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A survey of apicultural practices in Lira and Adjumani districts of Uganda: implications for beekeeping development

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ABSTRACT

Beekeeping plays a key role in the socio-economic development and environmental conservation in developing countries. This study assessed the socio-economics, hive colonization methods, management practices, beehive types and factors influencing beekeeping technologies in Lira and Adjumani districts of Northern Uganda. Data were collected through beekeepers' interviews followed by field observations to verify the data from interviews between April and May 2015. Overall, 89.7% of beekeepers in both districts were males. Most beekeepers (95.3%) in both districts had formal education. Also, most beekeepers (78.7%) in both districts used traditional beehives (TH). Also, most beekeepers (82.1%) baited their beehives with bee propolis or cow dung to increase chances of hive colonization. Factors that influenced the use of beekeeping technologies include attainment of formal education and training. Training on beekeeping increased the likelihood of using modern technology of beekeeping in both districts. In general, most beekeepers still predominantly use traditional beekeeping technologies. Therefore, there is need to develop beekeeping through training of beekeepers on improved beekeeping technologies.

Key words: Apiculture, hive colonization, hive types, management, socio-economics, Uganda

RÉSUMÉ

L'apiculture joue un rôle clé dans le développement socio-économique et la conservation de l'environnement dans les pays en développement. Cette étude a évalué les aspects socio-économiques, les méthodes de colonisation des ruches, les pratiques de gestion, les types de ruches et les facteurs influençant les technologies apicoles dans les districts de Lira et Adjumani dans le nord de l'Ouganda. Les données ont été collectées à travers des interviews d'apiculteurs suivies d'observations sur le terrain pour vérifier les données des entretiens entre avril et mai 2015. Dans l'ensemble, 89,7 % des apiculteurs des deux districts étaient des hommes. La plupart des apiculteurs (95,3 %) des deux districts avaient une éducation formelle. De plus, la plupart des apiculteurs (78,7 %) dans les deux districts utilisaient des ruches traditionnelles (TH). De même, la plupart

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des apiculteurs (82,1 %) amorçaient leurs ruches avec de la propolis d'abeille ou du fumier de vache pour augmenter les chances de colonisation de la ruche. Les facteurs ayant influencé l'utilisation des technologies apicoles comprennent l'obtention d'une éducation formelle et la formation. La formation en apiculture a augmenté la probabilité d'utiliser des technologies modernes d'apiculture dans les deux districts. En général, la plupart des apiculteurs utilisent encore principalement des technologies apicoles traditionnelles. Par conséquent, il est nécessaire de développer l'apiculture en formant les apiculteurs aux technologies apicoles améliorées.

Mots-clés : Apiculture, colonisation de la ruche, types de ruches, gestion, socio-économie, Ouganda

INTRODUCTION

Beekeeping plays a major role in socio-economic development and environmental conservation. Notably, beehive products such as honey and pollen are sources of food while propolis, bee venom and beeswax provide raw materials for pharmaceutical and cosmetic manufacturing industries (Ediriweera and Premarathna, 2012). In addition, beekeeping is important for poverty alleviation (Gupta *et al*., 2014) and has tremendous potential of widening national export base (Trust, 2012).

Despite the suitability of the prevailing ecological conditions and high floral diversity for beekeeping in Uganda, the country harvests only one percent of the estimated honey production potential of 500,000 metric tonnes (Amulen et al., 2019). The low honey production may be attributed to several factors including pests, poor management, and the predominant use of traditional beekeeping methods. Efforts to increase production to meet demands are however constrained by lack of adequate information (Mujuni *et al*., 2012).

In the northern Uganda districts of Lira and Adjumani, beekeeping can be a viable enterprise for generating household income because of the strong growing market for beehive products. Importantly, the two districts are located within the Mid-North and West Nile agro-ecological zones respectively (Kraybill and Kidoido, 2009) which are endowed with diverse bee flora and good environmental conditions suitable for beekeeping. In an effort to improve beekeeping as an alternative livelihood source, different stakeholders including: the private sector, government and non- governmental organizations have promoted use of improved hives. However, low production of honey persists in Lira and Adjumani (Chemurot, 2011; Ndyomugyenyi *et al*., 2015). Importantly, the limited information available on the beekeeping technologies currently in use hampers informed planning. Information on beekeeping technologies used is required for strategic planning of effective interventions to address low production of beehive products in the country. Hence, the objective of this study was to identify and characterize beekeeping technologies and management practices in Lira and Adjumani districts, and the influence of socio-economic factors on these practices.

MATERIALS AND METHODS

Study area. This study was conducted in Lira and Adjumani districts of northern Uganda between April and May 2015. These districts were selected because of their location within the main beekeeping agro-ecological zones of Uganda (mid-north and west Nile) and high numbers of beekeepers. Two Sub-counties per study district (Amach and Ogur in Lira) and (Pakele and Itirikwa in Adjumani) were selected using the list of beekeepers obtained from the District Production Departments. Lira

district lies approximately between 1° 21'N and 2° 42'N latitudes, and 320 51'E and 340 15'E longitudes (UBOS 2015) (Figure 1). The district covers approximately 3,777 km^2 of land with a human population of 431,500 (UBOS 2015). On the other hand, Adjumani district is located between the latitudes of 31o 24' and 32° 4' East of Greenwich and longitudes of 2° 53' and 3° 37' in the north of the Equator (Chemurot, 2011) (Figure 1). Adjumani district covers 3,128 km^2 of land with a human population of 237,100 (UBOS 2015). Both districts receive a bimodal rainfall, varying between 1200 -1600 mm, with a peak in April-May and August-October. The natural vegetation comprises of spatially wooded savannah grassland. Subsistence farming such as crop cultivation, livestock farming, beekeeping and fish farming are the predominant activities practiced by approximately 75.7% of the population in these districts (UBOS, 2016).

Sample selection. From the lists, 123 male and female beekeepers (59 in Lira and 64 in Adjumani) were randomly selected from the list of beekeepers obtained from the district production office.

Data collection. The data were collected using a semi-structured questionnaire, key informant interviews and focus group discussions. The semi-structured questionnaire was administered to the 123 respondents (59 in Lira and 64 in Adjumani) to collect data on the socioeconomic characteristics of beekeepers and beekeeping technologies used. Key Informant Interviews were conducted with ten extension workers (five from the District Production Department and five from other organizations supporting beekeeping in each district). Additionally, focus group discussions were conducted with key informants that included extension workers, lead farmers and local leaders. Sub-county and district production records were also reviewed for information. Also, direct observations were made to verify the information provided during interviews.

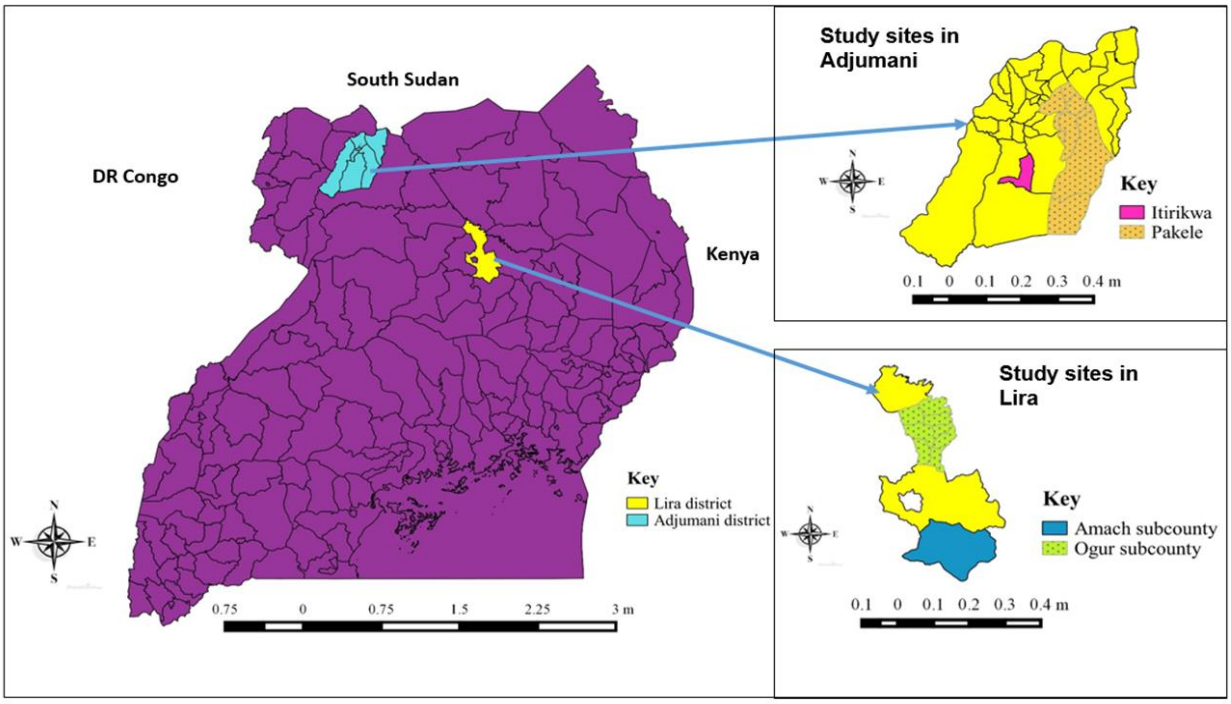

Figure 1. Location of study sites in Lira and Adjumani, Uganda

Data collected on the socio-economic characteristics of the beekeepers included: age, sex, marital status, level of education, household size, occupation, income, beekeeping training attended and experience in beekeeping. In addition, data on beekeeping technologies (beehive types and the beekeeping management practices) used by the beekeepers were collected. The data collected by interviews were checked for errors and corrections made before entry for computer analysis.

Data analysis. Data were analyzed using the statistical package for social scientists (SPSS), version 21. Descriptive statistics such as frequencies, percentages and means were used to describe socio-economic characteristics of beekeepers and beekeeping technologies. Kruskal-Wallis test was used to compare numbers of beehives owned per farmer in the different age groups, household size groups, experience and training. In cases where there were significant differences, post hoc analyses were conducted using Mann-Whitney U tests. The same test was used to compare numbers of beehives owned per farmer in Lira and Adjumani districts, gender, extension services and training. Logistic regression analysis was used to determine the socio-economic factors influencing the use of beekeeping technologies.

RESULTS

Socio-economic characteristics of beekeepers. In Lira district, over half (52%) of the beekeepers were in the 31-50 years age group, while in Adjumani, also over half (53.1%) were of a younger age group of 18-30 years (Table 1). Most beekeepers (94.9%) in Lira and 84.4% in Adjumani were male. Also, almost all (98.3%) beekeepers in Lira and 92.2% in Adjumani had formal education. In Adjumani, 79.7% of the beekeepers were married while in Lira, a higher proportion (91.5%) were married. Most of the beekeepers in Adjumani (51.6%) had 5-10 people in their household while in Lira, 71.2% had this category.

In Adjumani, 40.6% of the beekeepers had experience of 5-10 years in beekeeping while in Lira, 39% of the beekeepers had the same years of experience. Most beekeepers (71.2%) in Lira and a few (39.1%) in Adjumani had attended beekeeping trainings organized by Government departments and NGOs/CBOs in the year preceding this study. Majority of the beekeepers (89.5% in Adjumani and 50.9% in Lira) reported that they did not receive extension services in the entire year preceding the study. Among those who received extension services, 33.9% from Lira and 20.3% from Adjumani had received extension information from fellow farmers. Another 10.2% in Lira district and 6.3% in Adjumani district received extension information from government extension workers. The beekeepers who received extension information through radio were 6.8% in Lira and 6.3% in Adjumani (Table 1).

Beekeeping technologies

Beehive types. Beekeepers in Lira and Adjumani were using three types of beehives: traditional beehives (TH) Kenya top bar (KTBH) and Langstroth beehives (LH). Traditional beehives (TH) were the most used in both districts, though Adjumani had more preference (86.4%) than Lira (70.9%). Beekeepers in Lira had more KTBH (28.6%) than Adjumani (11.6%). The LH type was the least used in both districts (2% in Adjumani and 0.5% in Lira) (Table 2). Beekeepers in Lira had significantly more KTBH compared to beekeepers in Adjumani ($U = 1140.5$, $Z = 4.17$, $P < 0.01$). However, the number of TH and LH owned by beekeepers in the two districts was not significantly different (TH: $U = 1770.5$, $Z = 0.6$, $P < 0.56$; LH: $U = 1883$, $Z = 0.82$, $P < 0.94$) (Table 2). On average, the number of TH was higher than KTBH among the beekeepers in both districts. However, beekeepers in Lira had more TH and KTBH than those in Adjumani. On the other hand, beekeepers in Adjumani had

more LH than Lira (Table 2).

Factors influencing the types and number of beehives owned by the beekeepers. The number of beehives owned by beekeepers was not significantly different among the different age groups for all beehive types. In addition, the number of beehives owned was not significantly different among male and female beekeepers in both districts (Table 3). However, attainment of formal education influenced the number of TH owned by beekeepers in Adjumani district. Specifically, the mean number of TH among beekeepers with tertiary levels of education was significantly higher ($U = 0.00$, $Z = -2.491$, $p < 0.05$) than among those without any formal education. In Lira district, the number of beehives owned was not significantly different among the beekeepers with different levels of education. There was also no significant difference in the number of beehives owned among beekeepers of the different household sizes in both districts (Table 3).

Table 1. Socio-economic characteristics of beekeepers in Lira and Adjumani districts

	Lira (n=59)		Adjumani (n=64)		Overall (n=123)	
Variables	Frequency	%	Frequency	%	Frequency	%
Age groups (years)						
18-30	9	15.3	34	53.1	43	35.0
31-50	31	52.5	25	39.1	56	45.5
51 and above	19	32.2	5	7.8	24	19.5
Gender of beekeepers						
Male	56	94.9	54	84.4	110	89.4
Female	3	5.1	10	15.6	13	10.6
Level of education						
Non formal	1	1.7	5	7.8	6	4.9
Primary	27	45.8	36	56.3	63	51.2
Secondary	22	37.3	18	28.1	40	32.5
Tertiary	9	15.3	5	7.8	14	11.4

Table 2. The proportion of hive types owned per farmer in Lira and Adjumani districts

Hive type	Adjumani			Lira		
	n	%	Mean ± SE	n	%	Mean ± SE
Traditional	50	70.9	20.44±3.59	63	86.4	14.75±1.37
Kenya top bar	36	28.6	11.44±1.65*	18	11.6	6.94±1.53*
Langstroth	2	0.5	4.0±2.0 2	2.0	10.50±9.50	

*Denotes where there was a significant difference in the proportion of beehives owned/farmer in the two districts

Beekeepers who attended beekeeping trainings in both districts owned significantly more KTBH compared to those who did not. However, the number of TH and LH owned was not significantly different among beekeepers who attended trainings in both districts. There was no significant difference in the number of beehives owned by beekeepers with diverse years of experience in the two districts. Comparison of the number of beehives among beekeepers who received extension services and those who did not showed that the number of beehives owned was not significantly different among these beekeepers (Table 3).

Beehive colonization methods. Majority (81.3% and 82.8%) of beekeepers in Lira and Adjumani districts, respectively, baited their beehives. Only a few (6.8%) beekeepers in Lira district reported that they catch swarms. Another 8.5% of the beekeepers multiplied colonies while 3.4% of them did not apply any method. In Adjumani district, 6.3% of the beekeepers multiplied colonies while 10.9% did not use any method to promote hive colonization.

A binary logistic regression model developed explained 24.1% of the variance in hive baiting. Factors included in the model were: experience, age, gender, house hold size, educational level, training, total income and district. The model was considered not appropriate in predicting the baiting methods ($p = 0.243$). However, total income significantly ($p < 0.05$) influenced the likelihood of baiting (Table 4).

Most beekeepers in Lira (32.2%) preferred propolis as a bee bait. However, other materials used included: lemon grass (27.1%), beeswax (23.7%), cow dung (8.4%) and cassava flour (1.7%). In Adjumani, cow dung was the most preferred baiting material used by 34.4% of the beekeepers, followed by lemon grass (28.1%), beeswax (12.5%), propolis (6.2%) and cassava flour (4.7%). The results further showed that 6.8% and 14.0% of the beekeepers do not use any baiting materials in Lira and Adjumani districts, respectively.

Table 3. Factors influencing the types and number of beehives owned by the beekeepers

SN	Factor	Influenced type of hive	Influenced number of hives owned
1	Attainment of education (level)	P	P
2	Household sizes	N	N
3	Beekeeping years of experience	N	N
4	Beekeeping trainings (number attended)	P	P
5	Extension services (number of times received)	N	N
6	Age (groups)	N	N
7	Gender	N	N

Where P implies significant influence while N is not significant

Table 4. Logistic regression model predicting baiting as a hive colonization method in Lira and Adjumani districts

Variable	B	SE	Exp (B)	p
Experience	0.229	1.089	1.257	0.834
Age	1.062	0.923	2.892	0.250
Gender	0.007	0.950	1.007	0.994
House hold size	0.025	1.575	1.025	0.987
Educational level	-19.589	1.632	0.000	0.999
Training	0.071	0.615	1.074	0.908
Total income	3.105	1.253	0.045	0.013
District	-0.021	0.655	0.979	0.974
Constant	-0.093	2.333	0.912	0.968

$\chi^2 = 10.327$, $df = 8$, $p = 0.243$ (Homsmer and Lemeshow goodness of fit); Nagelkerke $R^2 = 0.241$

Apiary management practices. Few of the beekeepers in Lira district (16.9%) slashed their apiaries compared to only 1.5% of the beekeepers in Adjumani district. Only 32.2% and 3.4% of the beekeepers in Lira and Adjumani districts, respectively, inspected their apiaries. The same proportion (1.6%) in Lira and Adjumani repaired their beehives. About 5.1% and 1.6% of beekeepers in Lira district practiced record keeping and feeding of bees, respectively. In Adjumani, 3.1% of beekeepers kept records though no beekeeper fed the bees. A binary logistic regression model developed to determine the effects of selected variables on management practices was not appropriate ($p > 0.54$ in all cases). However, factors such as experience and educational level significantly influenced repairs of hives, while educational level and training significantly influenced feeding of the bees. Household size significantly influenced record keeping and pest control (Tables 5-8).

Honey harvesting technologies. Most (60.10%) beekeepers in Lira district and few (15.63%) beekeepers in Adjumani district used bee smokers to harvest honey. On the other hand, most (84.38%) beekeepers in Adjumani used open fire compared to few (33.90%) beekeepers in Lira district. Although the model developed did not significantly predict the honey harvesting method, it revealed that males and trained beekeepers were significantly more likely to use modern honey harvesting methods (Table 8).

Honey processing methods. Most beekeepers (87.5%) in Adjumani district crushed the honey combs to extract honey compared to a few beekeepers (6.8%) in Lira district. In addition, most (88.1%) beekeepers in Lira and few (9.4%) beekeepers in Adjumani district did not process honey. A few, 1.7% and 3.1% of the beekeepers in Lira and Adjumani districts, respectively, used straining methods to process honey. Few (3.4%) respondents in Lira district boiled honey. Although the model developed did not significantly predict the honey processing method, it indicated that more training and income level significantly led to adoption of better honey processing methods (Table 9).

Other beekeeping equipment. Most (53.81%) beekeepers in Lira district had beekeeping protective wear compared to few (11.72%) beekeepers in Adjumani district. About 51.86% of the respondents in Lira district utilized honey harvesting equipment compared to few

(19.69%) in Adjumani district. On the other hand, 3.39% and 4.88% of the beekeepers in Lira and Adjumani, respectively, used processing equipment. Logistic regression analysis revealed that increased experience and income level as well as more training, significantly increased the beekeeper's likelihood to use protective wear and use of honey harvesting equipment such as bee smoker, overall, bee Veil, knife and bee brush (Tables 10 and 11).

Table 5. Logistic regression model predicting repair of hives in Lira and Adjumani districts

Variable	B	SE	Exp (B)	P
Experience	0.986	0.582	2.681	0.040
Age	-0.846	0.672	2.331	0.208
Gender	0.720	1.006	2.054	0.474
House hold size	-0.446	1.255	0.641	0.723
Educational level	1.260	0.583	3.524	0.031
Training	-0.135	0.610	0.874	0.825
Total income	-1.747	1.421	0.174	0.219
District	3.037	0.663	20.837	0.000
Constant	-0.604	2.323	0.547	0.795

$\chi^2 = 1.952$, $df = 8$, $p = 0.982$ (Homsmer and Lemeshow goodness of fit); Nagelkerke $R^2 = 0.439$

Table 6. Logistic regression model predicting feeding of bees in Lira and Adjumani districts

Variable	B	SE	Exp (B)	P
Experience	-0.476	1.000	0.621	0.634
Age	1.288	1.036	3.625	0.214
Gender	-20.061	8.505	0.059	0.998
House hold size	-0.401	2.429	0.669	0.869
Educational level	2.342	1.186	10.397	0.048
Training	2.823	1.393	0.059	0.043
Total income	1.534	1.668	4.636	0.358
District	-1.341	1.04	0.261	0.197
Constant	21.169	8.505	1.562	0.998

$\chi^2 = 0.883$, $df = 8$, $P = 0.999$ (Homsmer and Lemeshow goodness of fit); Nagelkerke $R^2 = 0.603$

Table 7. Logistic regression model predicting record keeping in Lira and Adjumani districts

Variable	B	SE	Exp (B)	P
Experience	1.106	0.915	3.022	0.227
Age	-0.307	0.752	0.736	0.683
Gender	1.964	1.23	7.128	0.11
House hold size	6.647	2.589	770.139	0.01
Educational level (1)	0.827	0.806	0.305	0.305
Training	-1.662	0.905	0.19	0.066
Total income	-1.096	1.842	0.334	0.552
District	-4.77	1.43	0.008	0.001
Constant	-2.087	2.8	0.124	0.456

$\chi 2 = 7.01, df = 8, p = 0.54$ (Homsmer and Lemeshow goodness of fit); Nagelkerke R^2=0.569

Table 8. Logistic regression model predicting pest control in Lira and Adjumani districts

Variable	B	SE	Exp (B)	P
Experience	0.234	0.524	1.263	0.656
Age	0.817	0.783	0.297	2.264
Gender	-0.686	0.753	0.504	0.362
House hold size	2.899	1.494	0.055	0.042
Educational level	0.064	0.494	1.066	0.896
Training	-1.046	0.545	0.351	0.051
Total income	-0.557	1.197	0.573	0.642
District	-0.031	0.531	0.969	0.953
Constant	3.924	2.098	50.602	0.061

$\chi^2 = 1.745, df = 8, p = 0.989$ (Homsmer and Lemeshow goodness of fit); Nagelkerke R^2 = 0.278

Table 8. Logistic regression model predicting honey harvesting method in Lira and Adjumani districts

Variable	B	SE	Exp (B)	P
Experience	0.659	1.132	1.932	0.561
Age	1.402	0.974	4.065	0.150
Gender	3.642	1.335	38.151	0.006
House hold size	0.802	1.823	2.231	0.660
Educational level (1)	1.834	1.916	6.259	0.338
Training	3.327	0.869	0.036	0.000
Total income	21.619	1.560	2.450	0.999
District	-3.158	0.888	0.042	0.000
Constant	-20.629	1.560	0.000	0.999

$\chi^2 = 10.956, df = 8, p = 0.204$ (Homsmer and Lemeshow goodness of fit); Nagelkerke R2 = 0.746

Table 9. Logistic regression model predicting honey processing in Lira and Adjumani districts

Variable	B	SE	Exp (B)	p
Experience	1.588	1.09	4.894	0.145
Age	-0.778	1.441	0.459	0.589
Gender	-0.946	1.673	0.388	0.572
House hold size	0.966	3.915	2.628	0.805
Educational level	-2.285	1.407	0.102	0.104
Training	3.842	1.877	0.021	0.041
Total income	5.361	2.242	212.88	0.017
District	1.573	1.178	4.819	0.182
Constant	3.463	4.849	31.901	0.475

$\chi^2 = 0.834$, $df = 8$, $p = 0.999$ (Homsmer and Lemeshow goodness of fit); Nagelkerke $R^2 = 0.514$

Table 10. Logistic regression model predicting use of protective wear in Lira and Adjumani districts

Variable	B	SE	Exp (B)	p
Experience	1.686	0.75	5.399	0.020
Age	-0.327	0.74	0.721	0.659
Gender	0.672	0.984	1.959	0.494
House hold size	-0.038	1.744	0.963	0.983
Educational level	-0.261	0.684	0.77	0.702
Training	2.919	0.814	0.054	0.000
Total income	1.234	0.703	0.171	0.012
District	-1.764	1.424	3.433	0.387
Constant	2.043	2.437	7.711	0.402

$\chi 2 = 20.67$, $df = 8$, $p = 0.01$ (Homsmer and Lemeshow goodness of fit); Nagelkerke R^2=0.553

Table 11. Logistic regression model predicting the use of honey harvesting equipment in Lira and Adjumani districts

Variable	B	SE	Exp (B)	p
Experience	1.005	0.709	2.731	0.157
Age	0.284	0.698	1.329	0.684
Gender	1.733	1.005	5.659	0.085
House hold size	1.537	1.406	0.274	4.649
Educational level	0.639	0.654	1.895	0.328
Training	2.931	0.791	0.053	0.000
Total income	0.027	1.443	1.027	0.985
District	-1.555	0.662	0.211	0.019
Constant	-0.485	2.373	0.616	0.838

$\chi 2 = 27.36$, $df = 8$, $p = 0.001$ (Homsmer and Lemeshow goodness of fit); Nagelkerke R^2=0.559

DISCUSSION

Beekeeping is an important rural household activity which contributes to the income of individuals through sale of beehive products (Masuku, 2013). Although the sector in Uganda has the potential for fast development because of the suitable ecological conditions, the production potential is below the expectation (Amulen *et al.,* 2019). This is mainly attributed to the predominant use of traditional technologies for honey production and lack of sufficient information (Mujuni *et al.,* 2012; Al-Ghamdi *et al.,* 2017).

This study found out that the beekeeping activity in Adjumani and Lira districts is dominated by males with formal education. Culturally, men in African societies dominate most socio-economic activities of their households. As such, much emphasis is always put towards educating the boy child (Shabaya and Konadu-Agyemang, 2004). Consequently, the knowledge gained through education leads to diversification of efforts towards income generating activities including beekeeping (Alarape *et al.,* 2020).

Attainment of formal education by males has not completely changed their preference from traditional beehives to modern beehives (Chemurot, 2011). The possible reasons for continued use of TBH among beekeepers are that they are inexpensive, long-lasting, easy to make and maintain (McMenamin *et al.,* 2017). However, with frequent training on beekeeping, the adoption of modern beekeeping technologies such as the use of KTBH is increasing as shown in other studies (Affognon *et al.,* 2015; Kalanzi *et al.,* 2015).

In Africa, beekeepers use baits to increase chances of beehive colonization (Falade *et al.,* 2012; Mujuni *et al.,* 2012). Among the most commonly used baits are propolis (Schmidt, 2001) and cow dung (Alarape *et al.,* 2020). The findings of the current study are consistent with the reports of cow dung and propolis being commonly used as bee bait. This study also shows that total income increases the baiting practice among beekeepers. Money obtained from the sales of hive and honey products are reinvested to boost honey production. Apiary management such as hive inspection and repair, pest control and provision of sugar syrup and water are among the key factors that reduce bee abscondment leading to better yields of honey (Schouten and Lloyd, 2019).

Beekeepers in Lira and Adjumani districts used bee smokers and open fire in honey harvesting. Trained beekeepers adopted modern processing and harvesting methods by using equipment such as bee smokers, overalls, bee veils, knives and bee brushes. This was also true among beekeepers with increased income level. The findings concur with those of Bunde and Kibet (2016) and Jebesa (2017) who indicated that trained beekeepers adopted modern beekeeping technologies compared to non-trained beekeepers. In addition Mujuni *et al.* (2012) also indicated that the level of income at house hold level influenced the adoption of a new beekeeping technology.

From this study, it is clear that most beekeepers in Lira and Adjumani districts still predominantly use traditional beekeeping technologies. Therefore, there is need to strengthen beekeeping programs in the two districts through provision of more trainings to beekeepers in order to promote the adoption of appropriate improved beekeeping technologies.

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STATEMENT OF NO-CONFLICT OF INTEREST

The authors declare that there is no conflict of interests in this paper.

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