# Apiculture Information Network Technical Report

**Executive Summary**

Encouraging women and youth participation in beekeeping is a priority for the Rwandan government due to its potential to diversify income and improve food security. This multidisciplinary study[1] was conducted in the Kayonza district of eastern Rwanda to identify information networks that could encourage women and youth to participate in modern beekeeping technologies. Mixed methods were employed to collect qualitative and quantitative data through key informant interviews, focus group discussions, and individual surveys.

The study found that most beekeepers in the district are married and have limited education. While female beekeepers have less experience than their male counterparts, they have similar age ranges. Traditional hives are used by the majority of beekeepers, and material benefits, such as income and medical insurance, are the primary reasons for joining cooperatives.

At the national level, a top-down multi-step information hierarchy was observed from MINAGRI to individual beekeepers. The inter-cooperative networks showed strong clustering effects within each cooperative, but weak connections between cooperatives. The intra-group level network showed that cooperative leadership acted as the central resource for information, and leadership acted as a bridge between women and men. Youth and women were moderately underrepresented in the social networks across different levels.

We also identify four major challenges faced by beekeepers in Kayonza, including: (1) limited access to information about modern beekeeping, (2) inadequate training programs, (3) lack of transportation, and (4) insufficient incentives for youth and women to join beekeeping businesses.

[1]This project was made possible through funding received from USDA-NIFA & Stanley W. Warren Endowment Fund.

To achieve the objective of promoting more women and youth engagement in modern beekeeping, this report provides the following policy recommendations:

- Training district and sector animal resources officers as community liaisons. Breaking up tight knit information flows between cooperatives by training community liaisons would make it easier for cooperatives to communicate with each other.
- Empowering more women and youth into local leadership roles. Moving the information-sharing structure from having a key informant within a cooperative to having multiple key informants ensures information is dispersed more rapidly and efficiently.

**Problem Context**

Rwanda is currently ranked as the fifth largest producer of honey in Africa and has witnessed a significant increase in the number of beekeepers over the previous two decades. The country's forests, warm tropical climate, and a wide array of flowering plants provide a favorable environment for Apiculture. Considering that 78% of the country's population is under 35 years of age, and a significant proportion of them are women, there exists a prospect to tap into the potential of the youth and female population by promoting apiculture. A report by the United Nations Women's division showed that by closing the current gender gap, Rwanda could see a 19% increase in food production, resulting in a substantial $419 million boost to the country's GDP. Moreover, it is estimated that up to 238,000 Rwandans could be lifted out of poverty as a result of this increase.

However, in the current status quo, women are less likely to cultivate high-yielding crops, and face significant obstacles in accessing agricultural resources and opportunities including a lack of land ownership in many developing countries. Additionally, youth are also

facing obstacles in accessing agricultural opportunities, despite their significant contributions to the sector. While a substantial percentage of youth in countries like Rwanda engage in agriculture, many are gradually shifting away from agriculture due to limited resources and opportunities. Therefore, it is critical to address the barriers that disproportionately affect women and youth and provide them with the support they need to thrive in agriculture and the apiculture industry can lead the way in this effort. By doing so, we can level the playing field and create a more equitable and sustainable future for all.

In light of this, government institutions have continued to promote apiculture as an important economic driver and sustainable income diversification enterprise that complements crop and livestock farming. The Food and Agriculture Organization (FAO) in Rwanda estimates that there are approximately 120,000 beekeepers in the country and only 35% are using modern beekeeping practices. Most of the beehives used are also constructed from hollow tree logs, tree barks, leaves, grasses, mud, and cow dung and thus prone to varroa mites, beetles, ants, and other pests. Recognizing that honey is a versatile commodity that holds significant cultural and economic value, this report identifies and maps the various social networks that promote access to information on apiculture.

In a recent study that assessed the characteristics of the apiculture value chains in Kayonza district, Mushonga, et al (2019) found that despite increased government and NGO funded programs, women and youth participation in apiculture has remained low primarily due to limited information and access to training on modern beekeeping practices. Likewise, men still make up most of the beekeepers and majority lack both primary level education and formal apiculture training. Promotion of modern beekeeping technologies present various economic, social, technological, and environmental benefits. Examples of economic, social, and

environmental benefits include increased revenues, improved food safety standards, improved animal husbandry/disease management, and improved sustained biodiversity. Numerous studies focused on apiculture in Rwanda have shown that apiculture offers a relatively cheap and accessible entrepreneurial opportunity that could help rural households to diversify their income while supporting food production (Desire, 2014; Mushonga, et al,2019; Ntawubizi et al, 2021; Nsengiyumva, 2021). This is primarily because beekeeping requires a low level of technological and capital input. Recognizing that much of our daily activities and relationships are influenced by others, this multi-year (2022-2024) study proposes using social network theory to identify and examine how different types of networks promote access to information that might promote modern beekeeping technologies among women and youth in Kayonza district. Social network theory assumes network structures affect access to specific knowledge/information shared among actors within the system. Therefore, the extent to which networks are either closed or open will influence the participants' access to knowledge.

The findings from this study will contribute towards Rwanda's apicultural development, . This study seeks to identify the types of networks that might promote access to information that encourages women and youth participation in modern beekeeping technologies in the Kayonza district, eastern Rwanda.

**Research Questions**

The research questions are as follows:

(1) What types of social networks do beekeepers in E. Kayonza access for bee keeping knowledge?

(2) What are the information networks that promote market access?

(3) What are the challenges facing beekeepers in E.Kayonza?

## Environmental Scan

### Analysis of Rwandan Beekeeping Industry

Rwanda's Ministry of Agriculture (MINagri) has set a goal to improve food security and increase honey production, as outlined in the PSTA4 (the strategic plan for agricultural transformation). The plan aims to increase honey production from 5.6k to 8.6k tons by 2024. It is made possible through several trade agreements which have created markets in the Common Market for Eastern and South Africa (COMESCA), and the African Continental Free Trade Area (AFCTA) .Being the fifth-largest producer of honey in Africa, there are significant opportunities for market diversification due to high demand for honey from the aforementioned markets, however the use of traditional beekeeping methods have limited the production capacity of honey producers. (Ntirenganya, 2016) Currently, Rwanda holds the 36th position in the global ranking for the percentage share of honey production. With a promising outlook for the future, we have recognized the potential of social networks as a valuable tool for capitalizing on market opportunities, both locally and internationally. Therefore, this report seeks to explore the role that women and youth can play in existing social networks within cooperatives to help meet current honey production goals.

Presently , there is a significant push for a greater representation of women and youth in the beekeeping industry, which has traditionally been dominated by men, which presents an even greater opportunity for growth in the industry. Additionally International organizations like The Food and Agriculture Organization of the United Nations And UNESCO (FAO 2021) have identified this opportunity and have begun providing training for beekeepers, with a particular

focus on female beekeepers.To advance this goal, cooperative structures, which are usually made up of families, are the main benefactors of training programs.(FAO, 2022)

Despite the numerous opportunities for growth, a closer look at current beekeeping methods within cooperatives reveals why the apiculture industry is lagging. A report by the FAO revealed that 35% of Rwandan beekeepers use modern hives,(FAO 2021) with about 300,000 beekeepers using traditional log hives and 75,000 using Langstroth hives(modern hives) which produce about 72% more honey. (Al-Ghamdi et al., 2017) This shows that with increased use of modern beekeeping technology, increased honey production is more likely. From a political, economic, social, and technological standpoint, Rwanda's beekeeping industry has potential for growth and which can be spearheaded by increasing involvement of women and youth in apiculture. Therefore, placing a strong emphasis on the social dimensions of the apiculture industry, particularly the information exchange within cooperative systems, could play a crucial role in strengthening the industry. This approach would offer valuable understanding of the workings of current social frameworks and how they can be leveraged to facilitate future training initiatives.

**The Cooperative Model**

Cooperatives are organizations owned and controlled by their members, who are also their primary beneficiaries. Members work together to pool resources, such as capital, labor, and expertise, to achieve common goals that they could not achieve individually. This pooling of resources allows cooperatives to leverage economies of scale and negotiate better prices for their products and services. Development practitioners promote the use of cooperatives because they

are a powerful tool for promoting economic development and improving the livelihoods of people, especially in rural areas.

In Rwanda, cooperatives are particularly advantageous for small-scale producers who may not have access to markets or the resources needed to compete with larger producers. By joining a cooperative, these small-scale producers can benefit from collective bargaining power, access to credit, and training and technical assistance. Cooperatives can also provide members with access to markets, storage facilities, processing facilities, and other critical infrastructure that they may not be able to afford on their own. In addition to their economic benefits, cooperatives also promote social development by promoting democratic decision-making, equality, and community development. By working together and pooling resources, members of cooperatives can build stronger and more resilient communities, reducing poverty and improving the overall quality of life for their members.

On the flip side, there are also some disadvantages to consider, such as the potential for conflicts among members and challenges in achieving efficient decision-making. Despite these challenges, cooperatives have been successful in many countries, particularly in Africa, where they have played a vital role in promoting economic growth and reducing poverty. In Rwanda, cooperatives have been an important part of the country's development strategy, with the government providing support through training, technical assistance, and access to credit. The vision for cooperatives in Rwanda and other African countries is to continue to promote their growth and development, particularly in the agricultural sector, where they can help to increase productivity, improve food security, and promote sustainable development.

**Women and Youth Participation in Apiculture**

Women and youth are playing an increasingly important role in the beekeeping industry, and their involvement has had a significant impact on the sector. Firstly, they aid in economic empowerment for themselves and their families. Beekeeping is viewed as a low-cost, low-risk, and high-return activity in Rwanda, making it an ideal economic activity for women and youth who may not have access to land or other resources. By participating in beekeeping, women and youth are able to generate income and contribute to their families' and communities' economic development. Secondly, their involvement in beekeeping has resulted in increased production and improved quality. Women and youth are often involved in different aspects of beekeeping, including honey harvesting, processing, and marketing. Their introduction of fresh perspectives and unique practices that better suit their operations has enriched the quality of communal outlooks toward the practice of beekeeping as a whole.

Third, women and youth have been champions for sustainability and environmental conservation. Beekeeping promotes the conservation of natural habitats and biodiversity by encouraging the planting of bee-friendly plants and protecting natural vegetation. Individuals with a dearth of adequate resources have often found creative ways to maintain beekeeping operations in sustainable ways while utilizing less resources. Lastly, the inclusion of women and youth has a positive social impact on the community as a whole. Beekeeping is a social activity that can bring people together and foster community development. Women and youth who participate in beekeeping often form cooperatives or other groups that provide a support network and create opportunities for shared learning and collaboration.

## Research Methods

### I. Data Exploration

The study followed a mixed-method approach comprising qualitative and quantitative components. This study proposes using a mixed-method approach. Qualitative and quantitative research methods will be employed to collect data that assists the researchers to understand the role existing social networks play in facilitating access to apiculture development information (see survey attached) in eastern Rwanda. Qualitative methods including face to face interviews and focus group discussions are proposed as they further assist the researchers in understanding the various cultural phenomenon surrounding apiculture development among rural populations. Quantitative methods, including the use of a computer-assisted survey questionnaire, are equally proposed as they provide the researchers with a cheaper and faster strategy to collect comprehensive inter and intrahousehold information network data.

The total sample size for surveys and focus group discussions was 48. Qualitative methods including interviews and focus group discussions were carried out to get more insights on bee health, beekeeping training programs, information channels and beekeepers business expectations and goals. There were seven total focus group discussions conducted comprising five mixed-gender, one female group and one male group. Key informant interviews included Akagera Community Liaison, MinAgri Director General and Head of Entomology at RAB.

Quantitative methods, which included the use of a survey questionnaire using tablets, provided more information on the demographics of beekeepers and how information was passed within the cooperative and outside of it. The survey questionnaire also comprised questions related to selling and transportation of honey and benefits of joining cooperatives.

## II. Social Network Analysis

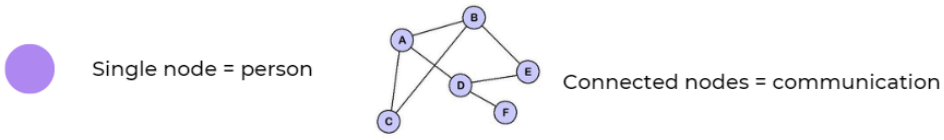
For data analysis, the study adopts a Social Network Analysis approach. This research method provides a valuable tool for understanding the relationships between individual beekeepers, cooperatives, and the larger organizations they interact with. It allows for the analysis and visualization of social structures, identification of key actors and influencers, and the tracking of the flow of information, resources, and power within and between social structures. This analysis will be aimed at better understanding how beekeepers utilize their information networks and social capital to access beekeeping information and markets for bee products.

Information networks refer to the interconnected systems, technologies, and processes that facilitate the collection, processing, storage, and sharing of information. In the real world, information networks are relevant in a wide range of contexts, from social media platforms and online marketplaces to research collaborations, how information travels within communities and disaster response efforts. Information networks enable individuals, organizations, and communities to access and share information quickly and efficiently, leading to increased productivity, innovation.

Social capital is structured in the form of beekeeping cooperatives, which enable farmers to pool their resources and expertise to access markets, communicate more efficiently with the government, procure funding and gain a strong consensus in operational quality as they grow. The strength of social capital within communities can be analyzed using social networks, which explore social structures, relationships and the connections between individuals, groups, and organizations. The patterns and dynamics of these connections show the diffusion of technology

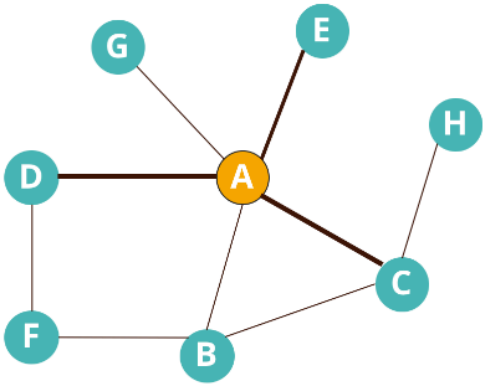
and new information, the formation of new relationships, and the evolution of beekeeping practices within cooperatives and larger communities.

Graphically, Social Network Analysis structures are made up of nodes and edges. Each dot, or node, represents a single person and each collection represents a group, or cooperative, with lines, or edges, between nodes representing communication or the existence of a relationship between nodes.

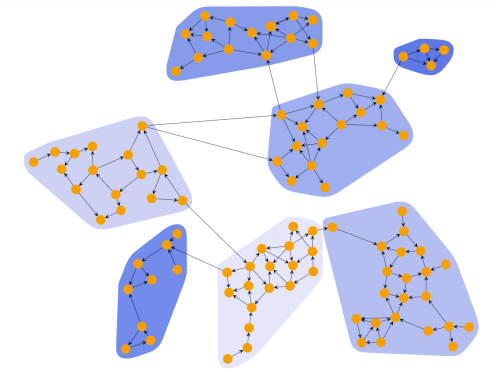



*Nodes and edges on a social network graph*

Interpreting a network analysis graph involves examining the structure of the network and identifying key nodes, clusters, and patterns of connectivity to gain insights into the underlying social dynamics and relationships within the network. Central nodes with high degrees of connectivity may be important influencers or brokers within the network. The presence of clusters or sub-groups may indicate distinct sub-communities or functional groups within the larger network. Patterns of connections, such as cliques or bridges between different clusters, may also reveal important information about the network's structure and function.




*Central nodes such as node A may be important influencers within a network.*



*Clustering can help us understand the social dynamics occurring within a network*

**III. Sample**

Kayonza district plays a significant role in Rwanda's apiculture development because approximately 40% of the country's honey is produced in this region. Therefore, the three cooperatives included in the sample were in the Eastern Kayonza region, with more information about the villages and cooperative names in the table below.

*Table 1. Field Sites Visited*

| **Village** | **Cooperative** |
|---|---|
| Nyagakonji Kabale | Kopanyaka |
| Gasabo Ndego | Abakunidinzuki Isangamo |
| Kanyinya Ndego | COPROMA |

**Data Insights**

**I. Data Exploration**

Among our sample of 48 beekeepers, 73% of them are male and only 27% of them are female beekeepers. The majority of them are married (85%). The following table 1 shows the profile of female and male beekeeper (in average). It also suggests that male beekeepers tend to be younger than female beekeepers and have longer years of experience in beekeeping.

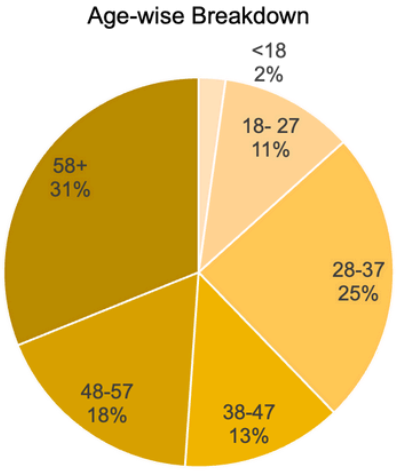
*Table 2. Average Beekeeper Profile*

| Observed gender | Age range (avg) | Married (%) | Years of schooling (avg) | Years of beekeeping (avg) |
|---|---|---|---|---|
| Female (n=13) | 48-52 | 69.2% | 4.6 | 12 |
| Male (n= 35) | 33-37 | 91.4% | 4.9 | 22 |

The pie chart below (Figure 1) presents the age-wise breakdown of our sample. Among all the respondents, the largest proportion of the age range is 58 plus which accounts for 31% of the sample. The youth among our respondents (age below 18 and between 18 to 27) has the

largest share (about 13%), suggesting that youth is not the main population engaging in beekeeping in the three villages we visited.

*Figure 1 Age-wise breakdown (by percentage)*




What type of hives these beekeepers use is another important aspect that our research looks at. Our study shows that 69% of people in our survey use traditional hives only, 29% of people use both traditional hives and modern hives, and only 2% of beekeepers in our sample use Kenyan top bar hives only (see Figure 2). In Figure 3, we show the pictures of traditional hives and modern hives collected in the field.

*Figure 2 Hive type breakdown (by percentage)*

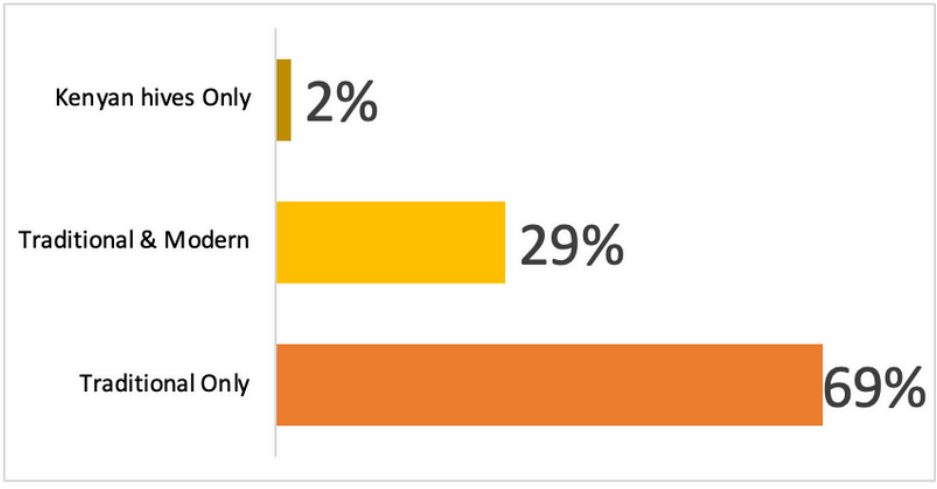


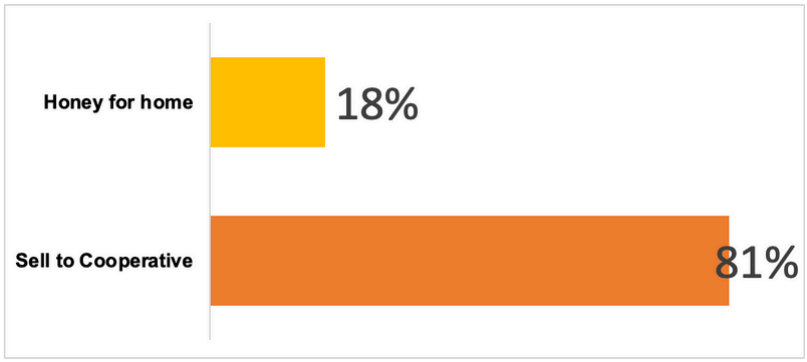
*Figure 3. Types of hives*

Traditional hives

Modern hives

This study is also interested in the production and the sales of honey. In our surveys, we asked the beekeepers: for all honey they harvested per year, how much do they sell to the cooperative / keep at home? On average, beekeepers keep 18% of their annual production at home, and sell 81% of their honey to the cooperatives (Figure 4).

*Figure 4  Honey sales per year (by percentage)*

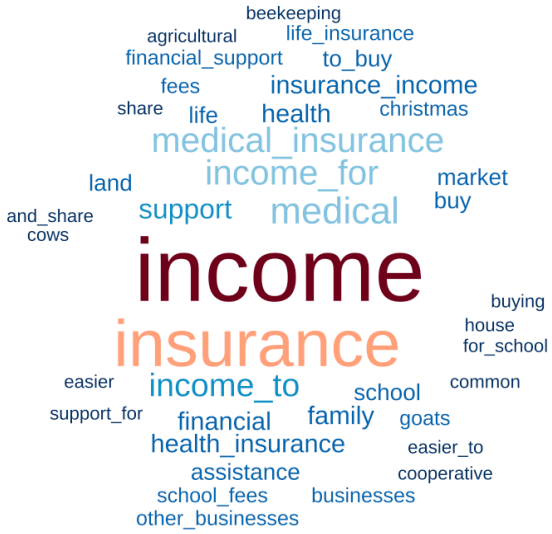



More importantly, the study wants to understand why people choose to join honey cooperatives. In our surveys, we asked each of our respondents why they chose to join the

cooperative and what the benefits are. We use text analysis techniques to understand beekeepers' motivations of joining a cooperative. The term frequency chart (Figure 5) below shows the top 20 terms that beekeepers mentioned in their answers. To show relative weight of each term, we also visualize most frequent terms into a word cloud (Figure 6). Note the larger the size of a term, the more frequent it appears in beekeepers' answers of reasons to join the cooperative.

We found that beekeepers choose to join a cooperative primarily for material benefits. The most frequent terms they mentioned in their responses are income and insurance. In terms of income, they mentioned that because the government only engages with the cooperative rather than individual beekeepers, by joining the cooperative they can have better access to the honey market and thus generate additional income from selling the honey. Regarding the insurance, some beekeepers told us that they use additional income to buy life and medical insurance, and others said that the cooperative provides them some support in the form of insurance by the end of a year.

Figure 5 Main reasons of joining a cooperative




Our surveys also find evidence that there are significant variations in people's engagement in beekeeping. We conducted statistical analysis (OLS regressions) to gain a deeper insight into the potential factors affecting the length of stay in beekeeping.

In our baseline model, we examine the effects of sex, years of schooling, and types of hives on the stay in beekeeping. From our prior observation of beekeepers' profile, we offer three hypotheses:

*Hypothesis 1 (H1):* being female may be negatively associated with the years of tenure in beekeeping.

*Hypothesis 2 (H2):* years of schooling may be negatively associated with the stay in beekeeping.

*Hypothesis 3 (H3):* the use of modern hives may be positively associated with the stay in beekeeping.

Results show that being female and years of schooling are negatively related to the length of beekeeping years. However, only schooling is statistically significant at $p = .05$ level with a

relatively small coefficient. The use of nontraditional hives (including modern hives and mixed hives) are negatively associated with the stay in beekeeping, which suggest that modern hives may not function well in terms of increasing honey production and incentive people to join and stay in beekeeping. This finding is consistent with our qualitative evidence from focus group discussions (see more details in later sections).

We then add additional confounding variables to our baseline model by including respondents' marital status and age range. The results from the new model shows that only the age factor is statistically significant at $p = .01$ level and positively correlated with the stay in beekeeping, suggesting that the lower the starting age of beekeeping, the longer a respondent may stay in beekeeping. All other factors are negatively associated with stay in beekeeping but they are not statistically significant. One caveat of our statistical tests is that our results might be biased given our small sample size.

*Figure 6. Baseline model coefficient plot*

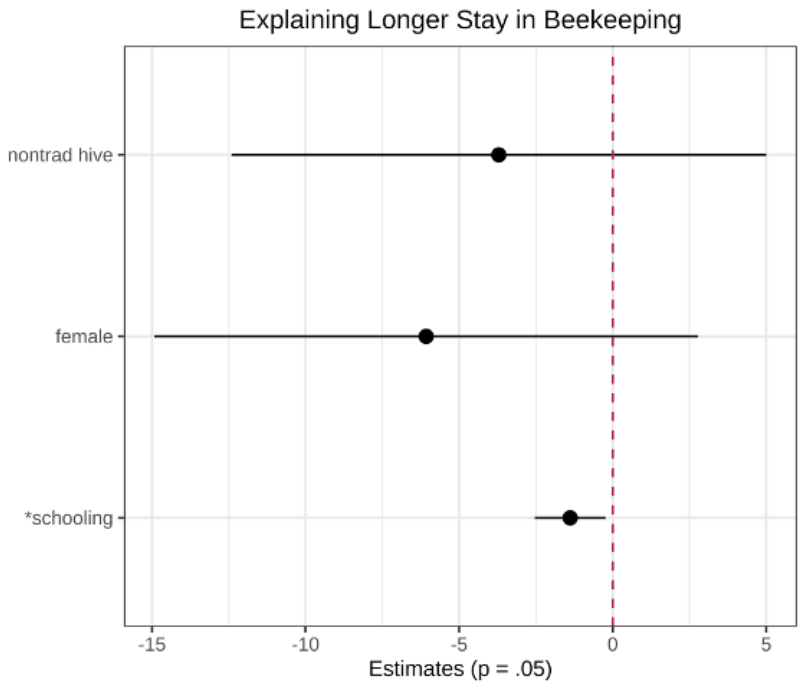
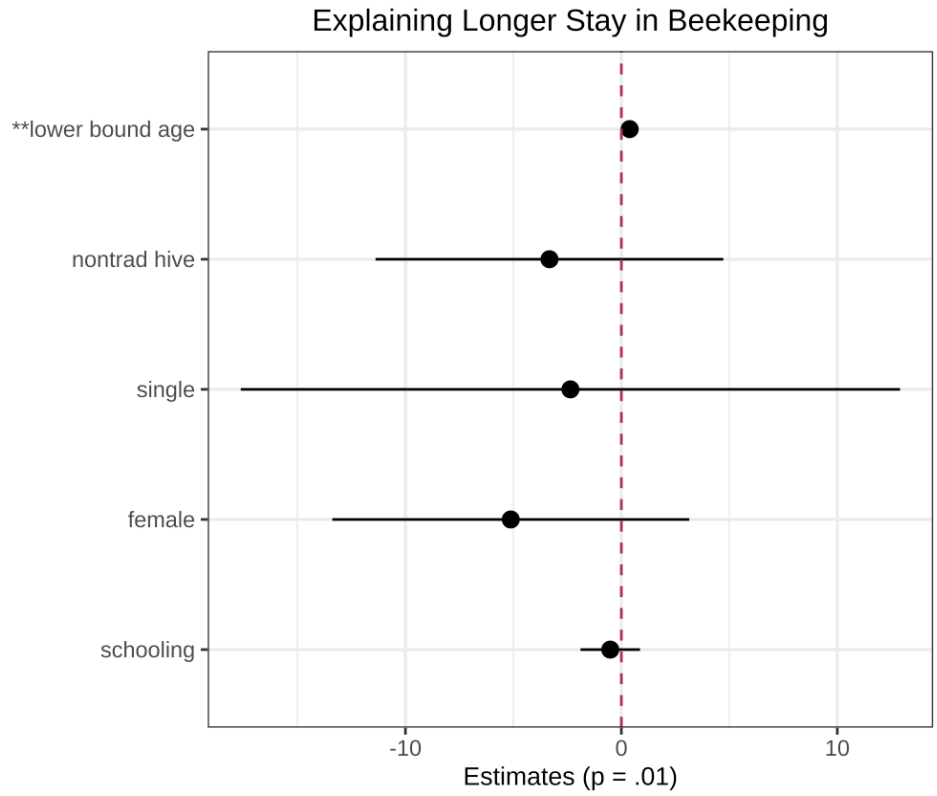


*Figure 7. Full model coefficient plot*



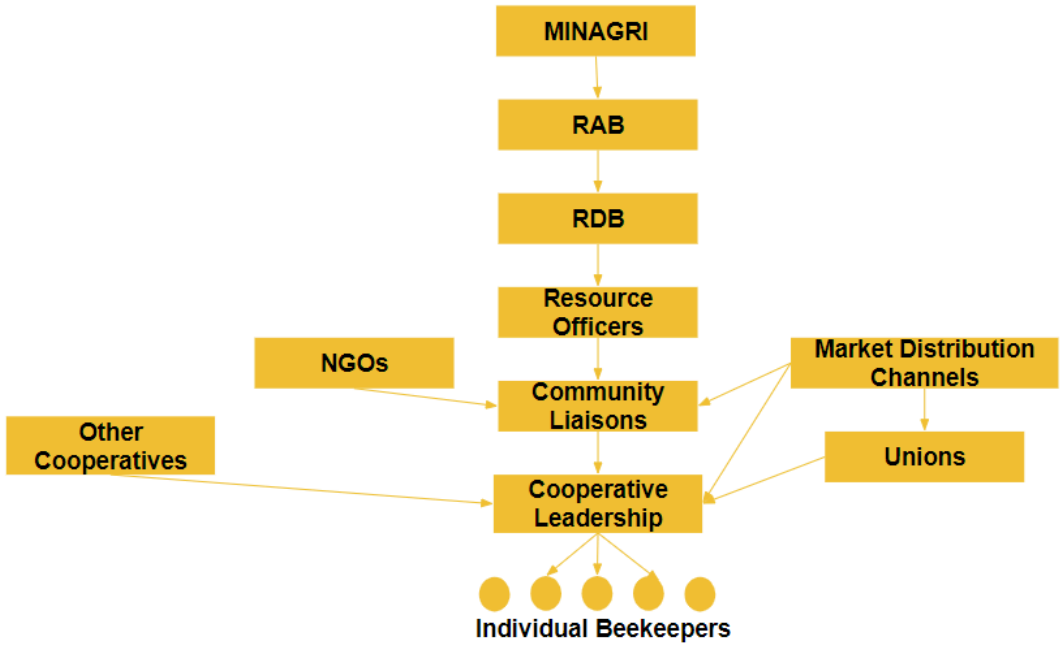

## II. Social Network Analysis

A further analysis of the data using the Social Network Analysis approach divides information flow into two major categories: one category explores how information travels through different channels and enters each cooperative, the other category explores how information proliferates within each cooperative to individual beekeepers.

### A. Information Hierarchy

Information hierarchies refer to the way in which information and its passage are organized within a system. Information hierarchies are used as a tool to manage access to information and resource allocation. In this instance, we follow the path information on

regulations, industry standards, beekeeping practices and technology takes from the original source all the way to an individual beekeeper. The figure below illustrates the current information hierarchy present within the Rwandan beekeeping industry.




*Information Hierarchy within the Rwandan Beekeeping Industry*

Information diffusion within the Rwandan beekeeping industry takes a top-down structure. Information on regulation, industry standards, beekeeping practices and technology use originates from the Ministry of Agriculture (MinAgri), NGOs and Agencies, Market Distribution Channels or Other Cooperatives. The shortest path goes from other cooperatives, to a given cooperative's leadership, then to individual beekeepers. NGOs and agencies such as the United Nations (UN) work with local resource officers and community liaisons to get information to cooperative leadership. Market distribution channels such as retail suppliers communicate with unions, who work with community liaisons. Finally, the government-beekeeper hierarchy is the lengthiest, with the Ministry of Agriculture (MinAgri) working with the Rwanda Agricultural Board (RAB), who then work with the Rwanda Development Board (RDB). At the local level,

RDB hands off to resource officers and community liaisons who then work with community liaisons.

From this figure, we can identify which individuals or groups may have the most influence over decision-making and information dissemination, and the potential impact of information bottlenecks. From an efficiency standpoint, it is most productive to reduce the number of channels that this information passes through in order to make access easier and faster for beekeepers. Furthermore, reducing the steps in such a hierarchy can encourage innovation, creativity and feedback by facilitating a two-way flow of information between the original source and the individual beekeeper.

In this case, community liaisons, resource officers and cooperative leadership appear to be central to this information hierarchy as they have the potential to create the most impactful bottlenecks between information sources and individual beekeepers. This suggests that empowering them by providing more sources of information and opportunities to connect with individual beekeepers can have a positive impact on the entire network. Alternatively, eliminating these steps in the hierarchy can reduce the potential bottleneck effect and make it easier for individual beekeepers to access information sources directly.

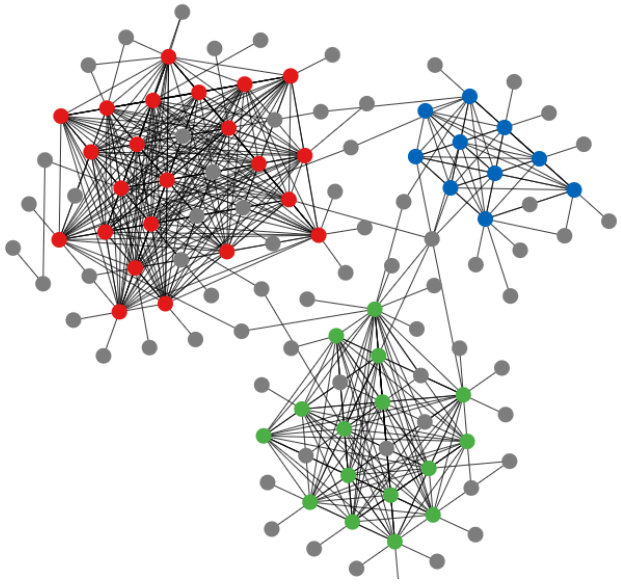
### B. Information Diffusion within the Cooperative Model

In order to answer the first and second research questions posed by this investigation concerning how information spreads, we look at information networks within beekeeping groups. These models were based on survey questions regarding specific points of contact that beekeepers consult for general beekeeping advice, or information on harvesting or selling bee

products. In creating these models, the following assumptions and scope limitations were adhered to:

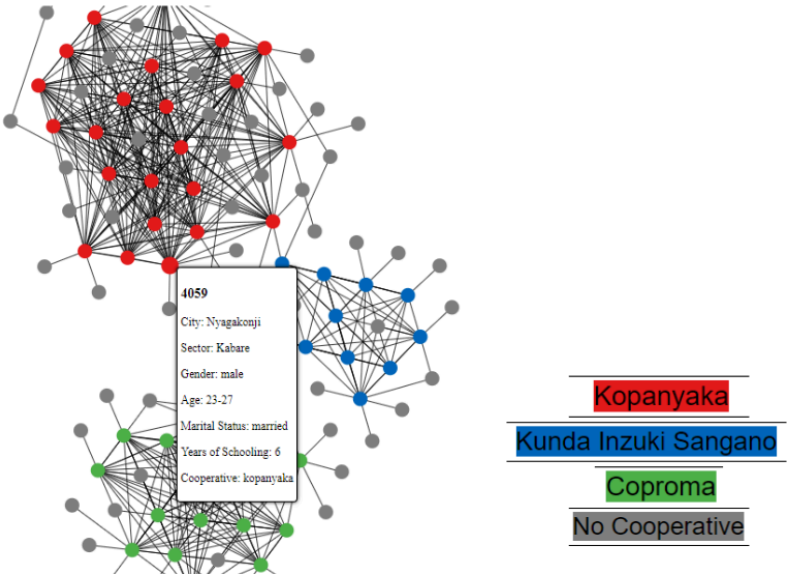
1. Cooperative members primarily consult other members of their cooperative for advice.
2. There is an existent amount of communication within any given pair of members in a cooperative.
3. The amount of weight held by non-cooperative members within the social networks is only concretely defined by their confirmed interactions with cooperative members.

The data sample of 48 beekeepers consisted solely of those who are members of one of three cooperatives. Just as with information hierarchies, this data was analyzed using the Social Network Analysis approach in order to provide insight into the impact of cooperative membership on information diffusion amongst smallholder beekeepers and situate the current position of women and youth within the beekeeping industry. A network analysis diagram of all beekeepers interviewed from each of the three cooperatives visited is shown below.



*A network graph displaying relationships between 48 beekeepers in Eastern Rwanda*

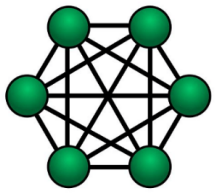
Each node represents a beekeeper; each colored node represents a beekeeper who is also in a cooperative and each edge represents communication such as the sharing of information on training, mentorship and advice on selling/harvesting bee products. Each node can be identified by their location, gender, age, marital status, years of schooling and cooperative membership.




*A network graph displaying cooperative members and their relationships*

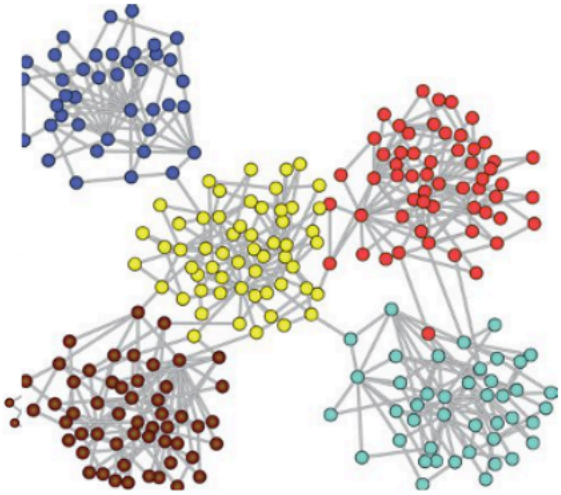
The information networks within these cooperatives yields three key insights:

1. *There is strong communication within cooperatives.* Each node has multiple edges stemming out to other nodes. Each member of the cooperative is well-connected and has strong bonds with at least five other members of the cooperative. This is confirmed by the cooperative members' qualitative response of the strength of the social network and the sense of community being amongst the benefits of joining a cooperative.



Full communication within cooperative

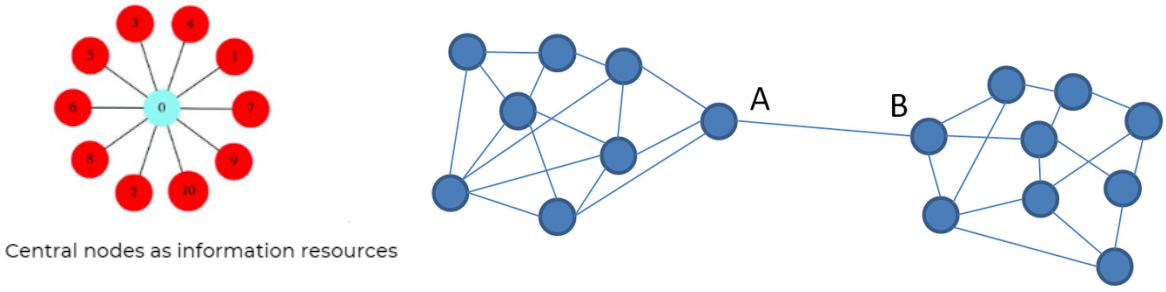
2. *Cooperatives form tight networks and strong clusters.* The strong communication within cooperatives does not translate to communication outside of cooperatives and due to such, there is relatively weak interaction between the different cooperatives. For example, the network analysis data suggests that members from the Kopanyaka cooperative only have one connection with the members of the Kunda Inzuki cooperative, through the presidents of both organizations. This finding corroborates findings from information hierarchies, where cooperative leadership tends to be the key (and sometimes only) points of connection between the cooperative and other cooperatives.



- Tight networks
- Strong clusters within cooperatives

3. *There is a disproportionate amount of power within the cooperative.* As Social Network Analysis (Ackland & Zhu, 2015) dictates, most networks do contain weighted nodes. The nodes with more weight are often those with the most number of connections to other

(connected or non-connected) nodes (i.e. bonding nodes), and those with connections spanning different clusters or networks (i.e. bridging nodes).

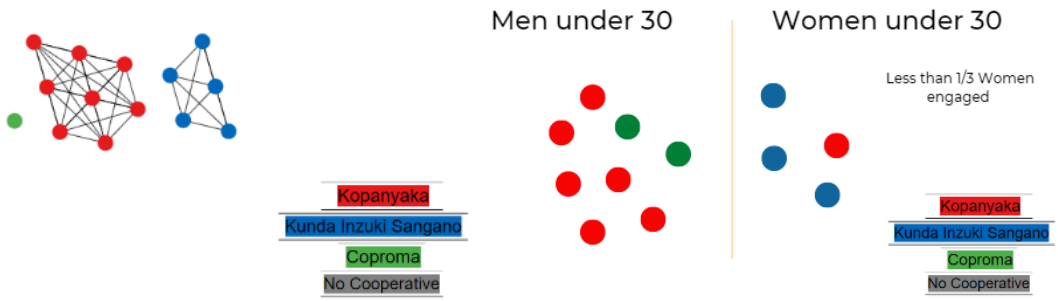



*In the first diagram, node 0 serves as a bonding node while in the second diagram, nodes A and B serve as a bridging node.*

In the case of the given cooperatives, members of leadership teams act as both bonding and bridging nodes. They act as bonding nodes as they are reported to be key powerhouses for sources of information on general beekeeping, harvesting bee products, and accessing the market. Furthermore, they serve as bridging nodes to bring together different clusters within the cooperatives. Women and youth tend to cluster more to themselves. However, just like men, an overwhelming majority report seeking counsel from cooperative leadership. Thus, leadership bridges the gap between women and youth, and the rest of the cooperative. Lastly, cooperative leadership also bridges the gap between the cooperative and other cooperatives or external organizations such as NGOs, unions, and the government. Cooperative members report bringing their yield to cooperative leadership so that it can be combined and prepared for processing. Furthermore, community liaisons and welfare officers report communicating to cooperatives through leadership. Thus, there seems to be a bottleneck for the passage of information, with either direction going through leadership.

### III. Women and Youth within Cooperatives

Women and youth make up the minority of the population within the sample.The data sample from this investigation consists of 27% female beekeepers, and only 13% of all beekeepers belonging to the 27 and below age group. However, there is strong communication between the existing women and youth within these cooperatives.




This underrepresentation of women and youth means that the quality of beekeeping operations as a whole may suffer. In order to achieve the goal of increased production of bee products, the Rwandan beekeeping industry needs increased human capital, fresh perspectives, and sustained proliferation of information. Promoting the participation of women and youth in beekeeping, can encourage gender equality and empower marginalized groups in order to increase the human capital available in the industry, introduce fresh perspectives via the unique practices coming from these groups and encourage the spread of information via social networks from community groups and social media.

### Qualitative Findings

**Comparative Analysis**

The analysis above provides insight into the challenges generally faced by beekeepers and cooperatives as a whole. In an effort to further address these challenges, we can examine similarities or differences in the current statuses of neighboring countries.

## I. Tanzania

From a political and regulatory standpoint, Tanzania has enacted laws to standardize the beekeeping industry. Through laws such as the Beekeeping Act of 2002 and the Plant Protection Act of 1997, the government works with national agencies to regulate the use of forestry, land and other natural resources; create programs to provide low-interest loans to beekeepers to enable them to invest in modern beekeeping equipment and facilities; and regulate the import and export of bees, beehives, and honey to ensure they meet national and international standards for quality and safety. The country has also established a Beekeeping and Honey Production Regulation, which provides for the registration of beekeepers, the inspection of beekeeping activities, and the regulation of honey production and marketing to ensure that honey meets national and international standards. Additionally, Tanzania has established a honey testing laboratory, which helps ensure that honey meets national and international standards, and is safe for consumption and export.

Economically, Tanzania has implemented several unique initiatives in the beekeeping industry, aimed at promoting sustainable production and improving the livelihoods of small scale farmers and beekeepers. One of these initiatives is the Participatory Forest Management (PFM) approach, which involves working with local communities to manage forest resources

sustainably, including the production of honey from forest bees. Under the PFM model, local communities are granted access to forest resources, including honey, and are trained in sustainable beekeeping practices to ensure the long-term viability of the industry. Not only does this approach provide more economic benefits to small beekeepers, it also creates more social capital as local groups form to maintain communal resources.

The social capital created from the utilization of such models has been used to study the impact of social networks on beekeeping outcomes, such as honey production and marketing. Researchers have used Social Network Analysis to identify the types of social networks that are associated with better outcomes, such as networks with high levels of knowledge sharing and collective action. The approach has also been used to evaluate the effectiveness of interventions aimed at strengthening social networks among beekeepers, such as training programs and technology-based platforms.

Lastly, Tanzania has established a national beekeeping development strategy, which aims to increase honey production and improve the quality of honey through the adoption of modern beekeeping technologies and value addition. The country is also utilizing technology such as top bar and modern hives,  and full protective gear in order to inspire greater productive yield for smallholder beekeepers.

## II. Ethiopia

Ethiopia is the leading producer of bee products in Africa. The Ministry of Agriculture works to support beekeeping operations by passing laws such as the Apiculture and Honey Production Development Proclamation of 2019, which outlines the procedures for registration of beekeeping enterprises, licensing of beekeepers, and the establishment of national standards for honey production, packaging, and marketing. It also prohibits the use of harmful pesticides in

beekeeping and provides penalties for those who violate the law. Additionally, the law mandates the establishment of a national apiculture and honey production board to oversee and regulate the sector's development, including providing technical assistance, training, and research services to beekeepers.

Furthermore, the Ministry of Agriculture has created economic benefits for small beekeepers by partially funding the African Honey Bee Genome Mapping Project, which is aimed at unlocking the genetic secrets of African honeybees to improve bee health and productivity. Following this project, the government has established a honey testing and certification laboratory via the Ethiopian Honey and Beeswax Marketing Development Authority (HBMDA) to provide quality testing and certification services for honey and beeswax and ensure that honey meets national and international standards, improving the quality of Ethiopian honey and increasing its marketability. Both of these actions have improved the quality of beekeeping techniques and in turn, the quality of bee products has greatly improved, appreciating their economic value and return to small beekeepers.

From a more beekeeper-focused approach, the Ethiopian government has worked to provide training and technical assistance to small beekeepers, including the use of modern beekeeping technologies such as frame hives and honey extractors via the Ethiopian Beekeepers Association, a non-governmental organization that works to promote beekeeping as a sustainable livelihood option and promote an enabling policy environment for beekeeping by advocating for policies that support beekeeping. This has created more social opportunities for beekeeping communities and encouraged healthier relationships between them and governmental organizations.

From a social networks standpoint, Social Network Analysis has been used to study the structure and dynamics of social networks among beekeepers in Ethiopia. Researchers have used SNA to identify the key individuals in these networks, such as knowledge brokers, who play important roles in information exchange and knowledge sharing. The approach has also been used to understand the factors that influence the formation and evolution of these networks, such as geography, culture, and market dynamics.

From a technological perspective, the country has implemented several unique initiatives in the beekeeping industry, aimed at improving the livelihoods of small scale farmers and beekeepers. One of these initiatives promotes economically sustainable production by introducing traditional beehives made from locally available materials, such as bamboo and straw. These hives are less expensive than modern beehives and are more suited to the local climate and bee species, making them a more sustainable option for beekeepers.

**Policy Recommendations**

We approached policy recommendations from an inter and intra level perspective. Where the inter level refers to the social network within cooperatives and the intra level refers to social networks between cooperatives.

Given the centralized nature of internal cooperative structures we suggest:

1. **Information sharing to combat information asymmetry**

   Expanding training opportunities to other members of the cooperative beyond the cooperative president can help to reduce information asymmetry and flatten social network structures within cooperatives, thus opening a window of opportunity for women and youth to be identified as potential informants. This approach was taken in Ethiopia

where the recognition of the social network patterns and dynamics among beekeepers prompted  collaboration between Oxfam and the Ethiopian government. This resulted in an initiative that encouraged women to participate in cooperatives and receive training on modern beekeeping technology (Oxfam, 2014). Similarly, training can be provided through private sector- companies as seen in Ethiopia with Beza Mar Agro (Beza Mar, 2022). This would help to foster greater collaboration between the private and public sector while also directly contributing to increased honey supply. Training several beekeepers within a cooperative is more sustainable than providing training to only the president, as it ensures information is well disseminated and avoids limitations for those not close to the president. The implementation of this policy is visually represented below.

CENTRALIZED TO FLATTENED SOCIAL NETWORK

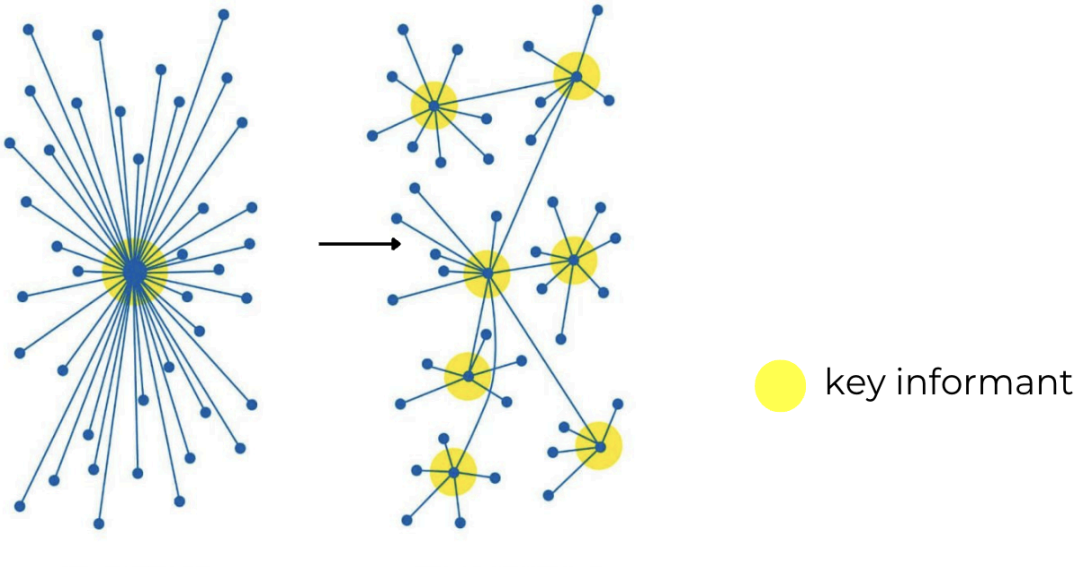



Image on the left shows what the current status quo is in cooperatives. Image on the right shows how direct training of women and youth in cooperatives would flatten social network structure as shown on the right.

2. **Foster communication between cooperatives by training more resource officers.**

This proposed policy recommendation complements the inter-level solution by suggesting the training of additional district and sector Animal Resource Officers through farmfield schools, (minagri, 2023) as is already being done, to provide beekeeping training with an emphasis on providing training to women and youth. By bringing together members from different cooperatives, the initiative could encourage collaboration and communication among beekeepers who can share best practices on beekeeping. Ultimately, the aim is to streamline the process for beekeepers seeking information from those in other cooperatives. To facilitate this knowledge exchange, a community resource liaison could serve as a bridge between different cooperatives.

By implementing this approach, the flow of information and overall productivity within the apiculture industry could be significantly improved.Furthermore, this presents an excellent opportunity for both local and international organizations to offer training programs, which have demonstrated a direct correlation with increased honey production, as exemplified by the International Labor Organization's (ILO) initiatives in Kenya. In 2021, the ILO collaborated with a local women's group (Ikip Farm) to provide training to cooperative leaders and female beekeepers, resulting in a substantial increase in honey production. (ILO, 2022) Similarly, the Women's Opportunity Center in Kayonza, in collaboration with community liaisons, could serve as a potential community partner to mobilize women for training.The implementation of this policy is visually represented below.

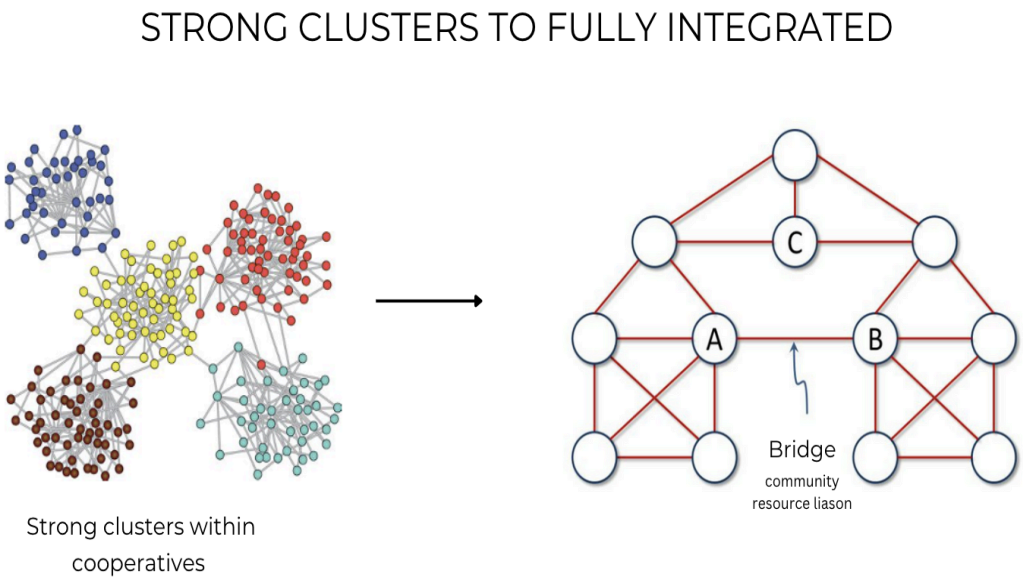



Image above shows what the current status quo is versus how the presence of a community liaison would create a bridge between members of different cooperatives.

## Qualitative Data Analysis

### I. Challenges

This section of the report recounts the five different focus groups conducted with the beekeepers. The focus group discussions were conducted in English with assistance from translators who helped with translating the questions into the local language. The beekeepers engaged in extensive discussions that provided further insight and context to the research. The qualitative data provided more insight into the challenges being faced by the beekeepers in Eastern Rwanda, and they can be divided into three categories (1) Challenges to beekeeping and bee health, (2)Interest in beekeeping and benefits of joining the cooperative ; (3) Selling and transporting honey and (4) Dealing with issues.

## II. Challenges to beekeeping and bee health

Most of the hives being used by the beekeepers are traditional hives. Many beekeepers mentioned that they do not have the knowledge to use modern hives, or the bees were not as receptive to them compared to traditional hives. Most common challenges to bee health cited included pesticides, warm weather, animal attacks, rain and lack of land availability causing the cooperatives to lose colonies every season. The cooperative in Gasabo is losing approximately 15-20% colonies every season due to worsening weather conditions, whereas beekeepers in Kanyinya reported to lose approximately 1000 colonies every season. Furthermore, it was imperative to note the traditional hive structures made it hard to carry out inspections. *"We lost 60 of our colony due to the recent ant attacks' as* mentioned by one of the beekeepers in the Kopanyaka Cooperative.

## III. Interest in beekeeping and benefits of joining cooperative

Upon discussing their interest in beekeeping, most of the beekeepers stated that they do it as a hobby or it was passed on to them by their ancestors. However, several of the members had now picked up on beekeeping as a commercial activity

*"Honey is needed in every sector"* as explained by one of the beekeepers.

Furthermore, while discussing the benefits of joining cooperatives most members cited the sense of community, some of the beekeepers explained it as follows:

*"When they're together in the group they share their ideas, and those ideas help each other to have an open mind" and "working together, it's really a strength"*

*"Another benefit it's very easy when they are working together that example one bring 10 beehives, another 10 So for example if there are 100 people in the cooperative, so they*

*may have like 1000 beehives so the harvest is big and it's easy from there to get a market"*

Furthermore, medical insurance, life insurance, educational expenses were amongst other reasons cited.

**IV**. ***Selling and transporting honey***

With respect to selling honey, lack of transport and low price offered were the most often cited issues. Most beekeepers believed that they were not paid fairly for their honey given the labor that was put into it. One of the beekeepers in Kopanyaka Cooperative explained this as: *"Means of transport is still an issue for example the clients in Kigali do not consider the length of the transport and don't count the expense of the transport. Another issue is that the name tags on the honey are not in a good quality so they may put the tag on the bottle because it's taking the long distance but by the end the words are already hard to read"*

Furthermore, beekeepers in Nyagakonji mentioned that the frequency of transportation provided by the government is inadequate since the car only transports the honey once a day and most of the times it is delayed, or service is suspended due to weather conditions. Therefore, beekeepers have to travel long distances on their bicycles.

**V. Dealing with issues**

Only a few people in the cooperative, mainly the president and some other office holders are provided with training per cooperative. Furthermore, lack of financial resources to acquire modern beehives and extraction equipment is another major hindrance for business expansion. There is also limited land for bee farming.

Most of the beekeepers cited that they used their mobile phones or radio as sources of information to cater to challenges. They also mentioned *"We go to park management when we face issues"* or *"ask the President since they have received some sort of trainings from the government"*

## VI. Challenges for local beekeepers

The common issues that were raised by all the cooperatives and can be deemed as the key takeaways for this project are as follows: (1) there is a need for more information about modern beekeeping technologies in the local language, (2) there needs to be better access to transportation for honey to the unions and better equipment for honey processing, (3) beekeepers need to be trained about honey and the production of other bee products, and (4) government needs to provide more incentives for youth and women to join the apiculture industry.

## Limitations

There are a few limitations of this technical report. Firstly, the scope of this report is only limited to Eastern Rwanda, with only three cooperatives being visited within this region. Hence, a national level study needs to be carried out for a national level policy. Secondly, the sample size was small with only 48 beekeepers, and limited female and youth representation. Lastly, information related to honey production is limited.

## Measuring Treatment Success

The research conducted culminates in the usage of productive yield as a metric to gauge the effectiveness of resource injections on the beekeeping industry. Beyond information sharing,

it is useful to consider other factors that may affect the overall yield of the Rwandan beekeeping industry by primarily considering literacy and product quality.

Literacy can have a significant impact on bee health and market access, as it affects beekeepers' ability to access and understand relevant information, communicate effectively with buyers and other stakeholders, and make informed decisions about their beekeeping practices. Low levels of literacy can be a barrier to accessing information about best beekeeping practices, disease management, and new technologies. Beekeepers who are unable to read or write may struggle to understand written materials, such as instructional manuals or extension materials, which can limit their ability to adopt new practices that could improve bee health and productivity. This can result in lower honey yields, reduced income, and increased vulnerability to disease outbreaks. In addition, limited literacy skills can also impact beekeepers' ability to access markets. Beekeepers who cannot read or write may struggle to understand contracts, negotiate prices, and communicate effectively with buyers, which can limit their ability to sell their products and generate income.

The quality of bee products, such as honey, beeswax, and propolis, can have a significant impact on their price in markets. Higher quality products are generally perceived to be more valuable by buyers and consumers, which can result in higher prices.

Several factors contribute to the quality of bee products, including their appearance, aroma, taste, and texture. For example, honey that is clear, golden in color, and has a pleasant aroma and flavor is generally considered to be of higher quality than honey that is cloudy, dark in color, and has an off-flavor. Other factors that can impact the quality of bee products include their composition, purity, and nutritional content. Products that are free from contaminants, such as pesticides and antibiotics, and have higher levels of antioxidants and other beneficial compounds

are generally considered to be of higher quality and may command a premium price. In addition to product quality, factors such as packaging, labeling, and branding can also impact the price of bee products in markets. Products that are attractively packaged, clearly labeled, and marketed under a recognizable brand are often perceived to be of higher quality and may command a higher price.

Therefore, it remains important to address these factors; the former by, for example, including targeted training programs, access to educational materials in local languages, and the use of alternative forms of communication, such as audio and visual aids to increase smallholder beekeeper's means of accessing information; and the latter by providing more training on factors and techniques that can impact the quality of the final product. Addressing these unrecognized aspects can eliminate potential confounding factors and thus, provide a means to more accurately measure the effect of more streamlined information sharing.

**Discussions**

The  results described are useful in providing an encompassing snapshot of what beekeeping looks like in a part of Rwanda. Research proves that decentralized information dispersal is optimal for the fast, efficient, proliferation of new information and thus, looking into the social networks within beekeeping cooperatives enables observation into patterns of information spread. From the three cooperatives in this research, we observe cooperative leadership as a key resource for information on training and market access. Thus, the introduction of any new social networks with women and youth may require a healthy amount of continued interaction with cooperative leadership.

The government of Rwanda has played a significant role in supporting the formation and growth of agricultural cooperatives, providing training and technical assistance to members, and facilitating access to credit and other forms of financing. The cooperative model has proven to be particularly effective in increasing smallholder farmers' productivity and income, while also improving their access to social services such as health care and education. Today, agricultural cooperatives are a significant force in Rwanda's economy, with over 6,000 registered cooperatives and more than 3 million members engaged in various agricultural activities.

Beekeepers in East Kayonza follow the cooperative framework, where groups of no less than ten but no more than a hundred individuals local to the area form an alliance, register it as a legal entity and agree on the responsibilities the cooperative has to each member and vice versa. Oftentimes, cooperative leadership is chosen based on majority vote, level of leadership and beekeeping experience, and the strength of the individual's ties within and beyond the community. The cooperative leadership team acts as a bridge between the cooperative's members and the rest of the beekeeping network and industry at large. Leaders are responsible for collecting bee products from the rest of the cooperative members and coordinating the processing and packaging of the raw products. They also serve as the face of the cooperative and facilitate communication and training between members and government officials, NGO representatives and community welfare organizations.

This study captures two essential features of the information network among beekeepers in Eastern Rwanda – the centrality and the closeness. Knowing the nature of the information, our study informs future research to empirically identify the types of networks that promote women and youth engagement in modern beekeeping technologies.  Apart from theoretical contributions, this study also provides important policy implications. First, our field study helps us gain

first-hand information of challenges that Rwanda's beekeepers are facing. By bringing this information to relevant stakeholders, government officials can make better informed policies to address challenges of the beekeepers. More importantly, this study maps out beekeepers' information networks through which we will be able to design a targeted intervention project aiming to facilitate women and youth participation in modern apiculture. Increasing participation in beekeeping is consistent with the Rwanda government's goals of higher honey production.

In order to draw more generalizable conclusions, future research should expand the representativeness of the network data. Several strategies can be considered. First, power analysis can help us estimate the smallest sample size needed for the field experiment (Imai 2017). Second, given the imbalance in our dataset – limited women and youth beekeepers, future research should consider oversample the above two groups. Lastly, before the implementation of the intervention project, a balance test between treatment and control groups will be helpful to make sure that pretreatment covariates are similar.

As we propose to add community liaisons to decentralize their network and bridge the information gaps among different communities, our next step should then focus on identifying personal characteristics that make individuals good fits for the key informant role of the community. Perhaps more importantly, our future study should also look at how externalities have a larger impact on the information flows from the government to individual beekeepers as oftentimes, when considering an information hierarchy, it is too late to inject impactful treatments if it is solely done at the cooperative level. Given the common challenges that local beekeepers are facing, particularly the access to modern beekeeping knowledge, it might be more productive to focus on understanding how information reaches the cooperatives as opposed to

how it spreads within each cooperative. By fastening information dissemination procedures, modern beekeeping technologies are more likely to be adopted by beekeepers.

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