= One day 2=One week 3= One month 4=Other (specify)

8.3 Do you process your own honey? 0=No 1=Yes

(If no, proceed with question 8.4 and if yes go to 8.10)

8.4 To which honey processing plant do you deliver your honey for processing?_______________________________________

8.5 Where is the processing plant located?

1=Within the sub county where it is produced 2=Outside the sub county where it is produced

3=Outside the county where it is produced

8.6 How far is the processing plant from your home? ________________________________kms

8.7 What is the common mode of transport that you use to the processing plant?

1=Walking 2=Public transport (car) 3=Cycling/riding (motorbike, bicycle) 4=Processors collect it from your home

5=Other (*specify)* ______________________

8.8 What is checked in your honey once you take it to a processing plant?

1=Moisture content 2=Brood 3=Pollen 4=Particles 5=Other (specify)

8.9 Where is honey processing done?

1= In an open area 2=In a closed room 3= Under the sun 4=I donqt know

5=Any other, specify____

8.10 How do you open up the combs in order to extract honey?

1=Smashing/crushing them 2=Using comb seal removing tool 3=Hand squeezing

8.11 Do you mix honeys from different areas while processing? 0=No 1=Yes

8.12 If yes, which honeys do you mix and at what ratios?

Honey mixed	**0=No 1=Yes**	**Ratios (%)**
From different hives of the same farmer produced in the same area		
From different hives of the same farmer in produced in different areas		

Honey mixed	**0=No 1=Yes**	**Ratios (%)**
From different hives of different farmers in the same area From different hives of different farmers in different areas		

8.13 How is your honey extracted from the combs?

Method	**0=No 1=Yes**	**Frequency of use of method** 1=Most frequently 2=Sometimes 3=Undecided 4=Rarely 5=Never
Centrifuging		
Pressing		
Heating the combs with		
Fire/sun		
Draining		
Any other (Specify)		

8.14 How long do you decant your honey?______________________hours

8.15 If you heat honey, what is the source of heat that you use to heat the honey?________________________________

Source of heat	**Source 0=No 1=Yes**	**Do you know the temperatures used** 0=No 1=Yes	**If yes, what is the temperature (in degrees centigrade)**
Electricity			
Firewood			
Stove			
Charcoal			
Sun			
Any other, specify			

8.16 What material do you use to filter honey and of what hole size?

Material do you use to filter	**Use 0=No 1=Yes**	**Size of the holes for the material** (*give a description of the material used if you cannot tell the hole size*)	**No. of times you filter**
Net			
Piece of cloth			
Plastic sieve			
Sieve made of wire			

8.17 How do you clean the materials used to extract honey and filtering honey?

1=Hot water and soap 2=Cold water and soap 3=Cold water only 4=Hot water only

5=Other (Specify)____

9 Honey storage

9.1 Which materials do you use to store your honey?

1=Plastic 2=Aluminum 3=Glass 4=Any other specify____________________

9.2 Where do you store honey?

1=In a dark and cold room 2=In a dark and hot room 3=In a room full of light and cold

4=In a room full of light and hot 5=In the fridge 6=Other (Specify)

9.3 Do you know the storage temperature for your honey? 0=No 1=Yes

9.4 If yes, how much in degrees centigrade? ______________________

9.5 How do you measure?

1=Using a thermometer 2=Feeling the normal body temperature 3=Other (Specify)

9.6 What changes takes place in your honey once stored?

Changes	**0=No 1=Yes**	**Frequency of change** 1=Most frequently 2=Sometimes 3=Undecided 4=Rarely 5=Never
The honey colour changes		
The honey crystallizes		
The honey ferments		
No change		
I donĝt know		
Any Other		

9.7 What do you do with the honey that crystalizes?

1=Discard it 2=Warm it to change back to its liquid form 3=Sell or consume it in its crystallized form

4=Other____

9.8 If you warm it, how do you do it?

1=Using direct heat 2=Dipping it in warm water 3=Put it under the sun

4=Dip in hot/boiling water 5=Other, specify____

9.9 Are you able to tell the temperatures to warm the honey? 0=No 1=Yes

9.10 At what temperatures do you warm the honey in degrees centigrade?______________________________________

9.7 How do you measure the temperatures? 1=Using a thermometer 2=Using your hand 3=Regulating the equipment being used 4=Other (Specify)

SECTION G: Honey marketing

10 Sale of honey

10.1 In what form is the honey sold from your farm? 1=Comb 2=Semi-processed 3=Fully processed 4=Other (*please specify*

10.2 How much do you get when you sell your honey in the following form?

Form of honey	**0=No 1=Yes**	**Price per kg/litre**
Comb		
Semi-processed		
Fully processed		
Other (*please specify*)		

10.3 How long you have been selling honey?____________________years

10.4 Where do you sell your honey and how often?

Where honey is sold	**0=No 1=Yes**	**Who mainly picks/buys it** 1=Consumers 2=Processors 3=Middlemen/brokers 4=Others	**Proportion of Percentage sold to the different (should total to 100%**	**Price per Kilo (Kshs)**
Farm gate				
On the roadside				
Kiosks in the centers				
Near the main markets				
Main market /towns				

10.5 Is the honey you sell from your hive only or do you buy more honey from other places to sell? Please elaborate

Honey sold	**0=No 1=Yes**	**What amount (Kgs/litres)**
From own hive		
Bought from other places		
From own hive and bought from other places		

10.6 What do you think is the main determinant of the price of your honey?

1=Taste of honey 2=Colour of honey 3=Region where produced 4=Processing methods used 5=Label of the product 6=The market prices for the same product 7=Competition in the market 8=Other____________________

10.7 Who sets the price that you receive as a producer?

1=The producer group/Association 2=Individual 3=The processor 4=I donȇt know 5= The market prices 6=Other

10.8 Do you have any influence on the price you receive per kg/litre? 0=No 1=Yes

10.9 How often are the prices increased?

0=Never 1=Monthly 2=Semi annually 3=Annually 4=Upon complain 5=Depends on demand and supply of the commodity 6= Other (specify)

10.10 Does quality of your honey influence the price you receive per kg/litre? 0=No 1=Yes

10.11 Does the region where honey is produced influence the price you receive per kg/litre? 0=No 1=Yes

10.12 Explain your response above (10.11)

1=High quality honey in terms of taste aroma etc. fetch better prices 2=Some regions fetch higher prices for honey irrespective of quality 3=The sellers dictate the minimum price they prefer for their honey

12.13 Do you sell all your honey produced in a particular season?_______________ 0=No 1=Yes

12.14 If no, why? 1=Inadequate market 2=I keep some to sell when prices are high 3=I keep some for use at home 4=Other

13 Honey labelling

13.1 Do you label your honey before selling? 1=Yes (*go to 13.3*) 0=No (*go to 13.2*)

13.2 If no, why? 1=It is expensive to label honey 2=I do not sell final packaged honey 3=I do not have a brand name 4=Other (specify)

13.3 If yes, do you label your honey with a name? 0=No 1=Yes (specify the name______________________________)

13.4 Is that name used by the entire group you belong to or is it an individual label

1=Group/association name 2=Individual name 3=Other______________

13.5 What do you associate the name you label your honey with?

1=The name of the group 2=The area where it is produced 3=Name of a plant known to be the source of the nectar/pollen 4=Land feature in the area of production 5=Other________________________________

13.6 Does the label determine the price of honey? 0=No 1=Yes

13.7 If yes, what label adds value to honey and by how much?_________________________

Honey labelled as	**0=No 1=Yes**	**Order of value (1-5) 1- most important and 5-least important**
The name of the group		
The geographical area where it is produced		
Name of a plant known to be the source of the nectar/pollen		
Land physical feature in the area of production		

13.8 What other information do you include in the label?

Information	**0=No 1=Yes**	**Order of importance (1-5)** 1- most important and 5-least important
Contact information		
Nutrition		
Manufacture and expiry date		
Any other specify		

13.9 What do you think are the important reasons of labelling honey?___________________

1=Quality assurance 2=To give information 3=Protection of honey reputation 4=Other

Section H: Honey quality traits and potential for GI

14 Honey uniqueness

14.1 What do you mainly use honey for? (only one)

1=Spreading on bread 2=Sweetener (e.g in tea) 3=Baking 4=Use as Medicine

5=Preservative 6=Consume it without adding anything 7=Any other, specify_______________________________

14.2 Does the honey that you produce have a specific uniqueness/characteristics that is related to the geographical characteristics of the region? 0=No 1=Yes

14.3 If yes, which unique characteristics does it have?

Characteristics	**0=No 1=Yes**	**Order of preference (1-5)** 1- most important and 5-least important	**Source of characteristics** 1=Specific vegetation in the area 2=Micro-Climate conditions in the area 3=The culture (history, norm) of the people 4= Topographical features 5=Other
Taste			
Thickness			
Colour			
Texture			
Smell			
Any other specify			

14.4 What value does your tradition attach to your honey in order of importance?

Value	**0=No 1=Yes**	**Order of importance (1-5)** 1 meaning most important and 5 meaning least important
Medicinal		
To keep a healthy lifestyle		
Religious value		
Customary value e.g. dowry price		
Any other, specify		

15 Producer knowledge on GI and potential for labelling honeys as GI

15.1 Are you aware of the concept of geographical indications (*Enumerator to explain the concept (paraphrased) as "a name which identifies a product originating in a specific place, region or country whose given quality, reputation or other characteristic is essentially attributable to its geographical origin)*

0=No 1=Yes

15.2 Are you aware whether there is honey from other regions within the country that is marketed as though it originates from your region?

0=No 1=Yes

15.3 If yes, what are you doing about it? 0=Nothing 1=Contacting group leaders/county government 2=Giving the best to my customers to ensure they do not go for the other honey 3=Other_______________________

15.4 Have you heard of other honey from other regions within the country that has characteristics that can qualify them for GI labelling

0=No 1=Yes

15.5 If yes, where?____

15.6 Which is the main quality traits of honeys do you think can give a possibility for GIs labelling of honey? *(pick one)*

1= Taste 2=Aroma 3=Viscocity 4=Colour 5=Other ____________________

Section I: Political and Institutional environment

16. Existing institutions

16.1 Do you know of any existing ***guidelines, policies, laws, rules, guidelines and standards*** that can facilitate GI labelling?

Institutions	**0=No** **1=Yes**	**Importance (only one)** 1=Very important 2=Important 3=Neutral 4=Not so important 5=not important at all	**Are they sufficient to facilitate honey protection as GI** 0=No 1=Yes
Policies			
Laws			
Guidelines and rules			
Standards e.g. quality assurance			
Norms and taboos			
Other			

16.2 Do you know of any existing ***Political environment*** that is likely to facilitate GI labelling

	0=No 1=Yes	**Importance (only one)** 1=Very important 2=Important 3=Neutral 4=Not so important 5=not important at all	**Are they sufficient to hinder honey protection as GI** 0=No 1=Yes
County Government			
National government			
Development partners			
Political Parties			
Lack of Corruption			

16.3 Do you know of any existing services could facilitate GI labelling of honey?

	0=No 1=Yes	**Importance (only one)** 1=Very important 2=Important 3=Neutral 4=Not so important 5=not important at all	**Are they sufficient to facilitate honey protection as GI** 0=No 1=Yes
Credit facilities/Finances			
Extension services			
Training and capacity building			
Supply of equipment			
Infrastructure			
Formation of groups			

Section J: Household Characteristics

17 Household Roster: Members of households, Education, Occupation

17.1 What is the household size ______________________ persons

(Household refers to all whose daily livelihoods depend on House Hold Head (HHH)

17.2 Provide the demographic characteristics of household members (Include students, but donŕt include employed children not residing or depending on the household)

A household is a group of people who cook together and eat together and drawing food from a common source – share resources together. Family members who work away or are not dependent on the household for at least 6 month are excluded.

(For this purpose, household members are not necessarily the same as family members)

Fill the table each column downwards before moving to the next column

ID	**Full Name of household member (Start with household head)**	**Year of birth (e.g. 1948)**	**Sex of the person** ***1=Male 2=Female***	**Relationship to current HHH** ***(CODE A)***	**Marital Status** ***(CODE B)***	**Highest level of education completed** ***(CODE C)***	**Years spent in school**	**Main occupation (only one)** ***(CODE D)***
1								
2								
3								
4								
5								
6								
7								

CODE A: Relationship to household	**CODE B: Marital Status**	**CODE C: Highest Education**	**CODE D: Main Occupation**
1. Head	1. Married	0. None	1. Beekeeping
2. Spouse 1	2. Single	1. Standard 1	2. Crop farming (incl. food & cash crops; feed & fodder)
3. Spouse 2	3. Divorced/Separated	2. Standard 2	3. Livestock keeping
4. Spouse 3	4. Widowed/Widow	3. Standard 3	4. Poultry keeping
5. Spouse 4	5. Others (Specify)	4. Standard 4	5. Mixed farming
6. Parent		5. Standard 5	6. Livestock and livestock product trading
7. In laws		6. Standard 6	7. Trading in non-livestock agricultural products (e.g. groundnuts)
8. Child		7. Standard 7	8. Formal salaried employment
9. Grandchild		8. Standard 8	9. Livestock herder
10. Employee		9. Form 1	10. Self-employed business
11. Other		10. Form 2	11. Farm labourer on other farm
		11. Form 3	12. Farm worker on household farm
		12. Form 4	13. Mining (quarry, minerals etc.)
		13. Form 5	14. Fisherman
		14. Form 6	15. Fish trading
		15. Craft/vocational/ Certificate	16. Old/Retired /Pensioner
		16. Diploma	17. Domestic work in own home
		17. Higher National	

		Diploma 18. University	18. Not working/unemployed 19. Infant \ child < 7 years 20. Student/ pupil

17.3 What are your main sources of income for the household?

Source of income	**0=No 1=Yes**	**Average income per year for the last three years (Kshs)**
Farm-livestock, poultry, crops, pigs, income		
Business		
Formal employment		
Pension		
Remittances (help form other people)		
Other (specify)		

17.4 Is there anything else that you would like to share about the discussion/question?

End Time______________________

Appendix 4: Focus group discussion checklist

County_____________________________ Sub- County ____________________________

Location ____________________________ Sub-location ____________________________

Date________________________________

1. Is beekeeping practiced in this sub county?
2. Which kinds of bees do you know?
3. Are bees in this sub county present all the year round?
4. What are the importance/value of the bees?
5. What do you know about pollination?
6. Which crops are grown in this sub county?
7. Where do bees get food from? Please elaborate on what kind of food
8. What season do bees go out to look for food?
9. Are there honey groups/associations in this sub county? If yes, are the hives are owned by these groups communal or individually?
10. Do you know what good beekeeping practices are?
11. If yes, please mention ways on how you practice good beekeeping
12. How did you learn about the practices?
13. Which months do bees in this sub county produce honey?
14. Is the honey produced good or special? If yes, what honey characteristics make it good or special and in what seasons is it considered good or special?
15. What do you think makes the honey good or special?
16. What preparations do you make when planning to harvest honey?
17. Are there any cultural practices, norms and taboos associated with honey in this sub county?
18. Where is the honey produced in this sub county taken/sold? Why?
19. What means are used to transport honey produced in this sub county?

20. Under what conditions do you store your honey once it is harvested (especially temperatures)?
21. What help/assistance do you get in your beekeeping activities and from who?
22. What are the challenges faced by beekeepers in this sub county?
23. What are the interventions to the problems?

Appendix 5: Checklist for key informant interviews

County____________________________ Sub- County ___________________________

Location ___________________________ Sub-location ___________________________

Date________________________________

1. What is the status of honey production in your region?
2. Describe the existing institutions and regulatory framework governing honey production in in your region and their role?
3. What challenges are facing honey producers, processors and traders in in your region?
4. What efforts/interventions have you undertaken to address/respond to these challenges and other areas that need your intervention?
5. What changes have you observed in in your region as a result of the initiative you have undertaken in relation to honey production?
6. How can sustainable production and marketing of in your region be improved?

Appendix 6: Checklist for interviews with honey processor/traders/marketing agents

County____________________________ Sub- County ___________________________

Location ___________________________ Sub-location ___________________________

Date________________________________

1. Where do you get the honey that you process/sell
2. Who owns the processing plant where you process honey?

3. Do you process honey which is produced from this sub County only or also honey from other regions?
4. Do you wait for the honey producers to bring their honeys to you or do you get it yourself?
5. Do you collect honey from groups/associations or from individuals?
6. Which form of honey do you collect from the honey producers (e.g. sealed honey in combs, crude honey, processed filtered honey, honey in containers ready for sale)?
7. Do you process honey for honey producers who have no facilities to process?
8. Do you process/sell honey throughout the year? Elaborate
9. Which characteristics do you look out for in the honey that you collect for processing/selling?
10. Do you consider these characteristics when processing/packaging or selling honey? Please elaborate
11. How do you store your honey once it is received and for how long?
12. Which processing methods do you use to process honey? Why the method?
13. Do you describe the methods of production, honey harvesting and processing methods in the honey that you sell
14. How do you package the honey that you sell/process
15. What do you associate the name labelled in the honey with? Why?
16. Do you sell honey as an individual or as a group?
17. Do you comply with the existing honey standards? Please elaborate your answer
18. Which are the existing honey markets?
19. Are you satisfied with the trading opportunities /markets of your honey? Please elaborate
20. What are the challenges that you face in marketing and selling your honey and what are their interventions?
21. Do you separate honeys during processing in relation to their characteristics? Please elaborate your answer

Appendix 7: Checklist for interviews with consumers

County____________________________ Sub- County ___________________________

Location ___________________________ Sub-location ___________________________

Date_______________________________

1. For how long have you consumed honey?
2. What do you use honey for?
3. What characteristics do consumers look out for when buying honey?
4. Do you consume honey produced from this region only or from other regions?
5. What varieties of honey do you prefer and why?
6. Do you consider prices when buying honey?
7. Which honey fetches good prices in the market? Please elaborate (List prices by being guided by 16)?

Appendix 8: Data collection template- Acacia flower visitors/pollinators and yields

A. Acacia visitors and their behaviour

Date: County: Sub County: Location: Village:

Observer´s Name: Start Time: End Time:

Flower no.	Visitors name (describe if can´t identify	Number of flowers visited	Time of the day	Time spent by visitor	Contact with stigma and anthers	Any other behaviour of the visitor/comments

B. Acacia yields

Date: County: Sub County: Location: Village:

Observer´s Name: Start Time: End Time:

Flower no.	No. of flowers with pods	No. of pods in each flower	No. of flowers without pods	No of flowers aborted	Any other observations (e.g. insects inside the pod, pest infestation, pod deformity, bag removed or open)