Adoption of Modern Beekeeping Technology among Smallholder Beekeepers in Selected villages of Mpanda District, Tanzania

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ABSTRACT

The Government of Tanzania recognizes the untapped potential of beekeeping industry in the country. Efforts have been made to promote and support modern beekeeping technology especially in areas with high potential for beekeeping. Little is known about adoption of the modern beekeeping techniques. In April 2016, a cross sectional study was conducted in two villages of Mpanda district to assess the determinants of adoption of modern beehives among smallholder beekeepers. A total of 210 beekeepers (105 adopters and 105 non-adopters of modern beehives) were enrolled in the study. Predictors of adoption of modern technology of beekeeping were assessed using a Logit model. Results show that the odds for adopting modern beekeeping technology increased with age of the household head (p = 0.029), the level of education i.e. secondary education or higher (p = 0.041), access to technical support services (p = 0.05), access to credits (p = 0.022), involvement in beekeeping for ten or more years (p =0.047), involvement in off-farm activities (p =0.000), and availability of market for bee products (p = 0.003). Further, results show that on average, adopters had higher yield of honey than non-adopters (16kg vs. 7kg per colony per annum). Consequently, the average income of adopters was 2.3 fold higher that of non-adopters (t = -10.1, p<0.000). The findings underscore the need to increase awareness and leverage interventions on improved technology as a means to improve the overall social well-being among smallholder beekeepers. Such interventions should take into account the socio-economic characteristics that influence the adoption of the modern beekeeping technology.

Keywords: Modern beehives, adopters, non-adopte

1.0 INTRODUCTION

Beekeeping is an economic activity with great potential for addressing poverty challenges in many developing countries (Giliba *et al*., 2010; Teferi *et al*., 2011; Woldewahid *et al*., 2012). Research has shown that beekeeping can sustain productivity while maintaining ecological stability because the honey bee does not compete for natural resources with any other agricultural enterprise (Seeley, 2014). Beekeeping deals essentially with the management of honey and other products which are known for their nutritional and medicinal values (Cortés *et al*., 2011; Ajibola *et al*., 2012).

Majority of the beekeepers in sub-Sahara Africa employ traditional production method often with poor technical skills (Prandin *et al*., 2000; Abebe and Puskur, 2011). This method mainly uses log and bark hives in which bees are hardly protected. Honey yields from the traditional method is as low as 8kg per hive per annum or 40 percent of the world average (Shenkute *et al*., 2012; Michael, 2008). Alternatively, honey is produced using the modern method that uses frame and top bar hives. A host of activities is associated with the modern beekeeping method. These activities include cleaning, watering and regular inspection of the hives, hive shading, supplementary feeding and honeybee colony multiplication. Whereas the modern beekeeping method is labour demanding, honey produced is of high quality. Overall, beekeeping is known for its role in augmenting household income (Kinati *et al*., 2012; Mujuni *et al*., 2012; Gebiso, 2015) and pollinating food crops (Kremen *et al*., 2002). Indeed studies (e.g. Muya, 2014; Affognon *et al*., 2015) show that beekeeping supports livelihoods of many people in the rural areas.

In Tanzania, the beekeeping industry produces on average 9380 metric tons worth USD 9.38 million and 625.3 metric tons of beewax worth USD 1.9 mil (Kagya, 2014). However, its full potential has not yet been realized. Estimates show that only 7% of the available potential is utilized annually (*ibid*). Realizing the untapped potential of the beekeeping sub-sector, the Government of Tanzania initiated beekeeping support services particularly in areas with high potential for beekeeping including Mpanda District. These initiatives aimed at promoting modern beekeeping technology. The main focus has been, on the one hand, to reduce food insecurity and unemployment, and on the other hand, to improve household income and the overall social well-being. However, little is known about the adoption of the modern beekeeping practices. Thus, a study was designed to (i) explore both the adoption and the determinants for adoption of the modern beehives, and (ii) identify the challenges facing the beekeeping sub-

sector. The study was conducted in two villages of Mpandandogo and Tongwe in Mpanda District, Tanzania.

2.0 METHODOLOGY

2.1 Study Area

This study was conducted in two villages of Mpandandogo and Tongwe in Mpanda District, Tanzania. This District lies between 300˚ and 330 31'E, and 50 15˚ and 70 03'S, covering 16, 911 square kilometers. The selected areas are endowed with Miombo forest reserves. The Miombo ecosystem is known to be highly favorable for production of bee products (Hausser and Mpuya, 2004). During the 2012 Census, the District had a total of 179,136 inhabitants (URT, 2013).

2.2 Data Collection

Data collection methods involved household survey. A random sampling technique was used to select representative samples of households in Mpandandogo and Tongwe villages. A total of 210 survey participants (105 adopters of modern beehives; herein referred to as "adopters" and 105 non-adopters of modern beehives referred to as "non-adopters") were enrolled in the study. This sample size was sufficiently large to represent the households of interest. The household was used as a sampling unit because much of the daily activities and decision making processes take place at this level. A household meant a group of people living, cooking and eating together. A semi-structured questionnaire was used to collect quantitative data. The questionnaire was pre-tested on a non-sample population with similar socio-economic background. The questionnaire included the following major aspects: background characteristics of the respondents, potential determinants for adoption of the modern beehives, bee keeping experience and the challenges facing the beekeeping sub-sector. The sample size (n) was estimated as described by Fisher *et al*. (1991) as follows:

$$\mathbf{n} = \frac{(Z_{\alpha/2})^2 pq}{\lambda^2} = (1.96)^2 * (0.5 * 0.5)/(0.1)^2$$

Where: $Z_{\alpha/2}$ = 1.96 (by assuming 95% confidence interval); p = 1-q = 0.5 = Since the proportion of adopters of modern beehives in the areas was not known, p was assumed to be 0.5 as this proportion maximizes the sample size; and λ = Maximum error = 10%. Further, by assuming a none-response rate of 10% and

design effect of 2, the estimated sample size was 210 (105 adopters and 105 non-adopters of modern beehives).

In addition, four- sex disaggregated Focus Group Discussions (FGDs) were conducted (two for adopters and two for non-adopters). In total, FGDs involved 40 participants. The adopter group involved two FGDs (one with 10 men and another with 12 women). Similarly, the non-adopter group was represented by two FGDs (one with eight men and another with 10 women). Data were also obtained through key informant interviews (district officials) and site observations.

2.3 Data Analysis

Data were analyzed using both quantitative and qualitative techniques. Quantitative data analysis was performed using Statistical Package for Social Sciences (SPSS) Version 17. Data were analysed for descriptive statics mainly frequencies and percentages. A t-test analysis was carried out to compare the average income of adopters and non-adopters from honey sales. Data were also subjected to binary logistic regression analysis to explore determinants of the likelihood of adoption of modern beehives. This analysis was preceded by a multicollinearity test . This test was performed by assessing Variance inflation factors (VFIs). At least one predictor was dropped among correlated predictors with large VIFs (*VIFs>4*). The essence was to improve precision in estimation of regression coefficients. The following model was fitted:

$$In\left[\frac{p}{1-p}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \ldots + \beta_{12} X_{12} + e_i.$$

Whereby;

n = number of independent variables; P_i = probability of adopting modern beehives; 1 – P_i = probability of not adopting; β_0 = intercept; β_1 to β_n = independent variable coefficients; X_1 = age of a beekeeper (years); X_2= sex of a household head (1= male, 0 = female); X_3 = education level of respondent (1= formal education, 0 = no formal education); X_4 = marital status (1= married, 0 = otherwise); X_5 = access to technical support services (1 = yes, 0 = no), X_6 = access of credit services (1 = yes, 0 = no); X_7 = Number of years in beekeeping (1= less than ten years, 2= ten years or more); X_8 = participation in leadership (1 = participate, 0 = not participate); X_9 = distance to farmers training centre (km); X_{10}

= distance to the nearest market (km); X_{11} = engagement on off-farm activities involvement (1 = yes, 0 = no); X_{12} = availability of market for bee products (km) and e_i = error term. The qualitative data obtained from observation, FGDs and key informant interviews were transcribed and analyzed using qualitative content analysis technique.

3.0 RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics of Beekeepers

The socio-economic characteristics of beekeepers disaggregated by adoption and non-adoption of modern beehives are presented in Table 1. From these results, most of the beekeepers were 36 years or above (53.3% adopters and 42% non-adopters), male (91.4% and 80%), married (68.6% and 66.7%) with primary education as their highest education level attained (66.7% and 64.8%). In general, most beekeepers are also small-scale farmers, for whom beekeeping is part of a diverse livelihood portfolio.

3.2 Beekeeping Experience

Information obtained from Mpanda District Council showed that only 3.3% of the beekeepers had adopted modern beehives. The rest of the beekeepers used traditional method with log hives (37.5%) or bark hives (59.2%). The hives were normally suspended high in trees and some distance from the homesteads. Further, results in Table 2 show that majority of the respondents had 10-20 colonies. Beekeepers with more than 20 colonies were largely those who owned the modern beehives. Usually, the potential of beekeeping in a given area is assessed against the availability of bee colonies and other factors such abundance of foraging materials and water sources (Kagya, 2014). As stated earlier, the study area has favourable conditions for beekeeping as indicated by high availability of bee colonies in which over two thirds of the hives were stocked.

Table 1: Background characteristics of respondents

Variable	Adopters (n=105)	Non-adopters (n=105)
Age (Years)		
18-25	21 (20.0)	38(36.2)
26-35	28(26.7)	22(21.0)
36+	56(53.3)	45(42.9)
Sex		
Male	96(91.4)	84(80.0)

Variable	Adopters (n=105)	Non-adopters (n=105)
Female	9(8.6)	21(20.0)
Marital status		
Married	72(68.6)	70(66.7)
Single	33(31.4)	35(33.3)
Education level		
No formal education	15(14.3)	28(26.7)
Primary	70(66.7)	68(64.8)
Secondary or higher	20(19.0)	9(8.6)
Household size (members)		
1 – 3	25(23.8)	29(27.6)
4 – 6	48(45.7)	50(47.6)
6+	32(30.5)	26(24.8)

Figures in parenthesis are percents

Table 2: Number of colonies, bee keeping experience and support services for adopters and non-adopters of modern beehives

Variable	Adopters (n=105)	Non-adopters (n=105)
Number of colonies		
<10	20(19.0)	37(35.2)
10 or more	85(81.0)	68(64.8)
Number of years in keeping		
<10	18 (17.1)	28(26.7)
10 or more	87(82.9)	77(73.4)
Training on beekeeping		
Attended	77(73.3)	32(30.5)
Not attended	28(26.7)	73(69.5)
Distance to farmer training centre (km)		
<2	62(59.0)	54(51.4)
2-5	27(25.7)	20(19.0)
5+	16(15.2)	31(29.5)

Figures in parenthesis are percents

Indeed, beekeeping was found to be more effective among adopters who had more than 10 years of experience in the industry and who had attended training on beekeeping. The trainings spanned from basic beekeeping concepts, apiary site selection, apiary management, harvesting and processing techniques of bee products to marketing and entrepreneurship skills. This initiative proved to be effective because competences in managing and handling honey bees require special skills. As a result, the average yield of honey per colony per annum was

higher for the adopters (16kg) than for the non-adopters (7kg). Similarly, average income of TZS 1, 41617 (equivalent to USD[1] USD 69.5) among adopters was higher than 576, 200 (equivalent to USD 268.4) for non-adopters (t=-10.1, p<0.000). These findings suggest that modern techniques of beekeeping have high potential for increased income honey sales.

3.3 Determinants of Adoption of the Modern Beehives

Table 3 shows that almost all factors used in the model are important predictors of adoption of modern beehives. Beekeepers in 36+ age bracket were more likely to adopt modern beehives compared with those in lower age categories. This is probably due to the fact that older age is associated with increased access to financial resources and assets. These resources would be necessary for investing on a technology such as the modern beehives.

Adoption of the modern beehives was also associated with sex and education of the respondents. The likelihood of men adopting modern beehives was 20% higher than women's (p = 0.041). Indeed, experience from other places also shows that beekeeping is a predominantly male-dominated activity (Bhusal and Thapa, 2005; Qaiser *et al*., 2013; Mburu *et al*., 2017). In Uganda, for example, Ogaba and Akongo (2001) established that some of the factors that deterred women from participating in beekeeping included lack of time at night when honey is usually harvested, and the nature of bees kept.

Nevertheless, introduction of the modern technologies has been shown to allow more women involvement in beekeeping (Mujuni *et al*., 2012). Discussions with key informants indicated that women can handle successfully and even surpass men in proficiency, particularly in honey processing. This suggests that there is much more women can do especially if they have access to technical support services needed for production, harvesting and processing of bee products. With regards to education, survey participants having secondary education or higher had increased probability (+48.5%) of adoption of modern beehives relative to those with primary education or lower (p = 0.044). A possible explanation is that households with more years of education are more likely to have access to information and are, therefore, acquiescent to the modern beekeeping practices.

Results also show that availability of market for bee products significantly

[1]Based on the exchange rate of one USD = TZS 2,146.99 at the time of this study.

explained the adoption decision (p = 0.003). Although marketing and market structure for honey is rather undefined, adopters had more advantage over non-adopters in terms of access to markets. It is possible that this happened because of increased market competitiveness for the latter. Indeed, this may have been an outcome of improved technical skills and material acquisition or indirectly through linkages to financial service providers as observed in other studies (Yirga *et al*., 2012; Martey *et al*., 2013). These findings underscore the need to increase awareness and leverage interventions on improved technology to promote the level of adoption. Other variables (marital status, p = 0.184 and participation in leadership, p = 0.912) fitted in the model did not influence the adoption of modern beehives.

Table 3: Logit model estimates for determinants of adoption of modern beehives

Independent variable	ME	Std. Err.	P>|z|
Age of household head	0.08713	0.05786	0.029*
Sex of head of household (1=male, 0=female)	0. 20326	0.38172	0.041*
Education level (1=formal, 0=informal)	0. 48523	0.53827	0.044*
Marital status (1 = married, 0 = otherwise)	-0.02155	0.71551	0.184
Access to extension services (1= Yes, 0 = No)	0. 61197	0.09572	0.050*
Access to credit (1 = Yes, 0 = No)	0. 59545	0.46363	0.022*
Years of experience in beekeeping	-0. 15315	0.09756	0.047*
Participation in leadership (1=Yes, 0 = No)	0. 77977	0.21981	0.912
Distance to farmers training centre (km)	0 .09682	0.07195	0.026*
Distance to the nearest market (km)	-0. 08067	0.20614	0.361
Involvement in off- farm activities (1=Yes,0= No)	0. 40565	0.02846	0.000**
Availability of market for bee products (1=Yes,0= No)	0. 08383	0.71854	0.003*
Number of observations			210
LR $x^2(12)$			137.2
$p > X^2$			0.000
Pseudo R^2			0.817

*p<0.05; **p<0.01; ME = Marginal Effect

3.4 Challenges Facing Beekeeping Enterprise

This section draws on practical issues raised as challenges during focus group discussions as well as interviews with key informants. On the whole, the beekeeping industry faces a number of challenges amid its unlocked potentials in the study area. Information obtained from focus group discussions with the beekeepers indicated that limited access to market of bee products impedes efforts toward a more developed beekeeping industry. Initial cost of investment for the modern beekeeping technology is considered high. Technical support and

other services such as credit services are largely inaccessible. There is generally, inadequate and ineffective beekeeping extension services to beekeepers and honey processors. Limited access to beekeeping technologies makes the enterprises less competitive in the market particularly for apiarists who use traditional method of beekeeping. These producers use traditional harvesting and processing techniques, which often lead to poor-quality honey. Absence of standardization of bee products coupled with inadequate and inappropriate processing and packaging facilities for bee products limit assurance and marketability of the products especially at the regional market and beyond.

4.0 CONCLUSIONS AND RECOMMENDATIONS

This study has demonstrated that adoption of modern beehives has positive and significant effect on yield of honey and income from honey sales. It is evident that modern beekeeping is an ideal approach to address livelihoods needs of beekeepers. Its potential to improve the welfare of rural communities is immense. Considering the benefits of beekeeping, future interventions should aim to scale up technical advice and support services taking into account the socio-economic characteristics that influence the adoption of modern hives.

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