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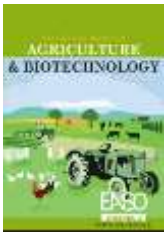

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Gender Dynamics in Beekeeping: An Examination of Roles of Men and Women in the Beekeeping Value Chain in Chamwino District, Tanzania

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ABSTRACT

Information on gender specific contribution and challenges within the beekeeping values chain is vital for shaping policies that promote gender equity and enhance productivity. This study examined gender dynamics in beekeeping, focusing on the roles of men and women in the value chain. Using cross - sectional design, 265 individuals were surveyed, and interviewed. Descriptive statistics summarized respondent's demographic and socioeconomic characteristics, while binary logistic regression identified factors influencing involvement in beekeeping. The findings found that most respondents (81.1%) were males aged 41-60 years, and over 80% were married. A majority (87.2%) were heads of their families, and over 60% had incomes below 1,500,000TZS. Most respondents (57.7%) involved in beekeeping as a part-time activity. Men were engaged in apiary preparation, placing hives, honey harvesting and selling with women's involvement significantly lower across most beekeeping activities. Older men, household heads from large families, and those attending seminars were more involved. Factors such as a gender, family size, household position, age, education, income, seminar attendance, technology, market access, and number of beehives influencing involvement, with a p – value of < 0.05, indicating strong associations with beekeeping activity levels. The illustrated notable gender disparities in beekeeping, with the beekeeping, with men dominating key activities compared to women.

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INTRODUCTION

Beekeeping is an important income-generating agriculture activity with a global impact on biodiversity, food security, and household revenue. The sector keeps on expanding in different parts of the world as a result of advances in technology and a growing global understanding of the role that bees play in ecosystem services. China is the leading global honey producer with a production of 472,000 tons a year, followed by Turkey (STATISTA, 2023). Africa contributes only 9.8% of the total global honey production (Wolde, 2016).

Olana and Demrew, (2018) in Ethiopia pointed out that most of women were involved in modern and transitional beekeeping rather than traditional beekeeping methods.

Tanzania is ranked the second largest producer of bee honey in Africa (FAO, 2021) after Ethiopia which is a leading producer with a production of 45,000 to 50,000 tons of honey per annum and an export of 1000 tons of honey (Richardson, 2019). Over 200,000 farmers in Tanzania are involved in beekeeping with around 2.2 million estimated beehives (FAO, 2021). The favorable climate and environmental conditions such as presence of nectar and pollen producing plants contribute to the production of high-quality bee products and accelerate sectorial growth (MNRT, 2007). However, confront difficulties such as restricted access to technology, inadequate training, and market limitations hinders the prosperity of the industry.

Studies by Lydia *et al.,* (2019), Guiné *et al.,* (2021), and Olana and Demrew, (2018) examined gendered participation in the beekeeping industry. While the qualitative study by Lydia *et al.,* (2019) in Kenya reported active participation of women in beekeeping, Guiné *et al.,* (2021) reported low participation of women in beekeeping for all the surveyed seven countries. However, the qualitative nature of the former study, and the broader scope of the latter study failed to quantify the gender dynamics of the context specific, particularly the Chamwino district context.

In Romania, a descriptive study by Pocol and McDonough, (2015) found that most of women are actively engaged in subsistence beekeeping rather than commercial large-scale beekeeping. Olana and Demrew, (2018) in Ethiopia pointed out that most of women were involved in modern and transitional beekeeping rather than traditional beekeeping methods. The methodological approach employed in these studies failed to quantify contextual analysis of gender dynamics and the factors influencing it in Chamwino district. Thus limited empirical information is available in Chamwino district regarding the gender dynamics and factors influencing it.

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Chamwino district, a top producer of bee honey in Dodoma region, boasts a thriving beekeeping sector, a variety of ecological resources, and smallholder farming communities. Beneath the seeming productivity, there is a complex tale of how socioeconomic factors, cultural standards, and gender norms interact to influence men's and women's involvement in beekeeping (Fisher, 2018).

Specifically, this study examined the level of involvement in beekeeping value chain between men and women, the roles played by men and women, and the factors influencing their involvement in beekeeping value chain. A value chain Approach (VCA), it was an analytical frame work that was borrowed from Michael Porter (1985) who first coined the term "value chain" to refer a value-adding chain of interrelated activities from the inception of an idea to the existence of the final consumers products. Analyzing gender disparities in the beekeeping sector and the livelihood income generated in it, in the light of VCA, requires step-by-step analysis of gender roles at each phase of activities along the entire series of activities in beekeeping value chain. Various activities and roles in the value chain of most forest products such as bees honey are gendered in nature, with variations in some aspects depending on the phase of the series of actions involved (Ingram et al, 2014).

Policymakers, development professionals, and beekeeping stakeholders may utilize the findings from this study to develop contextually appropriate policies that promote gender equity and strengthen marginalized groups by recognizing the many responsibilities and contributions played by men and women in the industry. Furthermore, by improving the beekeeping industry's resilience, productivity, and inclusivity, these interventions may spark more widespread socioeconomic growth in Chamwino District and other comparable settings.

Materials and Methods

The main objective of the study was to assess the socioeconomic characteristics, participation, benefits, and challenges of beekeeping activities in Chamwino District with a focus on gender dynamics. Specifically, the study aimed to examine factors influencing honey production and income disparities between male and female beekeepers; to explore the gender-related barriers that limit women's participation in beekeeping for local communities and sought to provide insights into the role of beekeeping in improving livelihoods and promoting gender equity in rural areas.

Description of the study area

The study was conducted in Dodoma region, specifically in Chamwino district comprising eight wards with and without forest reserves. Chamwino district has an elevation range from 1000 meters to 1500 meters above sea level. It lies on the central plateau of Tanzania, with an area of 8,056km square. The district is bordered to the west by Singida Region, Bahi District and Dodoma District, to the north by Chemba District, to the south by Iringa Region, and to the east by Kongwa District, Mpwapwa District and Manyara Region. The district is administratively divided into 5 divisions, 36 wards, 107 villages and 820 hamlets. In terms of Agro-ecological zone, the district is divided into two zones (Zone 1 and Zone 2). Zone 1 is very dry, undulating with low population and receives unreliable rainfall of about 400mm per year. Zone 2 is flat undulating with a large population and receives low and unreliable rainfall of about 550-650mm per year (Mgulo & Kamazima, 2022). The district experiences long dry seasons and a savannah type of climate

The highest temperature is 35^{o}C (August-December) while the lowest temperature is 19^{o}C commonly from June to July (Mgoba and Kabote, 2020). Cultivation, livestock keeping, beekeeping, and business activities are the popular economic activities undertaken in Chamwino district.

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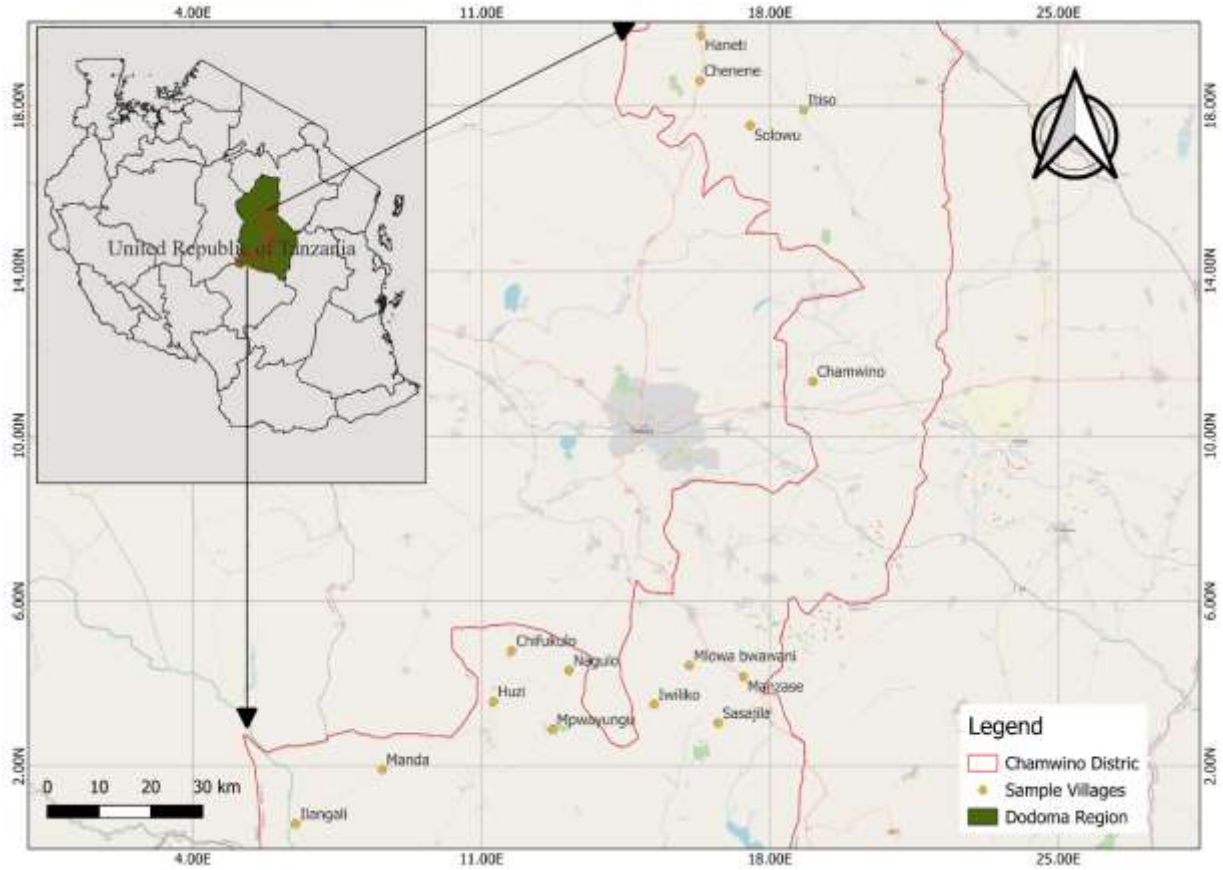
Chamwino district was chosen due to: 1. its savanna type of vegetation with scattered grasslands, 2. Bush thickets, and 3. Forests in some parts of hilly areas (URT, 2019). The district has protected forest reserve areas including, Chenene 29,839 ha, Chinyami 43,330 ha, Goima 6,959 ha, Sasajila 1,145ha, and Chamhene 3,785ha. The forest and woodland areas in the district have been greatly neglected due to deforestation as a result of shifting cultivation, uncontrolled bushfires, overgrazing and catering for energy use (Kahimba *et al.*, 2015).

Figure 1: A Map of Chamwino District



Study design

The study adopted cross-sectional design which allows to collect data at a single point in time (Thomas, 2020). In this design, the researcher simultaneously evaluated both, exposures and outcomes of the study participants (Setia, 2016). Through this study design, data are collected from various groups of participants at the same time while determining the relationship among variables (Katani and Ndelolia, 2020). This design helps a researcher to save time and cost during data collection. The choice to select wards with and without forest reserves in a geographically representative manner is a methodological decision aimed at improving the quality, relevance and holistic assessment between forest reserves while considering the diverse conditions that exist within the selected region.

Study population and sampling procedures

In this study, all actors of beekeeping value chain were surveyed. A multi-stage sampling which involves more than one stage of sampling (Bhandari, 2021) was used to select wards, villages and respondents from Chamwino district. In the first stage, purposive sampling was used to select eight wards with and without forest reserves. The

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selection of wards to be surveyed was further based on the large number of individuals involved in beekeeping activities. The second stage involved random sampling of two villages from each selected ward. Further, households engaged in beekeeping value chain were the sampling units and were randomly sampled from a list of all participants of beekeeping value chain. The selection of respondents based on their involvement in beekeeping value chain was important to ensure validity and integrity of the data collected. A sample size of 265 respondents were randomly selected from the study population, and were surveyed from 15 villages of Chamwino district. Purposive sampling was further used to select Key informants for interview which involved Beekeeping group leaders, Beekeeping district officer, Village Executive Officer and Village Chairperson.

The sample frame was constructed with the help of the ward and extension officers. The total population size was 265 optimal neither too large nor too small for ideal statistical analysis (Kothari *et al.,* 2004). In this research, the number of respondents was obtained using Cochran formula (Charan and Biswas, 2013), which was ideal for obtaining the sample size from an unknown population. Below is the derived Cochran formula:

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where: n_0 =Sample size, p =proportional population size, q = *1-p*, *e* = Precision level (5%), *Z* = Statistical certainty (1.96)

Data collection

Household's interview using structured and semi-structured questionnaire was used to collect primary data in this study. Additionally, direct observation and informal discussion were used to get more insightful data. Face to face administration of structured questionnaire was used during data collection. A review of relevant literature was also done to get more information on gender disparity in beekeeping value chain and house hold income in beekeeping value chain. Different data collection methods were examined to provide a more comprehensive understanding of these issues. The data collected included the socio-economic characteristics of the respondents, the involvement of men and women in beekeeping value chain, factors that influence gender disparity in beekeeping value chain, and roles played according to their perceived sex of being male or female.

Data Analysis

In this research, Microsoft Excel and statistical package for Social Science (SPSS) were utilized during data analysis. Interviewees' responses were recorded, compiled, and examined.

The involvement of men and women in beekeeping value chain

Descriptive statistics (frequency and percent), and inferential statistics (binary logistic regression) were used to quantify the involvement of men and women in beekeeping value chain. The binary logistic regression was used to examine the factors influencing the observed differences in level of involvement.

Level of involvement = $\alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 \ldots\ldots\ldots\ldots + \beta 11X11$

Whereas:

Level of involvement = 0 for Part-time, 1 for full-time

X1 = Age (1 for 18-40, 2 for 41-60, and 3 for above 60)

X2 = Education level (1 for no formal education, 2 for primary, 3 for secondary and 4 for tertiary)

X3 = Gender (0 for female, 1 for male)

X4 = Family size (1, 2, 3, 4……)

X5 = Being a head of household (0 for No, 1 for Yes)

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X6 = Access to advisory services (0 for No, 1 for Yes)

X7 = Access to credit (0 for No, 1 for Yes)

X8 = Access to market (0 for No, 1 for Yes)

X9 = Access to technology (0 for No, 1 for Yes)

X10 = Awareness on benefits of beekeeping (0 for Not aware, 1 for Aware)

X11 = Seminar attendance (0 for Yes, 1 for No)

Different activities undertaken by men and women in beekeeping value chain

Descriptive statistics method was used to analyze data concerning different beekeeping activities undertaken by men and women. Frequencies and percentages were used to explore the data whereas graphs were used to visualize data pictorially.

Determinants that shape the individual involvement in beekeeping value chain.

Binary logistic regression was used to examine the determinants of gender disparity in beekeeping. In this part the dominance of men in beekeeping were quantified in relation with several determinants. The model equations below illustrate in nutshell.

- Involvement in APH = $\alpha + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 \ldots\ldots\ldots\ldots + \beta13X13$
- Involvement in PHA = $\alpha + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 \ldots\ldots\ldots\ldots + \beta13X13$
- Involvement in HA = $\alpha + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 \ldots\ldots\ldots\ldots + \beta13X13$
- Involvement in PA = $\alpha + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 \ldots\ldots\ldots\ldots + \beta13X13$
- Involvement in PS = $\alpha + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 \ldots\ldots\ldots\ldots + \beta13X13$
- Involvement in TR = $\alpha + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 \ldots\ldots\ldots\ldots + \beta13X13$
- Involvement in SE = $\alpha + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 \ldots\ldots\ldots\ldots + \beta13X13$
- Involvement in others = $\alpha + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 \ldots\ldots\ldots\ldots + \beta13X13$

Whereas:

APH, PHA, HA, PA, PS, TR, and SE represent Apiary and hives preparation, Placing hives in the apiary, Packing, Harvesting Processing/ Sieving, Transporting, and Selling respectively. Involvement was a binary response with 0 for no and 1 for yes.

X1 = Family Size (1, 2, 3, 4……nth)

X2 = Being a head of household (0 for no, and 1 for yes)

X3 = Gender (0 for female, 1 for male)

X4 = Age (1 for 18-40, 2 for 41-60, and 3 for above 60)

X5 = Education Level (1 for no formal education, 2 for primary, 3 for secondary and 4 for tertiary)

X6 = Income Level (1 for Below 1,500,000 Tsh, 2 for 1,500,000 Tsh and 3 for over 1,500,000 Tsh)

X7 = Seminar Attendance (0 for Yes, 1 for No)

X8 = Beekeeping Experience (Years) (1, 2, 3, 4……nth)

X9 = Awareness on Benefits of Beekeeping (0 for Not aware, 1 for Aware)

X10 = Technology (0 for Yes, 1 for No)

X11 = Access to credit (0 for Yes, 1 for No)

X12 = Access to advisory services (0 for Yes, 1 for No)

X13 = Beehives Number (1, 2, 3, 4……nth)

Results

Socioeconomic characteristics of the respondents

The demographic information showed that most respondents were male, while a smaller portion being female. The largest age group was between

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41-60 years and most were married. In terms of education, the majority had completed primary school, with some having no formal education, and a few attaining secondary or tertiary education. Economically, most respondents earned below 1,500,000 TZS annually, with fewer individuals earning either around or over this amount.

Table 1: The socio-economic characteristics of the respondents

Demographic information	Category	Frequency	Percent
Gender	Male	215	81.1
	Female	50	18.9
Age group	18-40	72	27.2
	41-60	130	49.1
	Over 60	63	23.8
Marital status	Married	233	87.9
	Single	4	1.5
	Divorced	10	3.8
	Widow	18	6.8
Education level	No formal education	54	20.4
	Primary	200	75.5
	Secondary	5	1.9
	Tertiary	6	2.3
Household position	Head of the family	231	87.2
	Housewife	23	8.7
	Son/Daughter	11	4.2
Level of income	Below 1,500,000 TZS	160	60.4
	Around 1,500,000 TZS	43	16.2
	Over 1,500,000 TZS	62	23.4

The involvement of men and women in beekeeping value chain

About 53% of the interviewees (215 respondents) were males, and 78% of females (50 respondents) were engaged in beekeeping activities in a part-time basis. Less than 50% of both interviewed whereby 215 males and 50 females were engaged in beekeeping activities on a full-time basis (Table 2). Overall, majority (57.7%) of the respondents were involved in beekeeping on a part-time basis rather than full-time basis (42.3%)

Table 2: The level of involvement in beekeeping activities.

Gender	Level of involvement		Total
	Full time n (%)	Part time n (%)	
Male (N=215)	101 (47%)	114 (53%)	215 (100%)
Female (N=50)	11 (22%)	39 (78%)	50 (100%)
Total	112 (42.3%)	153 (57.7%)	265 (100%)

The regression model was found to be statistically significant, χ^2 (11) = 52.23, $p < 0.05$ the varying level of involvement in beekeeping value chain was 24% explained by the model. The increasing level of involvement was found to be 2.16 times higher for males than females. Access to credits, markets, and technology contributed to the increased level of involvement in beekeeping by 1.22, 2.62, and 2.22 times higher than lack of access to credits, markets and technology respectively. Increased age, education, and family size was related with increased level of involvement in beekeeping value chain. Surprisingly, the study found that access to advisory services and increased awareness on the

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benefits of beekeeping were associated with a reduction in the level of involvement of beekeeping activities. Table 3 shows the model summary, coefficients, and odds ratios.

Table 3: Factors influencing varying level of involvement in beekeeping

		β	S.E.	OR	Sig.
Constant	α	-2.713	1.06	0.07	0.010
Age (1 for 18-40, 2 for 41-60, and 3 for above 60)	X1	0.47	0.21	1.60	0.025
Education Level (1 for no formal education, 2 for primary, 3 for secondary and 4 for tertiary)	X2	0.28	0.26	1.32	0.292
Gender (0 for female, 1 for male)	X3	0.72	0.48	2.16	0.110
Family Size (1, 2, 3, 4……)	X4	0.10	0.05	1.10	0.031
Being a head of household (0 for No, 1 for Yes)	X5	0.67	0.58	1.96	0.243
Access to advisory services (0 for No, 1 for Yes)	X6	-0.25	0.32	0.78	0.423
Access to credit (0 for No, 1 for Yes)	X7	0.12	0.33	1.12	0.723
Access to market (0 for No, 1 for Yes)	X8	0.97	0.46	2.62	0.035
Access to technology (0 for No, 1 for Yes)	X9	0.80	0.69	2.22	0.247
Awareness on Benefits of Beekeeping (0 for Not aware, 1 for Aware)	X10	-2.08	0.58	0.13	0.000
Seminar Attendance (0 for Yes, 1 for No)	X11	1.43	0.48	4.17	0.003

Dependent Variable: Level of Involvement (LI) (0 for part-time, and 1 for full-time); $R^2 = 0.24$

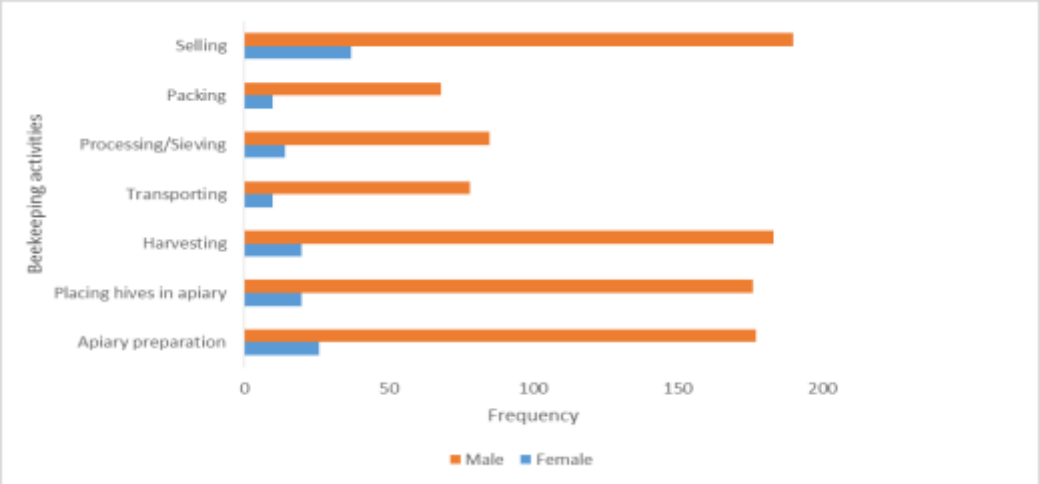
The model equation showing the function of the factors which determines the level of involvement in beekeeping value chain

$$LI = -2.713 + 0.47X1 + 0.278X2 + 0.772X3 + 0.097X4 + 0.6733X5 - 0.254X6 + 0.115X7 + 0.965X8 + 0.795X9 - 2.082X10 + 1.428X11 + \mu$$

Different activities are undertaken by men and women in the beekeeping value chain

Males were more engaged in apiary preparation, placing hives in apiary, honey harvesting, and selling similar to females who were more involved in selling, apiary preparation, harvesting, and placing hives in apiary (Figure 2). The overall involvement of women in different beekeeping activities was low compared to men.

Figure 2: Beekeeping activities undertaken by men and women



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Determinants that shape the participation of individuals in different activities undertaken in beekeeping value chain

The regression model was found to be statistically significant for both beekeeping activities studied: apiary and hives preparation; placing hives in the apiary; harvesting; packing; processing/sieving; transporting; selling; and other activities such as trees plantation ($p < 0.05$). Involvement of respondents in apiary and hives preparation activities was highly influenced with access to technology (6.755E8 OR) (Table 4). Awareness of the benefits of beekeeping (3.45 OR), gender (2.91 OR), income level (1.65 OR), beehives number (1.06 OR), household position (1.01 OR), and access to credits (1.00 OR) contributed to the increasing involvement of beekeepers in apiary and hives preparation. Further, seminar attendance (0.96 OR), access to advisory services (0.86), family size (0.68 OR), age (0.52 OR), and education level was found to be associated with decreased involvement in apiary and hives preparation activities. Below is the model equation (eq 3) with its coefficients.

AHP = -0.070 - 0.047X1 + 0.012X2 + 1.067X3 - 0.385X4 – 0.654X5 + 0.057X6 + 0.503X7 – 0.039X8 + 0.033X9 – 1.238X10 + 20.331X11 + 0.002X12 – 0.150X13 + μ…… eq3

The involvement of respondents on placement of hives in the apiary was found to be positively influenced by gender (4.48 OR), awareness (4.18 OR), income level (3.05 OR), education level (1.22 OR), beehives number (1.09 OR), household position (1.04 OR), and beekeeping experience (1.04) respectively. Family size (0.96 OR), technology (0.91 OR), age (0.90 OR), access to credits (0.74 OR), seminar attendance (0.73 OR), and access to advisory services (0.66 OR) was found to negatively influence involvement of respondents in hives placement in apiary. Below is the model equation (eq 4) with its coefficients.

PHA = -3.773 – 0.037X1 + 0.039X2 + 1.499X3 - 0.104X4 + 0.199X5 + 0.088X6 + 1.115X7 - 0.321X8 + 0.035X9 + 1.431X10 - 0.094X11 - 0.296X12 – 0.414X13 + μ…… eq4

Regarding harvesting activities, gender (6.37 OR), awareness (6.26 OR), income level (5.91 OR), education level (1.47 OR), seminar attendance (1.32 OR), beehives number (1.29 OR), household position (1.24 OR), age (1.19 OR), and beekeeping experience (1.03 OR) positively influenced the involvement of the respondents in harvesting activities. Other factors such as family size (0.86 OR), technology (0.61 OR), access to advisory services (0.43 OR), and access to credits (0.39 OR) had negative influence on the involvement of the respondents in harvesting activities. Below is the model equation (eq 5) with its coefficients.

HA = -5.637 – 0.154X1 + 0.215X2 + 1.851X3 + 0.177X4 + 0.382X5 + 0.256X6 + 1.778X7 + 0.278X8 + 0.033X9 + 1.835X10 – 0.487X11 – 0.943X12 - 0.839X13 +…… eq5

The involvement of the respondents in packing of honey was positively influenced by household position (3.50 OR), gender (2.40 OR), technology (1.84 OR), beekeeping experience (1.33 OR), access to credits (1.28 OR), awareness (1.23 OR), access to advisory services (1.05 OR), beehives number (0.99 OR), and seminar attendance (0.81 OR). Further, age (3.65 OR), family size (1.06 OR), income level (1.05 OR), education level (0.98 OR) was found to negatively influence the involvement of the respondents in packing of harvested honey. Below is the model equation (eq 6) with its coefficients.

PA = -2.226 – 0.042X1 + 0.078X2 + 0.494X3 - 0.810X4 - 0.083X5 + 0.005X6 - 0.036X7 + 1.010X8 + 0.067X9 + 1.443X10 + 1.223X11 + 1.332X12 + 0.141X13 +…… eq6

Awareness on the benefits of beekeeping (16.81 OR), household position (6.41 OR), access to credits (5.27 OR), technology (3.01 OR), seminar attendance (1.92 OR), income level (1.29 OR), education level (1.20 OR), and beekeeping

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experience (1.07 OR) were found to positively influence the involvement of beekeepers on processing/sieving of beekeeping products. On the other hand, beehives number (0.99 OR), family size (0.96 OR), access to advisory services (0.88 OR), age (0.53 OR), and gender (0.48 OR) were found to negatively influence the involvement of beekeepers in processing/sieving the harvested honey. Below is the model equation (eq 7) with its coefficients.

PS = -4.946 - 0.046X1 +1.858X2 - 0.739X3 - 0.638X4 + 0.180X5 – 0.007X6 + 0.251X7 + 0.654X8 + 0.071X9 + 2.822X10 + 1.103X11 + 1.661X12 – 0.123X13 + μ…… eq7

Beekeepers were positively influenced to participate in the transportation of beekeeping products by awareness (4.23 OR), access to credits (3.79 OR), technology (3.39 OR), seminar attendance (2.75 OR), gender (1.64 OR), access to advisory services (1.15 OR), household position (1.08 OR), beekeeping experience (1.07 OR), and beehives number (1.01 OR). Further, variables such as income level (0.97 OR), family size (0.96 OR), education level (0.92 OR), and age (0.45 OR) were found to negatively influence the involvement of beekeepers in transportation of beekeeping products. Below is the model equation (eq 8) with its coefficients.

TR = -5.424 + 0.046X1 – 0.215X2 + 0.284X3 + 0.204X4 + 0.611X5 – 0.009X6 + 0.244X7 + 0.046X8 + 0.054X9 + 1.252X10 + 0.875X11 + 1.294X12 – 0.016X13 + μ…… eq8

With respect to the involvement of beekeepers in selling of beekeeping products, variables such as gender (3.79 OR), education level (2.24 OR), access to advisory services (1.77 OR), income level (1.41 OR), family size (1.12 OR), beekeeping experience (1.03 OR), and beehives number (1.00 OR) had positive influence on their involvement in selling of products. Furthermore, beekeepers were negatively influenced to participate in selling activities by seminar attendance (0.84 OR), awareness (0.80 OR), age (0.65 OR), access to credits (0.56 OR), technology (0.39 OR), and household position (0.23 OR). Below is the model equation (eq 9) with its coefficients.

SE = 0.176 + 0.116X1 – 1.458X2 + 1.333X3 – 0.427X4 + 0.804X5 – 0.004X6 + 0.340X7 – 0.173X8 + 0.024X9 – 0.220X10 – 0.955X11 – 0.584X12 + 0.571X13 + μ…… eq9

Additionally, the involvement of beekeepers in other activities such as tree planting was found to be positively influenced by seminar attendance (3.51 OR), gender (2.25 OR), age (1.57 OR), family size (1.10 OR), access to advisory services (1.01 OR), and beehives number (1.00 OR). Beekeeping experience (0.97 OR), income level (0.67 OR), education level (0.58 OR), technology (0.50 OR), access to credits (0.37 OR), and awareness (0.25 OR) were found to negatively influence the involvement of beekeepers in other activities such as tree planting. Below is the model equation (eq 10) with its coefficients.

Others = 0.887 + 0.091X1 – 0.829X2 + 0.812X3 + 0.449X4 – 0.539X5 + 0.002X6 – 0.394X7 + 1.257X8 – 0.032X9 – 1.389X10 - 0.703X11 – 0.998X12 + 0.014X13 + μ…… eq10

Table 5 shows the odds ratios for factors influencing the involvement of beekeepers in different activities of beekeeping value chain.

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Table 4: Involvement of men and women in different activities in the beekeeping value chain

Activities	Gender		Total N=265
	Female	Male	
Apiary and hives preparation	26 (12.8%)	177(87.2%)	203(76.6%)
Placing hives in the apiary	20 (10.2%)	176 (89.8%)	196(74.0%)
Harvesting	20 (9.9%)	183 (90.1%)	203(76.6%)
Packing	10 (11.40%)	78 (88.6%)	88(33.2%)
Processing/ Sieving	14 (14.1%)	85 (85.9%)	99(37.4%)
Transporting	10 (12.8%)	68 (87.2%)	78(29.4%)
Selling	37 (16.3%)	190 (83.7%)	227(85.7%)
Others such as trees plantation for bees attraction	8 (24.2%)	25(75.8%)	33(12.5%)

The analysis in table 4 above, indicated that men were significantly more engaged in tasks like apiary and hive preparation, placing hives, and harvesting, while women had minimal participation in these areas. Male dominance was also evident in packing and processing activities though women showed slightly higher involvement in these tasks compared to men. In transporting, a similar trend emerged, with men primarily handling this aspect, likely due to better access to resources such transport.

Interesting, women played a large role in selling, showed their active participation in commercial activities. In other activities, such as planting trees for bee's attraction, women's involvement increased, suggesting that these tasks were more accessible to them, possibly due to fewer physical or resource- based barriers. Interestingly, women play a larger role in selling, showing their active participation in commercial activities. In other activities, such as planting trees for bee attraction, women's involvement increases, suggesting that these tasks are more accessible to them, possibly due to fewer physical or resource-based barriers.

Discussion

This study revealed a sizable portion (57.7%) of individuals involved in the beekeeping value chain in part-time basis. Similar findings were reported in a systematic review by Schouten, (2020) which found 80% of the reviewed studies indicates majority of farmers are engaged in beekeeping in part time basis rather than full time basis. Further, literature revealed that, the partial involvement in beekeeping may be due to the fact that beekeepers juggling beekeeping with other income generating activities, which reflects the supplemental nature of beekeeping revenue in the community (Hecklé *et al.*, 2018).

With respect to important beekeeping activities in the value chain, women were less involved compared to men (Figure 1). This discrepancy emphasizes that women participate in beekeeping activities on average less than men do (Mujuni *et al.*, 2012). The low rate of female participation in important tasks points to certain obstacles such as resources availability that can prevent women from participating fully in the beekeeping value chain (Shackleton *et al.*, 2011). Further, multiple important predictors of participation in the beekeeping value chain were found using the binary logistic regression analysis. Demographic factors such as gender, age, household position, level of income, family size, and education level were found to influence the involvement of beekeepers in beekeeping value chain.

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Table 5: Odds ratio for the factors affecting involvement of individuals in different beekeeping activities

Factors influencing involvement in different beekeeping activities	Odds Ratio							
	Apiary and hives preparation	Placing hives in the apiary	Harvesting	Packing	Processing/ Sieving	Transporting	Selling	Others such as tree planting for bees attraction
Family Size	0.95	0.96	0.86	1.05	0.96	0.96	1.12	1.10*
Household Position	1.01	1.04	1.24	0.81	6.41*	1.08	0.23	0.44
Gender	2.91*	4.48**	6.37**	1.33	0.48	1.64	3.79*	2.25
Age	0.68	0.90	1.19	1.23	0.53*	0.45**	0.65	1.57
Education Level	0.52	1.22	1.47	1.84	1.20	0.92	2.24*	0.58
Income Level	1.65	3.05**	5.92**	1.28	1.29	0.97	1.41	0.67
Seminar Attendance	0.96	0.73	1.32	1.05	1.9	2.75	0.84	3.52*
Beekeeping Experience (Years)	1.03*	1.04*	1.03	1.06***	1.07***	1.07***	1.03	0.97*
Awareness on Benefits of Beekeeping	3.45*	4.18*	6.26*	3.50	16.81**	4.23*	0.80	0.25**
Technology	6.76E8	0.91	0.61	2.4	3.01	3.40	0.39	0.50
Access to credit	1.00	0.74	0.39	3.65***	5.27***	3.79***	0.56	0.37*
Access to advisory services	0.86	0.66	0.43	0.98	.88	1.15	1.77	1.01
Beehives Number	1.06*	1.09**	1.29***	0.99	.99	1.01	1.00	1.00
Constant	0.93	0.02**	0.004***	.004***	.01***	.11	1.19	2.43
X^2	65.13	92.79	133.62	53.51	75.20	62.75	28.22	30.87

*, **, and *** indicate the significant influence of the respective factor at 0.05, 0.01, and 0.001 respectively

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Bunde and Kibet, (2016) reported similar findings that demographic variables such as gender, age, and education, plays a crucial role in shaping the adoption of modern beekeeping methods. Hecklé *et al.,* (2018) and Jeil *et al.,* (2020) found that gender shape the involvement of individuals in beekeeping, however men are more likely to participate in beekeeping value chain compared to women. This could be attributed with the fact that women are often constrained with traditional norms and beliefs, resources scarcity, and limited power of decision making (Galiè *et al.,* 2022). The findings from this study underscores that demographic variable irrespective of magnitude of directions plays a crucial role in shaping the involvement of individuals in beekeeping value chain.

The results emphasize the significance of demographic variables in determining engagement in economic activities, such as the beekeeping value chain. This is consistent with theories of sociology and development economics that highlight the influence of demographic factors such as gender, age, income level, and educational attainment on economic behavior and decision-making (Prasad *et al.,* 2021; Browman *et al.,* 2019).

Additionally, it offers empirical support for the improvement of models for resource allocation and livelihood diversification in rural areas, indicating that demographics play a significant role in determining an individual's engagement with particular value chains. Other factors such as market access, technology access, awareness, access to credits, seminar attendance, and advisory services had remarkable influence for beekeepers to participate in beekeeping value chain and were found to influence involvement of individuals in beekeeping activities (Said, 2019). Similarly, Drost *et al.,* (2011) revealed that access to markets, technology, credits, and knowledge shaped the honey and beeswax value chain. This implies that enhancing beekeepers' access to markets, technology, credits, and advisory services, and improving seminar attendance may increase their involvement and success in the beekeeping value chain, according to the research. These findings emphasize the scheming of tailored interventions to assist beekeepers and improve productivity and sustainability in the beekeeping industry.

In practical terms, the results from this study can help with the development of focused initiatives and policies that will increase involvement in the beekeeping value chain. To enhance the participation of diverse demographic groups in beekeeping, such as women or low-income households, initiatives should concentrate on offering specialized training and resources (Lydia *et al.,* 2019; Iseselo *et al.,* 2019). Policymakers might also use this data to address impediments that particular groups face, such giving younger or less educated people access to microfinance programs. Gaining insight into these demographic factors can also assist organizations in creating marketing plans that address the particular requirements and tastes of various beekeepers, thereby encouraging increased efficiency and inclusivity in the beekeeping sector.

However, the study was limited with financial resources, the availability of female respondents, and the research area's proximity to one another. Due to budgetary constraints, the research's size and breadth were limited and decreased the study's data collection. Furthermore, it was difficult to find female respondents, which might have had an impact on the study's diversity and representation. The results' applicability to other settings or places was further constrained by their concentration on a single geographic area. Together, these elements shaped the design of the study and might have affected the conclusions reached.

Conclusion

The study reveals significant gender dynamics within the beekeeping activities in Chamwino District men were more involved in all important beekeeping activities than women do. Beekeeping activities such as apiary preparation, placing hives

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in apiary, honey harvesting, packing and selling, similar to females who were more involved in selling, packaging, harvesting, apiary preparation, and placing hives in apiary were shaped with many factors.

The regression analysis indicates that access to markets and technology significantly enhances involvement, underscoring the critical need for targeted interventions in these areas. Conversely, the study surprisingly found that access to advisory services and increased awareness of the benefits of beekeeping were associated with a reduction in the level of involvement in beekeeping activities.

These findings emphasize the need for targeted strategies to improve women's access to credits, markets, and education, which could significantly increase their role and empowerment in the beekeeping value chain. Addressing these gender disparities is crucial for leveraging the full potential of beekeeping in enhancing livelihoods and promoting gender equity within Chamwino District.

Recommendations

Based on the findings of this study, the following are recommended

- Establish dedicated beekeeping centres for market access, training seminars, and collaboration, while ensuring alignment with national policies to enhance productivity, sustainability, and compliance within the industry.
- Enhance women's involvement in beekeeping by establishing women-focused cooperatives, offering targeted training programs, and addressing cultural barriers to promote gender equality in Chamwino District.
- Prioritize Morden beekeeping by providing access to advanced tools, offering training, and subsidizing equipment purchases.

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