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# APICULTURE AS A LIVELIHOOD ACTIVITY IN MAYO DARLE, CAMEROON: A SUSTAINABLE LIVELIHOOD FRAMEWORK ANALYSIS

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**ABSTRACT.** Beekeepers in Mayo Darle consider beekeeping to diversify their income sources. Nonetheless, this agricultural sub-sector is confronted with so many challenges ranging from limited knowledge and skills in production, pests and diseases, the dominance of informal sales channels, and poor-quality products are key challenges in production and marketing that affect the livelihoods of beekeepers. The main objective of this study was to explore the impact of beekeeping on people's livelihoods in the Mayo Darle Sub-Division of Cameroon. Specifically, the goal was to analyzed the financial benefits of beekeeping alongside its impact on the human, natural, social, and physical capital of beekeepers in Mayo Darle. The explanatory-sequential method was employed. Fundamental information was collected using a structured questionnaire and comprehensive interviews. A total of 175 surveys were conducted using stratified simple random sampling. The information was supplemented by secondary sources from both published and unpublished resources. Both descriptive and inferential statistics were utilized. The research results regarding the effects of beekeeping on livelihoods indicated an increase in financial, human, natural, social, and physical capital. The results from Spearman's Product Moment Correlation indicate a notable positive association between the number of bee hives owned by a farmer and the age of a farmer ($r(n= 175) = 0.25$, $p = 0.001$), the number of bee hives held by a farmer and the household size ($r(n= 175) = 0.308$, $p = 0.000$), as well as the number of bee hives held by a farmer and monthly income ($r(n= 175) = 0.248$, $p = 0.001$). The empirical research findings show that beekeeping has beneficial effects on the lives of beekeepers and should therefore be encouraged as a livelihood option in the Mayo Darle Subdivision. Essentially, the results of this research will offer valuable knowledge regarding the impact of beekeeping on livelihoods in Mayo Darle Sub-Division for groups advocating beekeeping and environmental conservation, beekeepers, and other

farmers, and will guide policy to enhance management of these impacts, leading to better beekeeping methods.

**Key words:** Adamawa Region; Apiculture, Livelihood Effects, Mayo Darle Sub-Division, Cameroon.

**Introduction.** Numerous individuals around the globe practice apiculture [1] as a means of earning a living. Beekeeping is a longstanding tradition [2, 3] in many of Cameroon's forest and savanna areas [4]. The practice of managing honeybee colonies for crop pollination [5, 6] and producing honey and various other products is referred to as apiculture, or beekeeping [7], [1]. In 2018, Cameroon had a multifaceted poverty measure of 0.244 [8], categorizing it as a medium-level developing country [1]. The country tackles poverty while maintaining natural biodiversity, with beekeeping serving as a vital income source [7], especially in developing nations [9, 10]. Beekeeping indirectly promotes ecological, economic, and nutritional stability [11, 12] while also directly aiding in the production of essential products such as honey [13], beeswax, queens, and colonies [14], along with additional items like pollen, royal jelly, bee venom, and propolis [15]. In Cameroon, honey treats burns, skin infections, and coughs [16].

Cameroon mainly has an agricultural economy [17], with nearly 70% [18, 19] of its population involved in farming, which tends to be very subsistence-based and unsustainable [20]. In 2023, the economy of Cameroon grew by 4.0%, up from 3.6% in 2022 [21-24]. However, the reduction in poverty remains slow, with 23% [21] existing below the worldwide poverty line of $ 2.15 [21], purchasing power parity (PPP) per day. Households in Cameroon still endure the unsustainable characteristics of agricultural methods [21]. The poverty conditions are said to be more severe in crisis zones and the Sudano-Sahelian regions [25] of Cameroon, where agrarian activities face difficulties due to insufficient or postponed rainfall [26]. Additionally, rural poverty levels remain elevated, with the Adamawa region (including Mayo Darle) reporting a poverty rate of 45.1% [27].

It seems that beekeeping may enhance the welfare of households in Cameroon that keep bees. The Adamawa region (including Mayo Darle) stands out as the foremost area dedicated to apiculture in Cameroon [1], suggesting that the impacts of beekeeping on livelihoods could be more pronounced than in other beekeeping regions across the nation, Nonetheless, despite Mayo Darle's beekeeping potential, numerous farmers in this agricultural subsector encounter difficulties that impact the sustainability of beekeepers' livelihoods, such as bee abscondment, pests and predators, insufficient funding, bush (wild) fires, inadequate education, health issues, limited empowerment, and personal insecurity [2], [28-30]. The production of honey was affected by various elements, such as the accessibility of forage [31, 32], equipment sources [32], understanding of standard

apiary management methods, experience in beekeeping [33], and availability of market information and accessible markets [34, 35]. Limited knowledge and skills in production, pests and diseases, the dominance of informal sales channels, and poor-quality products are key challenges in production and marketing that affect the livelihoods of beekeepers [32]. Farmers in Mayo Darle consider beekeeping to diversify their income sources.

Numerous researchers have conducted studies on different aspects of beekeeping in the Adamawa region of Cameroon including [36-39]. No Empirical research exists on the impact of beekeeping on livelihoods in the Mayo Darle Subdivision of the Adamawa Region in Cameroon. Thus, this study utilized the Sustainable Livelihood Framework to explore the impact of beekeeping on livelihoods in Mayo Darle. We concentrate on the conditions that would motivate rural farmers to engage in beekeeping as well as the impacts of several elements that influence beekeeping adoption and production in Mayo Darle. Initially, it analyzed the financial benefits of beekeeping alongside its impact on human, natural, social, and physical capital. The findings of this study add to the corpus of existing literature. They can serve as a reference for future researchers investigating similar topics, along with policymakers, donor organizations, and entities seeking to develop and implement sustainable livelihood solutions for beekeepers in Mayo Darle. Additionally, these findings will highlight the potential of incorporating beekeeping into various agricultural systems, such as wild forests and vegetation zones, and how it can serve as a sustainable method for reducing household poverty in Mayo Darle and other regions.

**Methods.** The study was conducted in the Adamawa region of the Cameroon highlands, particularly in the Mayo Banyo division, Mayo Darle Subdivision (Figure 1). It is located at roughly 6°28’0" North Latitude and 11°33’0" East longitude [40]. It houses a population of around 41,720 [41] residents, with 8,974 in urban settings and 32,746 in rural locales [40], considering a growth rate of 3.2% [40]. This Subdivision is limited to the north by Nyawa village and south by Mayo-Njinga [40], to the east by Bambol, and the west by the Mambilas Mountains [41]. Covering a total area of 1920 $km^2$ and a population of 7493 in 2005 [41], which has now grown to 23137 inhabitants [40], having a Sudano-Guinean climate [40], consisting of two distinct seasons (dry and rainy).

This Sudano-Guinean climate fosters numerous melliferous plants, including acacia trees that generate nectar and pollen, vital food sources for bees. The Mayo-Darlé Subdivision features a varied economy that ranges from a subsistence economy [41] marked by agro-pastoral practices to a relatively commercial developing economy. The activities with the highest engagement among populations consist of agriculture, livestock rearing, beekeeping, small-scale commerce, handicrafts, and the manual mining of Colombo-tantalite (Ta) [40] which is plentiful in its subsoil. It contains various natural resources including gallery forests, thick woodlands, arable land, tourist

attractions, low-lying areas, wetlands, ponds, rivers, and sand, among others [40]. Considering its abundant biodiversity, we selected this region as our case study because of its extensive beekeeping tradition and its environmental and socio-cultural opportunities. The primary challenge of this research will be to establish Mayo-Darlé as a representative model of beekeeping as a sustainable livelihood endeavour in Cameroon.

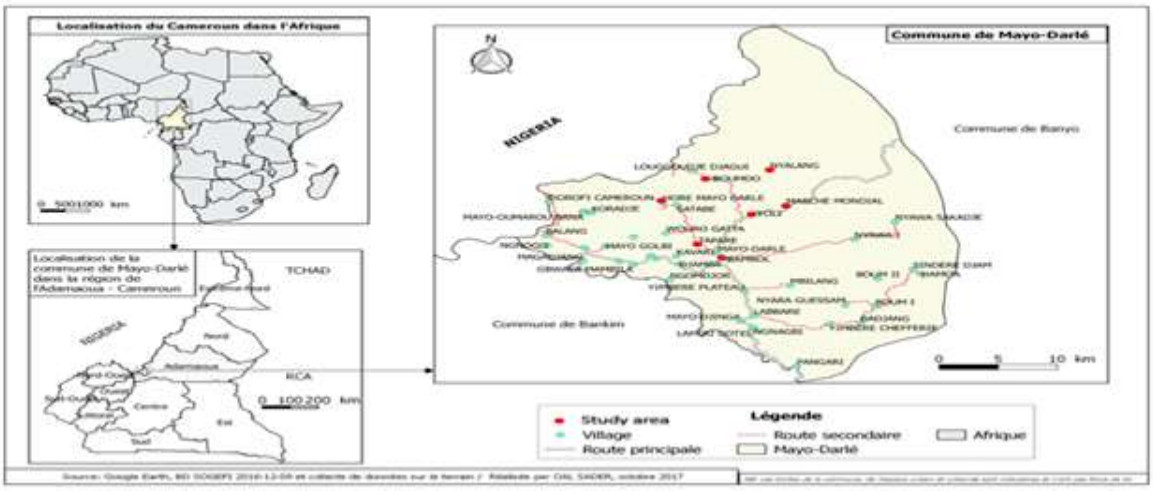


**Figure 1:** Map of Mayo Darle in Mayo Banyo, Adamawa Region, Cameroon
**Source:** Field Data (2024)

**Study Design.** To investigate the effects of beekeeping on livelihoods in the Mayo Darle Subdivision, the study employed a mixed-methods strategy, gathering and evaluating data through both quantitative and qualitative techniques. The explanatory-sequential method was employed to complement quantitative data with qualitative data. The qualitative data sought to provide a more profound insight [42, 43], to enhance the interpretation of the quantitative results. Although qualitative research was used as a supplementary strategy, the quantitative approach served as the primary strategy. Between March and April 2024, beekeepers in Mayo Darle took part in a cross-sectional survey.

**Study Population.** The study population was made up of beekeepers in the Mayo Darle Subdivision. According to information obtained from [40], there are about 6800 beekeepers in Mayo Darle from which the sample size for the study was obtained. Non-beekeepers were not included in the sample.

**Sampling.** The sample consisted of 175 participants. In the initial stage, the Mayo Darle Subdivision was deliberately chosen as beekeeping has emerged as a local tradition and a secondary source of income for the residents. In the second phase, during the time spent in Mayo Darle, (7) beekeeping villages were intentionally chosen, specifically Bambol, Boumdo, Hore Mayo Darle, Nyalang, Yoli, Mondial, and Tapare, as they are the primary honey-producing villages within the Subdivision. In the final phase, stratified random sampling was employed. This was achieved by

initially identifying all the neighbourhoods and main roads in Mayo Darle and categorizing them into layers. Sampling frames were created in the field with the support of the local authorities from each neighbourhood. The researchers went on to locate all beekeepers within each stratum and randomly chose twenty-five (25) beekeepers of each gender until the required sample size for the study was achieved. Purposive sampling was employed to choose (15) Key Informants (KI) for the qualitative data. They included both male and female beekeepers, consumers, sellers of bee products, traditional leaders, and regular community members from all seven (7) villages, and this information was utilized to enhance the quantitative data.

**Instruments.** Data for this study was collected using two approaches: document review (secondary data) and fieldwork with a structured questionnaire and key informant interview guide (primary data). Primary data was collected using a comprehensive interview guide and a validated structured questionnaire. Secondary data sources include information collected from examining both published and unpublished materials, which are utilized to enhance the primary data. The Divisional Officer (D.O) for Mayo Darle Subdivision, the Senior Divisional Officer (S.D.O) for Mayo Banyo division, and the Sub-Divisional Delegate of the Ministry of Animal Industries, Fisheries, and Livestock (MINEPIA) for Mayo Darle Subdivision all provided their ethical authorization. After obtaining the verbal consent of the respondents, participation in the study was made optional to honour their right to self-determination.

**Data Analysis.** The Sustainable Livelihood Framework and Chi-square ($\chi 2$) test statistics were used to examine the effects of beekeeping on livelihoods in Mayo Darle. Financial and human capital were examined through Spearman's Product Moment Correlation. The challenges encountered by beekeepers in Mayo Darle were examined by assessing the level of variance. The data from key informants was verified to enhance the quantitative findings and present the results.

**Ethical Consideration.** Ethical clearance was obtained from the Senior Divisional Officer (S.D.O) for the Mayo Banyo division, the Divisional Officer (D.O) for the Mayo Darle Subdivision and the Subdivisional Delegate of MINEPIA for the Mayo Darle Subdivision. Participation in the study was made optional to honour the respondents' right to choose after obtaining their verbal consent.

**Results and Discussion.**

***Socio-Demographic Characteristics of the Respondents.*** This part examines various traits of the beekeepers who were interviewed. Several variables examined include gender, age, marital status, education level, and religious affiliation, among others.

***Sex and Marital Status.*** The findings (Figure 2) indicate that most beekeepers were male (more than 94%) in contrast to females (around 6%). The results of the present study align with

those of [30], who found that beekeeping is primarily a male-oriented occupation, despite offering income opportunities for both genders. The results are consistent with analytical research on small-scale beekeeping in Eswatini: a case study in the Manzini region by [44]. The results indicate that a majority, specifically 70.2% [44], of the participants were male beekeepers. Additionally, while (76%) of the farmers were married, (24%) remained unmarried at the time of the interview. This suggests that beekeeping in the Mayo-Darle Subdivision is predominantly a male activity.

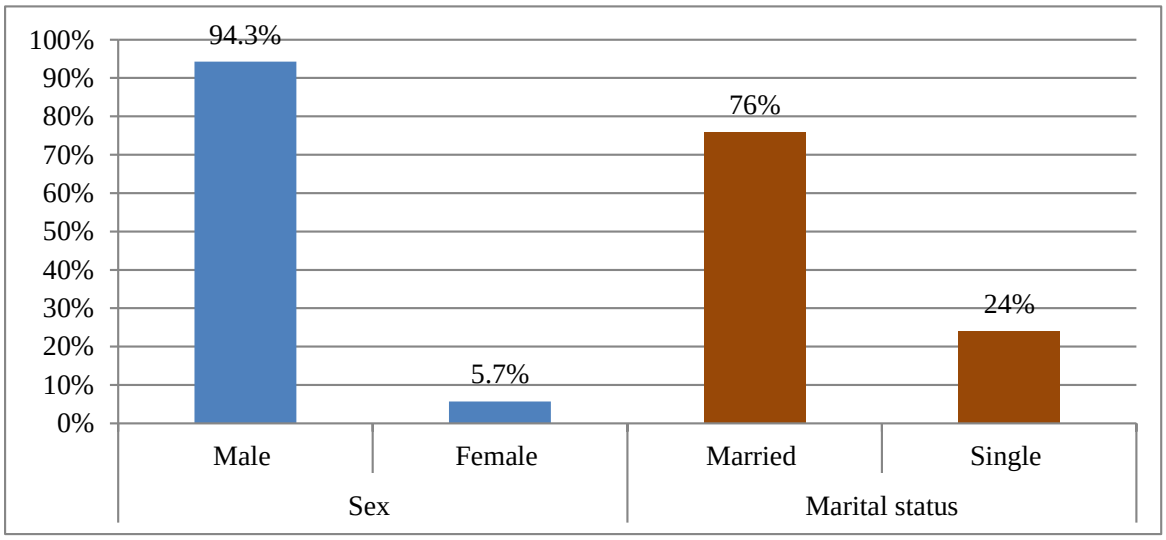


**Figure 2.** Distribution of Beekeepers by Sex and Marital Status
**Source:** Field Data (2010)

***Education and Religious Affiliations.*** Table 1 showed that more than 71% of beekeepers lacked formal education. Additionally, approximately (22%) of them possessed primary education, while just over (5%) had GCE Ordinary Level qualifications, and nearly (8%) indicated having a University education.

**Table 1. Education and Religious Affiliations**

| **The educational level of farmers** | | | |
|---|---|---|---|
| No formal education | FSLC | GCE Ordinary Level | Bachelor's degree and above |
| 71.3% | 21.8% | 5.2% | 7.7% |
| Religious affiliations | | | |
| Christian | Muslim | African Traditional Religion | |
| 17.3% | 82.1% | 0.6% | |

**Source:** Field Data (2024)

This outcome is different from that of [44], which indicated that most participants, 51.0%, attained secondary education. The findings of this recent research contrast with those of [45], who found that although Thai beekeepers achieved great success in beekeeping, their qualifications, management skills, ecological balance, and marketing effectiveness were all rated highly. This discovery demonstrates that the success of beekeeping depends on farmers' determination to

succeed, even though education will encourage innovative methods that foster sustainable livelihoods. Most of the beekeepers were Muslims (more than 82%), whereas only (more than 17%) were Christians. This makes sense since Mayo Darle is a Muslim community, which explains their significant representation in the data set.

***Main Source of Livelihood.*** An additional examination of the data (Figure 3) reveals that most of the beekeepers in Mayo Darle rely on farming as their primary means of support (over 91%), while a few indicated that Artisan activities constitute their main source of income 3.5%, and beekeeping is merely a part-time pursuit. A portion of 2.3% of the beekeepers were identified as students. Beekeeping therefore represents an essential economic and livelihood endeavor for the residents of Mayo Darle. These results support [44] findings about the socioeconomic standing of those who choose beekeeping as a business. According to their findings, a large percentage of respondents (96%) were men, 72% were young, 47% had only completed matriculation, and 51% worked in agriculture [44].

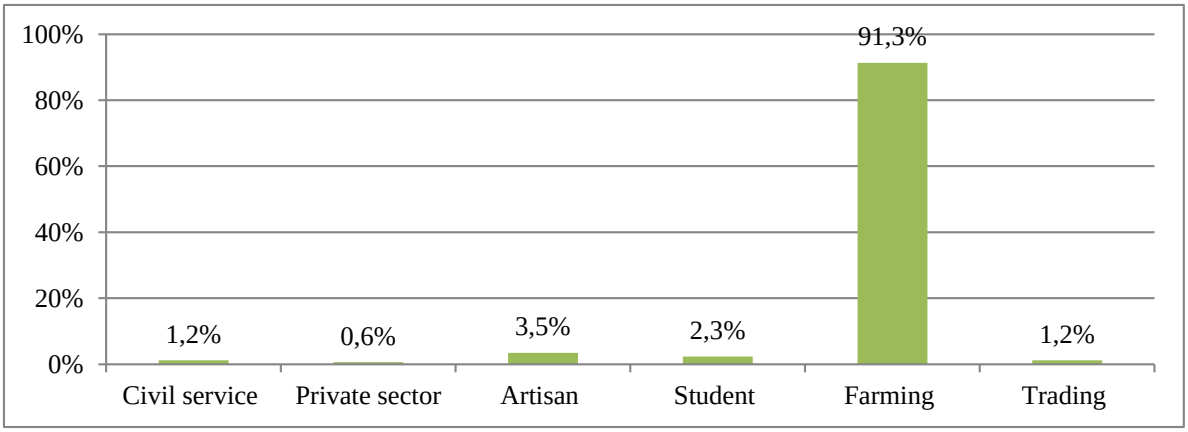


**Figure 3.** The Main Source of Livelihood
**Source:** Field Data (2024)

***Accumulation of Human and Financial Capital.*** Although 41.2% of the beekeepers possess the land used for beekeeping, 58.8% of the farmers indicated that they do not own the farms where they practice beekeeping (Table 2).

**Table 2. Accumulation of Human and Financial Capital**

| Variables | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|
| Age of farmer | 16 | 74 | 39.62 | 12.378 |
| Household size | 1 | 25 | 8 | 6 |
| Estimated monthly income/FCFA | 1500 | 375,000 | 30,700 | 44,030 |
| Number of years living in the community | 2 | 72 | 30.2 | 15.596 |
| Number of bee hives owned | 2 | 315 | 54 | 48 |
| Number of years in bee farming | 1 | 63 | 11.62 | 10.614 |

**Source:** Field Data (2024)

The results regarding human capital show that some beekeepers possess land, although most beekeepers in Mayo Darle do not own any land. This indicates that land value rises with the ongoing expansion of bee farms, and many beekeepers find it difficult to purchase and possess land. This resembled the results of [45], which signified that the absence of land to set up an apiary for environmental sustainability is a factor affecting Uganda's embrace of beekeeping technology. The typical age of the beekeepers was found to be approximately 40 (39.62±12.378) years, whereas the typical household size was 8 (8±6) individuals. This discovery differs from the one made by [44], which indicated that beekeepers in Eswatini have an average lifespan of 32 years. This could have been due to the problem of being unable to obtain and possess land, which usually restricts the quantity of hive production. Regarding the estimated monthly earnings, an average monthly income of FCFA 30,700 was determined by these beekeepers (with some earnings up to FCFA 375,000 monthly). Once more, this low income is likely connected to the conventional method of beekeeping and the quantity of bee hives possessed. These results [46] pointed out that the variety of bee hives affects the output and profit margins of beekeepers in Bangladesh. Additional examination of the data showed that these farmers have resided an average of 30 (30.2±15.596) years in Mayo Darle, with the longest being 72 years. In the realm of beekeeping, some beekeepers possess merely 2 bee hives, while others can have up to 315 bee hives (with a sample average of 54 bee hives). This is likely connected to the years spent in beekeeping, as some beekeepers have just 1 year of experience while others have been involved for more than 63 years (averaging nearly 12 years of experience across the total sample). This variation in bee hives might be linked to other elements like the beekeeper's age, the household size that can provide labour, and the household's income. Consequently, it was found that beekeeping is lucrative, very efficient, and better suited for poly hives compared to traditional wooden hives [47]. This resulted in a correlation analysis investigating the connection between the number of bee hives and the farmer's age, household size, and monthly income (Table 3).

**Table 3. Spearman's Product-Moment Correlation Test**

| **Variables** | | **Number of Bee Hives Owned** |
|---|---|---|
| Age | The Pearson Correlation | .250** |
| | Sig. (2-tailed) | .001 |
| | N | 175 |
| Household size | The Pearson Correlation | .308** |
| | Sig. (2-tailed) | .000 |
| | N | 175 |
| Estimated monthly | The Pearson Correlation | .248** |
| | Sig. (2-tailed) | .001 |
| | N | 175 |

**Source:** Field data (2024)

***Spearman's Product Moment Correlation Test.*** Findings from Spearman's Product Moment Correlation displayed in Table 3 reveal a significant positive correlation between the number of bee hives owned by a farmer and age of the farmer ($r(n= 175) = 0.25$, $p = 0.001$), the number of bee hives held by a farmer and the household size ($r(n= 175) = 0.308$, $p = 0.000$), along with the bee hives possessed by a farmer and monthly income ($r(n= 175) = 0.248$, $p = 0.001$). Thus, a rise in the age of the farmer, household size, and monthly income of the farmer results in a higher number of beehives the farmer will possess. This makes sense since growing older brings more experience in beekeeping. Furthermore, larger households might offer inexpensive and accessible labour for these farmers to utilize more land and manage their beekeeping activities effectively. Furthermore, greater income enhances farmers' capacity to buy additional bee hives and other essential inputs for honey production.

Moreover, increased income enhances beekeepers' capacity to buy additional bee hives and other essential inputs for honey production [48]. Results differ from those of [49], who reported that the regression outcomes showed that the subsequent elements had a notable and positive influence on entrepreneurial behaviour in Bangladesh: age, education level, number of hives, psychological aspects, and involvement in extensions. The number of beehives, age, and education minimally influenced entrepreneurial behaviour; however, psychological factors and greater involvement significantly affected it [49]. It was found that the beekeeper displayed somewhat entrepreneurial behaviour.

***Livelihood Contributions of Bee Farming in Mayo Darle Subdivision.*** The analysis was done following the Sustainable Livelihood Framework proposed by [50]. The financial benefits of beekeeping are examined first, followed by the contributions to human, natural, and social capital as well as physical capital (household assets).

***Contribution to Financial Capital.*** The outcomes displayed in Figure 4 indicate that there has been a general rise in employment in Mayo Darle due to the initiation of beekeeping (noted by almost 84% of the farmers). This has resulted in a rise in income, particularly from honey sales (from 22.6% to 74.9%, a rise of 52.7%, $\chi2 = 80.223$, $p = 0.000$), which also resulted in an increase in monthly income (from 19.4% to 72.6%, a rise of 53.2%, $\chi2 = 91.909$, $p = 0.000$). Due to the rise in monthly incomes, there has been a corresponding rise in monthly expenses in the households of beekeepers (from 29% to 71.4%, an increase of 42.4%, $\chi2 = 94.724$, $p = 0.000$).

The examination of financial capital indicates that there has been a general rise in employment in Mayo Darle due to the implementation of beekeeping. This has resulted in a rise in revenue, particularly from the sales of honey and its related products. The findings of this research align with those of [51], which observed that there are notable differences in resource endowments

and skill sets between beekeepers and non-beekeepers in Ethiopia. Engagement in beekeeping was shown to raise income by 51% once these variations were considered. Independent research conducted by [52] indicated that the productivity and monetary success of beekeeping were significantly influenced by the different management practices employed, encompassing the count of beehives maintained, growth of colonies, supplementary feeding, the month when honey is harvested, and the strategy for marketing. This study emphasizes the biological elements and management strategies associated with enhanced profitability in beekeeping. A major contributor of the qualitative data reinforced the quantitative data that:

Beekeeping has contributed financially to livelihood. The inhabitants can now harvest more medicinal plants around beekeeping farms to address some health issues affecting their community, the availability of herbal products in the local markets as a means of earning, and increase in employment in the honey value chain from production to transformation into other products results to increase in income levels in most bee farming communities *(President of Bee Farmers Group in Bambol Village, age 39, 19/04/2024).*

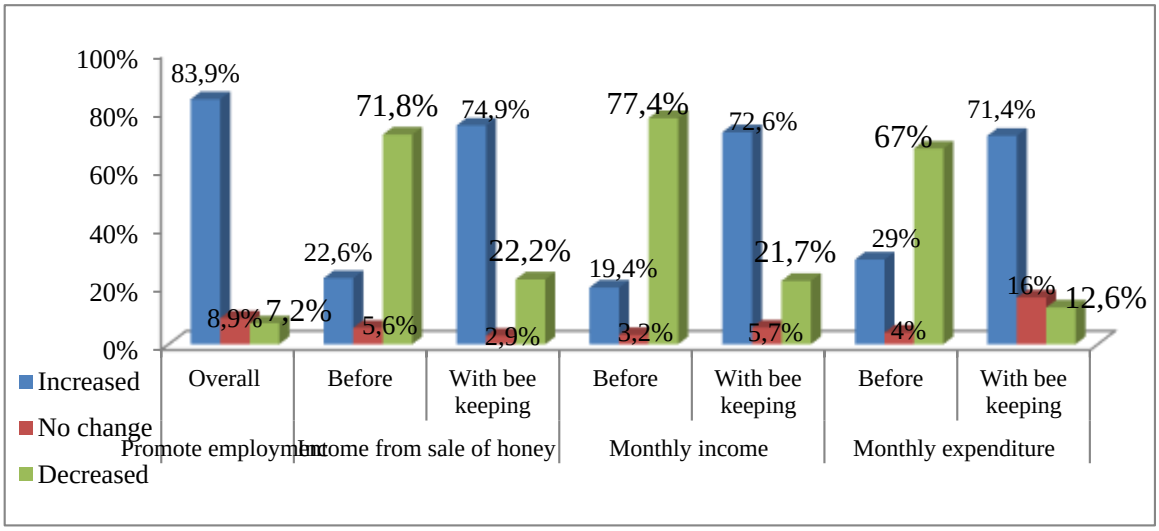


**Figure 4.** Changes in Financial Capital
**Source:** Field Data (2024)

Similarly, another participant supported that:

Beekeeping has created many sources of income ranging from the production of bee hives and sale, some indigenes sell colonized bee hives, some transport honey to various destinations and get paid, and some produce the honey and bee wax for sale. In addition, students from the school of agriculture also make use of our community for internship practices related to honey production *(Council Development Officer in Mayo Darle, Age 65, 19/04/2024).*

Succinctly, another key participant added that:

There is an observed increase in family income, getting to marrying of many wives because of money generated from beekeeping and this is very common with Muslims, the standard of living

has improved as many farmers can buy modern telephones that facilitate the day-to-day running of some of our businesses *(Beekeeper with 35 years' experience Boumdo village, Age 65, 19/04/2024)*.

***Contribution to Human Capital.*** Beekeepers were requested to signify their involvement in agricultural production training. As shown in Figure 5, there has been a rise in the proportion of beekeepers engaged in agricultural training in Mayo Darle (from 4.8% before bee farming to 46% with beekeeping, representing a 41.2% increase, $\chi 2 = 60.495$, $p = 0.000$). The results of [53], which highlight that research must pinpoint the operational level in Malawi, reveal clear variations in capital within the operational tiers of independent small farmers, commercial apiarists, associations/ cooperatives, and non-governmental organization beekeepers. The results suggest that although beekeepers' attendance at training has risen, their knowledge and/or skills appear to remain unchanged from before.

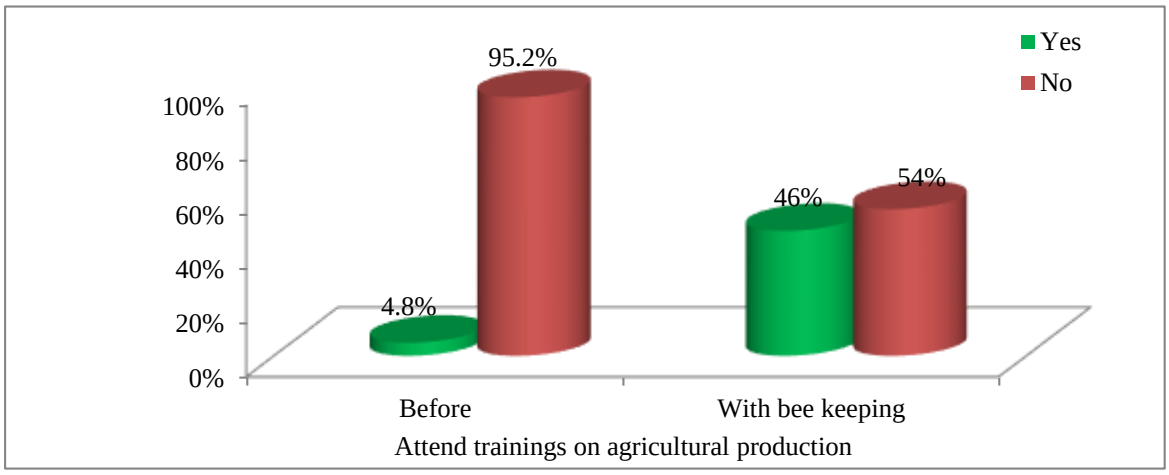


**Figure 5.** Attending Training in Agricultural Production
**Source:** Field Data (2024)

Additional analysis presented in Table 4 reveals that besides participating in training, there has been a notable rise in the number of training sessions attended by beekeepers (from 1 to 2, $t = -2.489$, $p = 0.015$), although their level of knowledge and/or skills appear to remain unchanged compared to before (averaging 4.71 and 4.07, $p = 0.25$). Human elements impacting the livelihoods of Tanzanian beekeepers include low income, dependence on traditional hives, lack of knowledge about sustainable beekeeping methods, restricted harvesting of bee products, inadequate packaging, financial difficulties, and lack of markets, as noted by [54]. To support these facts, the main participant admitted that:

In terms of human capital, beekeeping has contributed to capacity building and training of beekeepers regularly organized by NGOs. This has led to community development, more employment opportunities and enlightenment. Training on how to manage farmer-grazer conflicts is also frequently organized by these NGOs on how to mitigate farmer-grazer conflicts in beekeeping areas as some grazers are also practicing beekeeping in Mayo Darle Subdivision. There

is also the growth of more beekeeping businesses leading to economic growth and job creation *(President of National Youth Council for Mayo Darle, Age 32, 21/04/2024)*.

**Table 4. Contribution to Human Capital**

| Variables | State | Mean | Std. Deviation | t-test |
|---|---|---|---|---|
| Number of trainings attended | Before | 1 | .000 | t = -2.48 |
| | Now | 2 | 1 | p = 0.015 |
| Level of knowledge/skills acquired | Before | 4.71 | 1.254 | t = 1.233 |
| | Now | 4.07 | 2.396 | p = 0.25 |
| Number of children going to school | Before | 3 | 2 | t = -1.951 |
| | Now | 4 | 3 | p = 0.053 |
| Amount spent on schooling/FCFA | Before | 38,080 | 50,900 | t = -0.445 |
| | Now | 41,200 | 42,820 | p = 0.657 |
| Number of times a household eats a day | Before | 2 | 1 | t = -6.086 |
| | Now | 3 | 1 | p = 0.000 |
| Number of days households eat fish/meat a week | Before | 2 | 1 | t = -2.865 |
| | Now | 3 | 2 | p = 0.05 |
| Number of days a week household members ate only once | Before | 2 | 1 | t = -1.966 |
| | Now | 2 | 2 | p > 0.05 |

**Source:** Field data (2024)

Data analysis showed that there has been a notable rise in the number of children attending school (from 3 previously to 4 currently with beekeeping, p = 0.053), while the expenditure on education did not show a significant change, although it was marginally higher than for beekeeping (from FCFA 38,080 to FCFA 41,200 respectively, p > 0.1). A primary contributor in the KII validated the quantitative data that:

Youth who are bike riders are also fully engaged in beekeeping, which has not only employed them and provided income but has gone as far as reducing crime rate and idleness. Due to the increase in family income from honey, during harvesting season, most families tend to pay their debts and acquire new household utensils and telephones to manage the day-to-day running of other businesses. In our Muslim religion, utensils are very important items *(Beekeeper and Adviser of Motor Taxi Union in Mayo Darle, Age 40, 21/04/2024)*.

Succinctly, another key participant advanced that:

In terms of human capital, beekeeping has created many job opportunities for women from their daily commercialization of honey and locally made bee products like detergents and lotions in our local markets *(Female Bee Farmer Marche Mondail Village, Age 38, 21/04/2024)*.

Regarding household food intake, the frequency at which households eat daily rose notably from 2 meals a day before starting to 3 meals a day following the commencement of beekeeping (t = -6.086, p = 0.000). Furthermore, the frequency of days per week that households consume fish and/or meat rose notably from 2 days before starting to 3 days after beginning beekeeping (t = -2.865, p = 0.05). Results, however, indicate that there were still a few days when households consumed food just once daily (2 days both prior and currently). A significant contributor emphasized under social capital that:

Honey and honey drinks supplement feeding in Mayo Darle. Locally the average family eats twice a day. Many homes now consume honey as a natural sweetener coupled with its health benefits, thus improving the overall health of most family members. There is now the possibility of acquiring other social needs because of the increase in income. Beekeeping is seen as a gender-friendly activity employing everyone in the community. Where beekeeping is carried out, there is a significant increase in wild fruits and berries harvested by the locals for their home consumption *(Delegate of Agriculture in Mayo Darle Subdivision, Age estimate 45, 23/04/2023).*

***Contribution to Natural Capital.*** An examination of how beekeeping impacts natural capital (Table 5) reveals a rise in the number of plots held by beekeepers (from an average of 1 plot before starting beekeeping to 2 plots after starting beekeeping, t = -2.865, p = 0.005). Although meaningful solely at the 10% level, the size of the plots possessed by the farmers exhibited a notably larger plot size post-engagement in beekeeping compared to prior (averaging 4.2ha and 1.7ha respectively, t = -1.343, p = 0.09). Results, however, indicate that farmers experience a rise in natural capital accumulation after they adopt beekeeping. In Uganda, [55] reported similar results, showing that beekeepers had an average of 3.72 hectares for each household, and this space increased with the rising number of bee hives. This contrasts with [56], which highlighted that beekeeping occupies minimal space and thus does not necessitate extensive land or investment. This perspective was similarly promoted by the Gender Focal Point at MINFOF Age 49, on 22/04/2024 in Mayo Darle that: "*many beekeepers are purchasing and owning land to carry out their beekeeping activities*"**.**

**Table 5. Change in Natural Capital**

| Variables | State | Mean | Std. Deviation | t-test |
|---|---|---|---|---|
| Number of plots owned | Before | 1 | 1 | t = -2.865 |
| | Now | 2 | 1 | p = 0.005 |
| Size of plots owned | Before | 1.7460 | 2.18221 | t= -1.343 |
| | Now | 4.1906 | 22.26755 | p = 0.09 |

**Source:** Field Data (2024)

***Contribution to Social Capital.*** The accumulation of social capital was measured by involvement in groups and networks, as well as by the leadership roles held within these groups as

members and leaders, along with the count of friends of beekeepers before and during their participation in beekeeping. The data presented in Figure 3 indicated a rise in social group and network membership among these beekeepers after engaging in beekeeping (from 4.8% to 44%, a growth of 39.2%, $\chi 2 = 56.738$, $p = 0.000$). A noteworthy (9.2%) of farmers indicated they currently hold leadership roles in their social groups, in contrast to just (1.6%) who held such roles before their beekeeping activities (a 7.6% rise, $\chi 2 = 7.397$, $p = 0.007$).

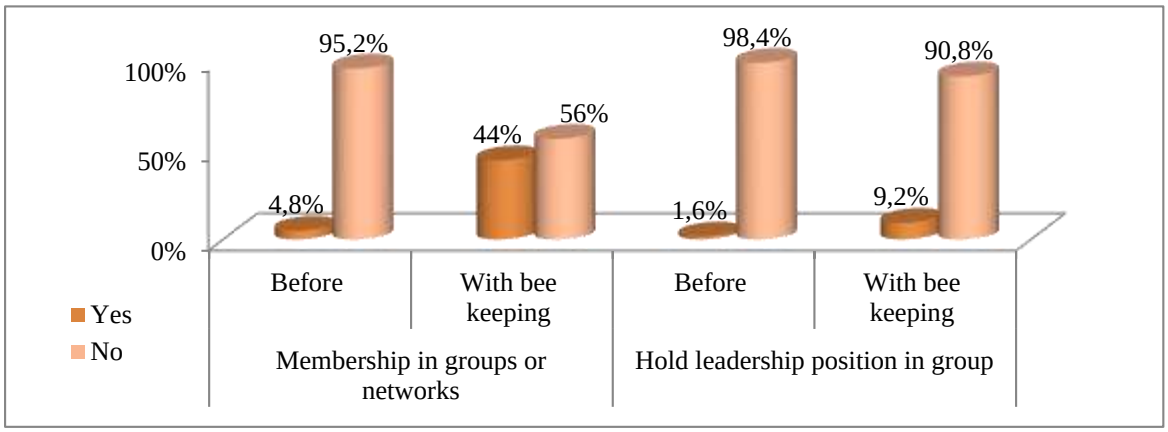


**Figure 6.** Membership and Leadership in Groups and Social Networks

**Source:** Field Data (2024)

In addition to being a member of a social network (Table 6), there was an increase in the number of groups these farmers belong to after engaging in beekeeping (from an average of 1 to 2 groups, $t = -2.592$, $p = 0.012$), though no difference was observed concerning the number of groups that they hold leadership positions in. Just as is the case with the number of groups with leadership positions, the number of close friends for these farmers showed no difference before engaging in beekeeping and after taking up beekeeping as a livelihood alternative (an average of 3 friends in both cases, $t = -0.165$, $p = 0.869$). These results align with those of [57], who found that social and familial resources affect beekeepers' choice to engage in entrepreneurship in India. The research indicated that beekeepers who benefited from larger apiculture businesses were more likely to start their ventures compared to those with more industry experience [57].

**Table 6. Number of Groups and Friends**

| Variables | State | Mean | Std. Deviation | t-test |
|---|---|---|---|---|
| Number of groups as a member | Before | 1 | - | t = -2.592 |
| | Now | 2 | 1 | p = 0.012 |
| Number of groups as a leader | Before | 1 | - | t = -0.295 |
| | Now | 1 | 1 | p = 0.77 |
| Number of close friends | Before | 3 | 2 | t = -0.165 |
| | Now | 3 | 2 | p = 0.869 |

**Source:** Field Data (2024)

***Contribution to Physical Capital.*** This section concludes with an examination of how beekeeping contributes to the acquisition of certain household goods and/or physical assets. Table 7 indicates that the primary asset purchased by these farmers using the earnings from their bee farms was mobile phones, which was noted by more than 81%. Additionally, around 63% of the farmers have purchased a plot of land with the earnings from their bee farms. An additional examination of the data showed that around 58% of the farmers indicated they purchased a house with the earnings from beekeeping, while approximately 41% also acquired a motorbike using the profits from beekeeping. Purchasing a car was the final entry on the list of these beekeepers, with only around 2% indicating they had acquired a vehicle from their beekeeping endeavours.

This resembles the results of [58] in Southern Ethiopia, which indicated that beekeepers utilize earnings from beekeeping to gain social capital. Physical capital is essential in beekeeping, influencing the welfare of beekeepers and the general health of honeybee colonies [59]. In apiculture, manual capital promotes knowledge sharing, enhances resilience, and supports sustainable methods, which advantages both beekeepers and honeybee communities [56].

**Table 7. Purchase of Physical Assets**

| Items Bought | Yes | No | Number Bought |
|---|---|---|---|
| Piece of land | 62.9% | 37.1% | 1±1 |
| A house | 57.7% | 42.3% | 1±1 |
| A car | 2.3% | 97.7% | 1±1 |
| A motorbike | 40.6% | 59.4% | 1 |
| A bicycle | 6.9% | 93.1% | 1 |
| A set of chairs | 20.6% | 79.4% | 1±1 |
| A television | 14.3% | 85.7% | 1±1 |
| A radio | 21.1% | 78.9% | 1 |
| Mobile phone | 81.1% | 18.9% | 1±1 |

**Source:** Field Data (2024)

***Challenges Faced in Beekeeping in Mayo Darle Subdivision.*** It is completely expected that these beekeepers encounter difficulties in their beekeeping endeavours. For example, it was noted from Table 8 that more than 97% of the farmers encountered difficulties related to inadequate skills in bee management, absconding, low honey production, bee pests and predators, absence of honey processing facilities, insufficient attractive packaging for honey, lack of consistent income from beekeeping, and limited knowledge in recognizing diseases and bee threats. Nonetheless, beekeepers in Mayo Darle encountered additional major challenges, including insufficient financial resources (noted by 98%), inadequate design of contemporary bee hives (noted by 96%), absent market for beehive products apart from honey (noted by almost 95%), and the absence of bee hives

(noted by more than 94%). Nonetheless, considering the seriousness of the challenges encountered, the top five significant obstacles, ranked by their level of importance, are the absence of a honey processing unit (average score of 8.22/10), insufficiently appealing packaging for honey (average score of 8.06/10), inadequate skills in bee management techniques (average score of 7.26/10), restricted access to loans (average score of 6.91/10), and substandard design of contemporary bee hives (average score of 6.84/10). These and additional items can be found in Table 8.

**Table 8. Challenges Faced in Beekeeping**

| Challenges | Yes | No | Severity Use score 1-10 |
|---|---|---|---|
| Inappropriate proficiency with beekeeping techniques | 97.1% | 2.9% | 7.26±1.867 |
| Abscondment | 97.1% | 2.9% | 6.59±1.41 |
| Modern beehives are poorly designed. | 96% | 4% | 6.84±1.78 |
| Low yields of honey | 97.1% | 2.9% | 5.72±1.383 |
| Hives are very few | 94.3% | 5.7% | 5.74±1.558 |
| Predators and pest | 97.7% | 2.3% | 5.5±1.5 |
| Insufficient financial resources | 98.3% | 1.7% | 5.72±2.623 |
| Wild (bush) fires | 63.4% | 36.6% | 5.69±1.751 |
| Lack of continuous income generation in beekeeping | 96.6% | 3.4% | 5.1±2.323 |
| Lack of a honey processing unit | 98.9% | 1.1% | 8.22±2.428 |
| Limited training in the production of value-added products | 74.9% | 25.1% | 5.33±2.28 |
| Limited knowledge in the identification of diseases and enemies | 96.6% | 3.4% | 6.05±1.916 |
| Lack of loan facilities | 89.7% | 10.3% | 6.91±2.199 |
| Honey's unappealing packaging | 97.1% | 2.9% | 8.06±2.492 |
| Absence of consumer dependence on honey quality | 40.6% | 59.4% | 4.96±2.944 |
| Absence of a market for other beehive products besides honey | 94.9% | 5.1% | 5.46±2.505 |
| Fear of high risk in apiculture related to changing climate | 78.9% | 21.1% | 5.36±2.304 |
| Fear of sting | 54.9% | 45.1% | 5.31±2.45 |
| Lack of family support | 85.1% | 14.9% | 5.59±2.395 |
| Less income than expenditure | 73.7% | 26.3% | 5.92±1.742 |

**Source:** Field Data (2024)

Similar findings were reported by [1] in Cameroon, indicating that beekeepers face production issues such as rising deforestation, climate change, bees absconding, pests and predators, use of detrimental agrochemicals, poor hive management, inadequate harvesting methods, and the presence of toxic flowering plants. The results also align with previous research

by [60] in Nigeria, which suggests that the high cost of modern technology, insufficient capital, lack of extension support, absence of incentives/training, limited access to credit, climate conditions, and scarcity of forage plants were the primary barriers to beekeeping in the region studied. Participants believe that the primary challenge to beekeeping livelihoods in Mayo Darle is insufficient funding to grow operations. A key informant disclosed that beekeepers encounter challenges like:

Beekeepers are not organized, and this has negatively affected the quantity of honey production and price determination at the local level, only very few women are involved in beekeeping, attacks from pests and other predators on bee hives, low knowledge in using modern bee hives by most beekeepers and unpredictable climate conditions *(Delegate of MINEPIA, 19/04/2024).*

Another key participant added that:

Bushfires from grazers, theft, snakes invading bee hives, sometimes bees leaving the hives, many youths still not engaged in beekeeping and too many changes in weather conditions whereby at one moment there is heavy rain and wind that destroys flowers needed by *bees (Leader of Village Beekeeping Group in Nyalang, Age estimate 55, 23/04/2024)*.

Succinctly, a key participant advanced the view that:

Advancement of the Sahara Desert leading to very hot sun accompanied by very high temperatures affects honey production, low colonization in some areas, lack of training in modern beekeeping, lack of honey packaging containers and government policies on honey exportation are some of the challenges faced by beekeepers *(Crop Farmer and bee farmer in Nyalang village, with 25 beehives, Age 42, 23/04/2024)*.

In the same vein, another key participant said:

The quality of honey is poor in areas where chemical farm inputs are applied as it kills bees and reduces the bee population and quantity of honey. Insects and birds attack bee hives and eat up all the honey *(Marketer of Honey in Mayo Darle Main Market, Age 47, 22/04/2024)*.

Another participant supported these challenges:

The issue of climate change is a challenge as the weather now is hotter than before with negative consequences on honey production, bees are forced to leave their hives during such poor climatic conditions, Honey badgers invade the hives and birds also eat the bees. The use of chemicals by many crop farmers also has a negative ecological effect on honey production leading to the killing of honeybees coupled with poor harvesting and drainage methods *(Head of Yoli Community Development Association, Age 52, 21/04/2024)*.

**Conclusion.** This study aimed to investigate the influence of beekeeping on livelihoods in the Mayo Darle Subdivision of Mayo Banyo in Cameroon's Adamawa region. The results regarding the economic benefits of beekeeping indicated an upsurge in the earnings of beekeepers. Human capital, natural capital, and social capital among beekeepers in the Mayo Darle Subdivision saw a rise. The findings indicate a rise in participation in social groups and networks, while the physical capital revealed that the primary asset purchased by these farmers with the earnings from their bee farms was mobile phones. Thus, beekeeping serves as a significant alternative income strategy for many farmers in the Mayo Darle Subdivision. Beekeepers in Mayo Darle encounter various challenges, including inadequate skills in bee management practices, colony absconding, low honey production, pests and predators affecting bees, absence of honey processing facilities, unappealing packaging for honey, insufficient continuous income from beekeeping, and limited knowledge in recognizing diseases and threats to bees. This research indicates that educational initiatives are a crucial means of spreading awareness regarding the significance of beekeeping as an alternative livelihood option. Raising awareness to incorporate beekeeping into various agricultural systems and in natural forested and vegetative regions might serve as a sustainable method for alleviating household poverty. To address the challenges encountered by beekeepers in the Mayo Darle Subdivision, modern beekeeping initiatives must focus on training beekeepers by ensuring access to improved beekeeping technologies alongside traditional seasonal bee management methods.

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