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ADOPTION OF TECHNOLOGIES AND INNOVATIONS IN SMALLHOLDER HONEY PRODUCTION IN SOUTHWESTERN NIGERIA

[1]Olatubosun, T. O., [2]Oluwale, B.A., & [3]Ilori, M. O.
African Institute for Science Policy and Innovation,
Obafemi Awolowo University, Ile-Ife, Nigeria.

Abstract

This study investigates the factors that influence the adoption of the production technology alternatives employed by smallholder honey producers in Southwestern Nigeria. The type and extent of innovations in honey production were also identified and critically examined. The study was conducted in Oyo, Ondo and Osun states using two sets of structured questionnaire as well as oral interviews to collect information. One hundred and eighty questionnaire were administered on randomly selected smallholder honey producers. The producers were members of Beekeepers Association of Nigeria (90), FADAMA III beekeepers (45) and freelance beekeepers (45). Information elicited included socio-economic characteristics of the farmers, technologies employed in housing the bees, extraction processes, sources and basis for the choice, cost of acquisition, types and extent of innovation, cost and returns on the use of the technologies. Six technology combinations/options with distinction in the hive and extraction technologies were identified and examined. Data were analysed using descriptive and logistic regression statistics. The results showed that Kenyan Topbar hive was the most (72%) acceptable bee-housing technologies in the study area, while the Press (Hydraulic (55%) and Screw (50%)) extraction technologies were most preferred. Stone press and Floating technologies were preferred by 5.8% and 7.6% of the respondents respectively. Similarly, improvements and innovations in both hives and extraction technologies increased by 9.5% with time and more innovations (mostly minor (81.5%)) were carried out than in preceding years. Ease of acquisition, ease of operation, yield, and availability of spare parts, cost and quality of output of the technologies are factors that influenced the adoption of these technologies. The results further showed that ease of acquisition, yield and output quantity influenced the choice of Kenyan Topbar while efficiency, cost and availability of spare parts influenced the choice of centrifugal extractor.

Keywords: *Beekeeping, Extraction technologies, Hives technologies, Innovations, Smallholder honey production and Regression statistics.*

Background to the Study

The focus of rural development strategies has been on agriculture as the solution to rural poverty and on the role of government in delivering services to enhance productivity (FAO, 2002, 2010). However, in Africa, the same has not fully occurred. Most countries in Africa still lag behind in terms of agricultural revolution and rural development (Babatunde *et al.*, 2007). For instance, the Nigerian agricultural sector has suffered much neglect by the government since the discovery of petroleum but its importance to the economy cannot be over-emphasized. With this in mind, the Nigerian government is currently focusing attention on how to increase agricultural production with a view to providing employment opportunities for the people and alleviate poverty (Anyanwu, 1996). In the past, the agricultural sector had been relied upon to provide an exit route out of these twin problems. However, increasing population pressure, shrinking per capita land availability and stagnating yield growth have challenged the conventional wisdom that the agricultural sector could provide an exit route out of poverty and declining rural income. Bee-keeping for honey production has been identified as one of the activities that could serve both purposes of providing employment and reducing poverty among rural dwellers in Nigeria (Akachukwu, 1993). Prior to the refining of sugar cane which was developed in the 19th century, honey was the only sweetening agent widely available. It was prized not only as food, but also for its uses in folk medicine (Gentry, 2001). Today, it is still being used as sweeteners for cake, tea, cereals, jam and jelly (Babatunde *et al.*, 2007). For most beekeepers in developing countries, beekeeping is a supplementary activity and therefore often only plays a secondary role in development policies by countries and donor agencies (Aburime *et al.*, 2006).

Over the years, emphases have been laid on promotion of various types of small-scale apiculture for honey production. Apiculture is a science of rearing bees for man's economic benefits; it is the maintenance of honey bee-colonies, commonly in hives, by humans (Ayansola, 2003). It is an occupation that combines knowledge of habits and behaviour of bees under varying environmental conditions with the efficient manipulation of special equipment by the operator. Bee-keeping is also a sustainable form of agriculture that is beneficial to the environment (Matanmi *et al.*, 2008). It requires a small capital outlay and minimal management of the hives. It requires little or no land, and is not labour intensive. It has the potential to add to household income and also allows rural people the opportunity to earn extra income (Oluwole, 1999). However, the failure of the agricultural sector in bringing about the needed reduction in poverty and improvement in rural livelihood have led to growing concern in international development discourse about the relevance of agriculture to poverty reduction and rural development in Africa. As a result of this, the promotion of rural income generating activities continues to gain widespread support among development agencies and rural development experts (Matshe and Young, 2004). Few authors have argued that the rural non-farm sector holds the key to rural development and poverty reduction in developing countries (de Janvry and Sadoulet, 2001; Ruben and van den Berg, 2001). A well-developed rural non-farm sector could provide employment to the growing rural labour force and help to reduce the migration of people from the rural to urban areas.

Traditional beekeepers in the tropical region used log hives, baskets, mud pots, gourds and other materials that cannot be opened for inspection and harvest. Their hope of harvesting also depends on weather conditions. The honey products from these traditional methods are impure even when undiluted. The method also does not sustain the hive system, as the young bees are destroyed (FAO, 1993). In recent times, various technology options have been adopted for keeping bees by smallholder honey producers. These technologies are defined in relation to the nature of materials used to design / build the hives and the type of extraction technology employed in extracting the pure honey by smallholder honey producers. This study therefore seeks to identify the technologies of production and innovations prevalent among smallholder honey producers and determine the factors that influence the use of these technologies. The study is expected to provide answers to the following questions;

i. What are the production technologies and innovations utilized among small holder honey producers?
ii. What are the factors that determine the adoption of the different technologies?

Honey Production Technology

The practices and processes involved in bee-keeping have been categorized into two main groups namely; the Hive Technology and the Extraction Technology. This categorization is informed by the activities involved in bee-keeping for honey production.

The Hive Technology is made up of the varying types of hollow containers or enclosure that are available to house the bees. Traditional bee hives are initiated in an attempt to utilize the cheap and plentiful local materials for hive construction. In Nigeria, the common traditional hives include: gourds, clay pots, raffia basket, rolled up straw and hollow trunks (Environmental Reporting Logistic System, ERLS, 1995). Modern bee hives on the other hand adopt the principle of having a box-like enclosure with removable top or frames, which facilitate routine inspection of the established colonies. The common modern bee hives in Nigeria include: Kenyan Top-bar, Langstroth and East African long transitional Top-bar hives (Olagunju, 2000). Recently introduced is the Warré hive that takes the form of the natural home of the bees. Bee hives construction varies from one area to the other (Olagunju, 2000). Under natural conditions bee colonies will choose their own nesting site, which can be any cavity, hollow tree, a rock cavity or a discarded container (Ayansola, 2003).

The Extraction Technology: involves the central process of removing honey from honeycomb so that it can be isolated in a pure liquid form. There are different methods and techniques employed by bee farmers to extract honey, the choice of which is determined by the materials available to them. Large scale bee farmers will make use of the centrifugal extractors while most small scales farmers i.e. farmers with one to ten functional hives, will rather use honey press or any local methods of extraction (Mid-Atlantic Apiculture Research and Extension Consortium, MAAREC, 2011). In this study, discourse is made on the Centrifugal Honey extractor, and the Press method of extraction. Basically, in pressing the harvested honey combs, farmers make use of the Screw Honey Press, Hydraulic Honey Press, the Stone Press and the method of Suspension / floating.

Description of the Study Location

This study was carried out in three states (Oyo, Ondo and Osun) in Southwestern Nigeria. The states have been important agricultural areas in Nigeria that are well-known for the production of cocoa, palm products, honey, cassava and yam amongst others. Also present in the states are timber processing, food and beverages processing industries, metal and paper products, cement, paints, furniture and soap industries. The people of these states have been practicing agriculture since the ancient times and are predominantly farmers. The states are situated in humid tropical region of Southwestern Nigeria with heavy and long rainy seasons, short dry seasons with tropical rainforest in most parts of Osun and Ondo States and predominantly guinea savannah vegetation in Oyo state. The weather throughout the year is relatively constant with little variation. The selection of these states was informed by the prevalence of honeybee keepers of different categories that employ diverse technology alternatives in honey extraction and hives for beekeeping.

Methodology

Survey method which involves the use of questionnaire and oral interviews to collect primary data, complemented with secondary data were adopted in this work. Two sets of questionnaire were administered. The first set which was administered directly to the bee farmers elicited information such as the type of hive used, method of extraction employed and tools, volume of honey produced, factors that influence the choice of hive and extractor used, and number of harvests made per year. The second set of questionnaire was administered to leaders of Beekeepers Association in the study area to determine the sales per litre of honey, and the different extractors. Secondary data were sourced from the publications / reports of Beekeepers Association of Nigeria (BAN), Organization for Economic Cooperation and Development (OECD) and reports from Bee-keeping Extension Society. Oral guided interviews were also conducted on some of the BAN representatives. Physical farm observations of the processes and the apiaries were also carried out for additional information.

This study was conducted with a study population size of 180, randomly selected from Oyo (50), Osun (50), Ondo (50) states in Southwestern Nigeria and BAN (30) as shown in Table 1. As aforesaid, the three states were purposively selected because of their prominence in honey production and high prevalence of smallholder beekeepers.

The reliability and validity of research instruments were pretested for effective measurement of the study variables before proceeding to the field. Data collected were analysed using descriptive statistics such as percentages, means, mean rating and regression for binary dependent variable. A model for the production of honey with the adoption of the different types of technology was designed.

The Model:

$$Y_h = b_0 + b_1X_1 + b_2X_2 + b_3X_3 \ldots b_8X_8 \text{ and } Y_n = b_0 + b_1X_1 + b_2X_2 + b_3X_3 \ldots b_8X_{8,\ldots\ldots\ldots} \quad (1)$$

Where Y_h =choice of hive

Y_n =choice of extraction technology

h ranges from one (1) to five (5) i.e. Kenyan Topbar, Langstroth, Tank, Tyre and Mud Pot hives.

n ranges from one (1) to six (6) i.e. centrifugal extractor, hydraulic press, screw press, stone press, floating and squeezing respectively.

b_0 = constant, X_1 = efficiency, X_2 = ease of acquisition, X_3 = ease of operation, X_4 = Yield (Output Quantity), X_5 = availability of spare parts, X_6 = Cost, X_7 = Maintenance, X_8 = Output quality.

$b_1, b_2, b_3, \ldots, b_8$ are the coefficients of X_1, X_2, X_3, …, X_8 respectively.

Results and Discussion

The socio-demographic characteristics of the respondents is presented in Table 2. The gender distribution of bee farmers shows that about 70% were males and 30% were females. This affirms the earlier findings that males are more involved in bee-keeping farming than females (Fadare *et al.,* 2005). Majority (64.6%) of the farmers were aged between 26 and 45 years, the modal age being 26-35 years. About 83% were married while 11.5% were single. This is corroborated by an earlier study (Adeola *et al.,* 2011) which observed that most bee farmers were in their active age because honey marketing involves using aggressive marketing strategies with high level of risk that can be easily undertaken more by the youth because of their adventurous psyches.

Table 1: Analysis of Respondents by States and Types of Farmer

		Category of Bee Farmers								
		BAN Farmers		FADAMA III Beekeepers		Freelance Beekeepers			Total Retrieved	
S/N	States	No. Administered	No. Retrieved	No. Administered	No. Retrieved	No. Administered	No. Retrieved	Total Administered	Freq.	%
1.	Oyo	20(13.3%)	15(10%)	15(10%)	15(10%)	15(10%)	15(10%)	50 (33.3%)	45	30
2.	Osun	20(13.3%)	20(13.3%)	15(10%)	15(10%)	15(10%)	15(10%)	50(33.3%)	50	330 .3
3.	Ondo	20(13.3%)	17(11.3%)	15(10%)	15(10%)	15(10%)	15(10%)	50(33.3%)	47	31. 3
	Total				**150**				**142**	**94. 6**

*This does not include the 30 BAN officials

Most (47.9%) of the respondents had higher education, which is an indication of high literacy level among practitioners. The above may likely engender the propensity for innovations among the farmers. Majority (41.9%) were self employed, 21.3 % were crop farmers, 16.9% were civil servants, while 19.1% were full-time bee farmers. This is an indication that many of the farmers engaged in bee-keeping on part-time basis and as an additional source of income.

Hives and Extraction Technologies used by Farmers

Analysis on the types of hives used by the farmers (Figure 1) reveals that 72% of the farmers made use of Kenyan Topbar hive, while 14.1% used the Langstroth hives. Other farmers preferred the use of traditional hives such as tanks (9%), Tyres (3.9%), and mudpot / clay hives (0.8%).

The use of the Langstroth hive which is a modern technology was rather low. This may be attributed to the high cost and difficulty in its acquisition. This result is an affirmation of an earlier finding that more farmers use Kenyan Topbar than Langstroth hives (Oluwatusin, 2008).

Table 2: Socio-Demographic Characteristics of Respondents

Variables	Classification	Frequency	Percentage (%)
Gender	Male	99	69.7
	Female	43	30.3
	Total	142	100
Age Group	16 – 25	3	2.1
	26 – 35	51	36.2
	36 – 45	40	28.4
	46 – 55	22	15.6
	56 and above	25	17.7
	Total	141	100.0
Marital Status	Single	16	11.5
	Married	115	82.7
	Divorced	3	2.2
	Widowed	5	3.6
	Total	139	100
Highest Education Qualification	Primary School	11	7.7
	Junior Secondary School	4	2.8
	Senior Secondary School	45	31.7
	OND / HND / BSc.	68	47.9
	M.Sc / M.Phil / PhD	2	1.4
	No Formal Education	3	2.1
	Others	9	6.3
	Total	142	100

Occupation	Civil Servants	23	16.9
	Self Employed	57	41.9
	Crop Farmer	29	21.3
	Bee farmer	26	19.1
	Others	1	0.7
	Total	136	100

Table 3 shows the six different methods of honey extraction technologies identified within the study area and the prevalence of usage in each state. The result reveals that hydraulic honey press was the most (23.2%) commonly used. Of these, 9% were found in Oyo state, 7% in each of Osun and Ondo states. Screw honey press had 17.6% usage with 7.1% found in Osun state, 6% in Oyo state and 4.2% in Ondo. Centrifugal Honey Press had a total of 17% usage with most (7.1%) usage found in Oyo state, 5% in Ondo and 5% in Osun state. Of all the technologies observed, the squeezing technique had the least (10%) usage with 6% and 4% from Osun and Ondo states respectively. No respondent claimed to use the squeezing method in Oyo state. This may be due to the respondents' relative perception of quality and their judgments as to what their customers/consumers would prefer (Adekunle *et al.*, 2002).

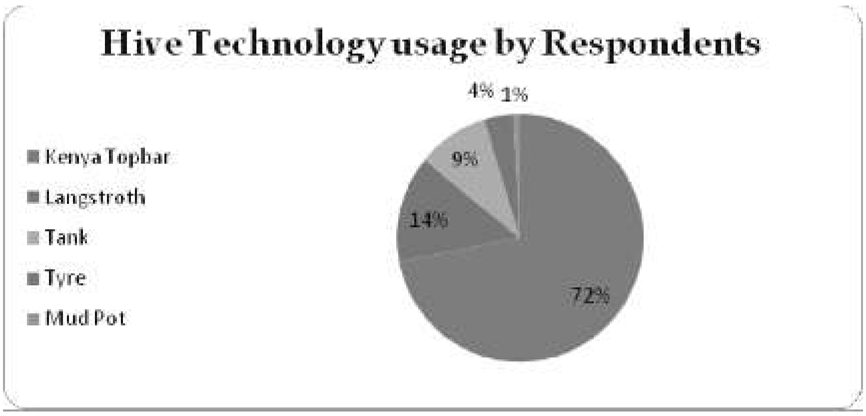

Figure 1: Hive Technology used by Respondents

Table 3: Extraction Technologies for Beekeeping

Extraction Technology	Total No. of Usage		State of respondents					
			Osun		Ondo		Oyo	
	Freq	%	Freq	%	Freq	%	Freq	%
Centrifugal Honey Extractor	24	16.9	7	4.9	7	4.9	10	7.1
Hydraulic Honey Press	33	23.2	10	7.1	10	7.1	13	9.0
Screw Honey Press	25	17.6	10	7.1	6	4.2	9	6.3
Stone Press	22	15.5	8	5.6	6	4.2	8	5.6
Floating Method	24	16.9	7	4.9	12	8.5	5	3.5
Squeezing	14	9.9	8	5.6	6	4.2	0	-
Total	142	100	50	35.2	47	33.1	45	31.7

Prevalence of Innovations among Honey Bee Farmers

The types of innovation the farmers had introduced in the last five (5) years, either in the process of honey bee-keeping or in the area of artifacts being used were also identified. In all the years, the innovations that have been introduced by the farmers in the production technology include:

i. Construction of hive types with both Topbar and Langstroth hive technologies to replace the simple topbar hive.
ii. Baiting with pure honey in order to attract bees replaces the traditional method of using pineapple peels or leaving hives bare and opened.
iii. Use of metal containers containing used engine oil to ward off reptiles and predators and
iv. The introduction of suspended aluminum sheets on top of the hives to protect against adverse weather conditions to replace the traditional means of searching for shady locations and sighting hives under trees.

All these were introduced to enhance the performance of the hive tools in honey production. Figure 2 presents innovations carried out on hives over a five-year period (2009-2013). Construction of hybrid hives comprising of both Kenyan Topbar and Langstroth hives was considered a major innovation as the combination produced a new technology. Introduction of suspended aluminum sheets on top of the hives to protect adverse weather conditions was also considered major. Baiting bees with pure honey as well as using spent engine oil to ward off predators were considered as minor innovations. Between 2009 and 2013, a progressive diffusion of innovation was observed. For example, while there was no hybrid hive technology in 2009 and 2010, there was a record of 4.84% adopted in 2013 and this increased to 10.6% in 2013. Introduction of suspended aluminum sheets which was 1.67% in 2010 increased to 3.31% in 2011, 6.45% in 2012 and 21.2% in 2013. The same trend of adoption was observed for the minor innovations as well. The diffusion of an innovation can be defined as a process in which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 2003). This is manifestly true of the innovations among the smallhoder honey producers.

The level of improved practice in the extraction methods was measured. Construction and use of the press with screw or hydraulic jack was considered a major innovation while introduction of metal mesh as sieve and introduction of layered tiny mesh filters to sieve out pure honey as multiple filters were considered minor innovations. Between 2009 and 2013, a progression of the adoption of the innovation was observed. In 2009, there was only 2% usage of the metal mesh sieve but 26% usage in 2013 as seen in Figure 3. A similar trend was observed for the use of metal mesh as sieve in place of the use of filter, introduction of screw and hydraulic presses and layered tiny mesh filters to sieve out pure honey.

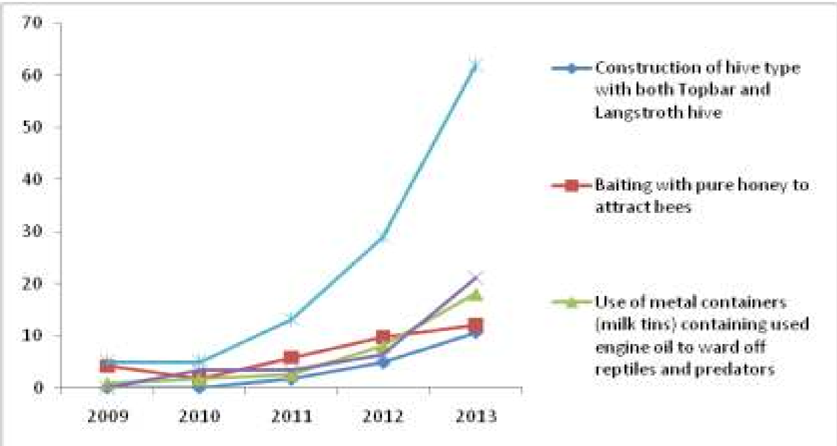

Figure 2: Adoption of Innovations in Hives over Five Years (2009 – 2013)

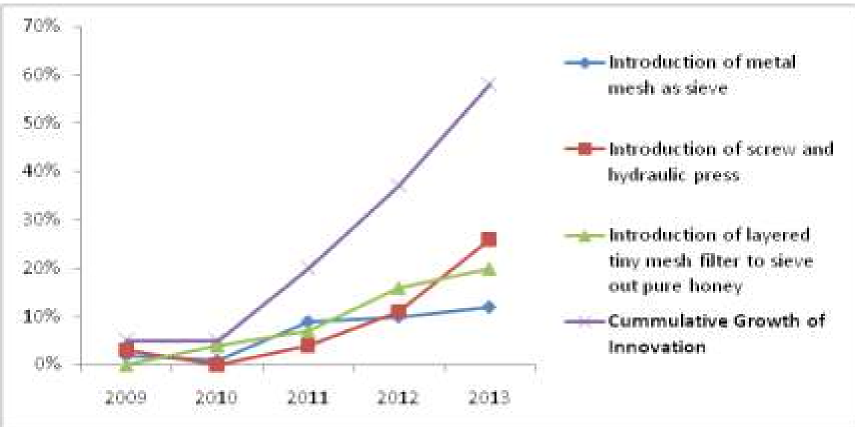

Figure 3: Extent of Adoption of Innovations in Extraction over Five Years (2009 – 2013)

Factors Influencing the Choice of Technology

Correlation analysis was used to examine the relationship between choice of hive and some independent variables efficiency, ease of acquisition, ease of operation, output quantity, availability of spare parts, cost and maintenance. Table 4 shows the result of the correlation analysis. Efficiency (-0.132), ease of acquisition (-0.129), ease of operation (-0.249), yield (output quantity) (-0/256), availability of spare parts (0.170), cost (-0.3), maintenance (-0.181) and quality of output (-0.157). There is a significant relationship between choice of hive and yield (Output quantity) ($r = 0.256; p < 0.05$); and cost ($r = 0.300; p < 0.05$) which implies that the volume of honey harvested from a hive as well as the cost of purchase of the hive are major considerations in the choice of hive used by the farmer.

Table 5 presents the relationship between the extraction technologies and the influencing factors. Mean rating results shown in the table indicate the relationship between all extraction technologies; centrifugal honey extraction, hydraulic honey press, screw honey press, stone press, floating and squeezing methods and the independent factors; efficiency, ease of acquisition, ease of operation, yield (output quantity), availability of spare parts, cost, maintenance and quality of output. The result reveals that the centrifugal extractor is highly efficient, produces a sizeable quantity of output (yield) and the best quality of honey output which explains its usage volume of 25% as seen in Table 2 above. However, the use of the other improvised technologies such as floating and stone press is arguably maintained as a result of their ease of acquisition and operation, low cost and ease of maintenance. The hydraulic press has all the factors supporting its use except its operation techniques; more farmers agreed that its operation is complex and do not support their usage of the technology. Furthermore, efficiency of the centrifugal extractor contributes positively to the choice of use of this technology. However, the non-availability of spare parts as well as high cost of acquisition contribute adversely and reduce the choice of this method of extraction. In the same vein, the inefficiency, unavailability of spare parts and cost of screw press influence the choice of use of the screw honey press negatively.

Assessment of the Relationship among Influencing Factors and the Extraction Technologies

Given the multiple factors' relationship on each of the extraction technology, further analysis was carried out to determine the impact of each factor (efficiency, ease of acquisition, ease of operation, yield (output quantity), availability of spare parts, cost, and maintenance and output quality) on the choice of the different extraction technologies.

The regression model $Y_1 = b_0 + b_1X_1 + b_2X_2 + b_3X_3 \ldots b_8X_8$ and the r^2 (coefficient of determination) are used to explain the impact.

Model 1: Choice of Centrifugal Extractor

The result of the Ordinary Least Square Regression shown in Table 6 explores the relationship that exists between each dependent variable and the use of the centrifugal honey extractor. The model summary indicates that the independent factors can explain eighty seven percent (87%) of the variation in use of centrifugal honey extractor by the farmers as indicated by the R^2 value. The analysis further shows that out of the eight factors analyzed, only ease of acquisition ($t = -3.925; p < 0.05$) and cost ($t = -3.628; p < 0.05$)

have significant effects on the use of centrifugal honey extractor by the farmers, the others have no significant effect on the use of centrifugal honey extractor by the farmers.

The Model $Y_1 = b_0 + b_1X_1 + b_2X_2 + b_3X_3 \ldots b_8X_8$ (2)

Y_1=Centrifugal extractor

$Y_1 = 0.091 + 1.756X_1 - 2.048X_2 + 1.123X_3 + 0.329X_4 + 1.324X_5 - 1.320X_6 - 0.068X_7 - 0.380X_8$ (3)

The model explains that a unit increase in ease of acquisition (X_2) will cause use of centrifugal extractor to decrease by 2.048 units keeping all the other variables constant. Similarly, a unit increase in cost (X_6) will cause use of centrifugal extractor to decrease by 1.320 units keeping all the other variables constant. This decrease implies that as cost of extractor increases the level of preference for it decreases. This supports the work of Adekunle *et al.* (2002) where he reported that the use of the press is preferred above the traditional technologies. However, it is not readily available in the Nigerian market.

Model 2: Choice of Hydraulic Press by Respondents

The result in Table 7 indicates that the independent factors can explain only 56.3% of the variation in use of hydraulic press as indicated by the R^2 value. The result further shows that ease of acquisition ($t = -2.393$; $p < 0.05$), ease of operation ($t = 3.219$; $p < 0.05$), cost ($t = -2.308$; $p < 0.05$) and output quality ($t = 1.955$; $p < 0.05$) have significant effects on the use of hydraulic press by the farmers, the others have no significant effect on the technology.

The Model $Y_2 = b_0 + b_1X_1 + b_2X_2 + b_3X_3 \ldots b_8X_8$ (4)

Y_2=Hydraulic Press, b_0=constant

$Y_2 = 3.311 - 0.665X_1 - 1.159X_2 + 1.730X_3 - 0.731X_4 - 0.656X_5 - 0.601X_6 + 0.354X_7 + 1.107X_8$ (5)

The beta values in Table 7 shows that a unit increase in ease of acquisition (X_2) will cause use of hydraulic press to decrease by 1.159 units keeping all the other variables constant. A unit increase in ease of operation will cause use of hydraulic press to increase by 1.730 units. Similarly, a unit increase in cost (X_6) and quality of output (X_8) will cause use of hydraulic press to extract honey to decrease by 0.601 units and increase by 1.107 units respectively keeping all the other variables constant. These four variables significantly contribute to farmers' choice of use of the hydraulic press.

Model 3: Choice of Screw Press by Respondents

The result in Table 8 indicates that the independent variables can explain only 53% of the variation in use of the screw press as indicated by the R^2 value. Result of the t-test explains that ease of acquisition ($t = -3.148$; $p < 0.05$), ease of operation ($t = 2.717$; $p < 0.05$) and cost ($t = -2.520$; $p < 0.05$) have significant effects on the use of screw press by the farmers; the others have no significant effect on the technology.

The Model $Y_3 = b_0 + b_1X_1 + b_2X_2 + b_3X_3 \ldots b_8X_8$ (6)

Y_3=Screw Press, b_0=constant

$$Y_3 = 4.348 - 0.380X_1 - 1.208X_2 + 1.248X_3 - 0.333X_4 + 0.044X_5 - 0.682X_6 + 0.253X_7 - 0.002X_8 \quad (7)$$

When all the independent variables are kept constant the use of the screw press will increase by 4.348 units as shown in Table 8, a unit increase in ease of acquisition will cause use of screw press to decrease by 1.208 units keeping all the other variables constant. A unit increase in ease of operation will cause use of screw press to increase by 1.248 units. Similarly, a unit increase in cost will cause use of screw press to extract honey to decrease by 0.682 units keeping all the other variables constant. These three variables play significant roles in farmers' use of the screw press as an extraction technology.

Model 4: Choice of the Floating/Sieving Extraction Technology by Respondents

The result as shown in Table 9 indicates that the independent variables can explain 77.2% of the variations in the use of floating / sieving extraction technology as indicated by the R^2 value. However, the result of the t-test does not show any significant relationship between the use of the floating technology and any of the independent factors. The model hence is not statistically significant for this technology.

Table 4: Relationship among Choice of Hive and Influencing Factors

	Choice of Hive	Efficiency	Ease of Acquisition	Ease of Operation	Yield (Output quantity)	Availability of spare parts	Cost	Maintenance	Quality of Output
Choice of Hive	1								
Efficiency	-0.132	1							
Ease of Acquisition	0.129	0.148	1						
Ease of Operation	-0.249	0.006	0.472**	1					
Yield (Output quantity)	-0.256*	0.497**	0.135	0.167	1				
Availability of spare parts	0.170	-0.160	0.319*	0.679**	-0.033	1			
Cost	-0.300*	-0.173	0.336**	0.245	0.096	0.287	1		
Maintenance	-0.181	-0.103	0.209	0.280*	-0.231	0.513**	0.363**	1	
Quality of Output	-0.157	0.401**	0.318*	-0.274*	0.339**	-0.140	0.325**	0.053	1

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2 tailed).
Source: Field Survey (2013)

Table 5: Mean Comparison among the Extraction Technologies and Influencing Factors

Factors/Extraction Technology	Centrifugal Extraction		Hydraulic Press		Screw Press		Stone Press		Floating Technology		Squeezing Technology	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Efficiency	0.2584*	0.0702	0.4386*	0.3371	0.2697	0.2807*	0.1910	0.2456*	0.2386	0.3158*	0.3258*	0.2105
Ease of Acquisition	0.1190	0.2742*	0.4048*	0.3387	0.3214*	0.2097	0.2738*	0.1290	0.3164*	0.1452	0.3571*	0.1774
Ease of Operation	0.1233	0.2466*	0.3014	0.4521*	0.3562*	0.1918	0.2377*	0.1370	0.2877*	0.2500	0.2603	0.3014*
Yield	0.2254*	0.1467	0.4267*	0.3239	0.2817*	0.2667	0.1549	0.2667*	0.2958*	0.2432	0.2676	0.2933*
Availability of spare part	0.1897*	0.1818	0.3793*	0.3750	0.2414	0.2955*	0.2241*	0.2045	0.3448*	0.2184	0.3621*	0.2273
Cost	0.1692	0.2051*	0.4154*	0.3590	0.2615	0.2692*	0.2462*	0.1795	0.3231*	0.2338	0.2615	0.2949*
Maintenance	0.1791	0.1899*	0.3881*	0.3671	0.3537*	0.2911	0.2537*	0.1772	0.3582*	0.1923	0.3433*	0.2278
Quality of Output	0.2000*	0.1690	0.4085*	0.3467	0.3333*	0.2113	0.1600	0.2576*	0.2297	0.3099*	0.2533	0.3099*

* High mean comparison.

Table 6: Impact of Factors on the Choice of Centrifugal Honey Extractor

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	0.091	1.829		0.050	0.962
	Efficiency	1.756	1.100	0.534	1.597	0.161
	Ease of Acquisition	-2.048	0.522	-1.599	-3.925	0.008
	Ease of Operation	1.123	0.692	0.781	1.623	0.156
	Yield (Output quantity)	0.329	0.667	0.161	0.493	0.639
	Availability of spare parts	1.324	00.826	0.777	1.602	0.160
	Cost	-1.320	0.364	-0.825	-3.628	0.011
	Maintenance	-0.068	0.404	-0.045	-0.168	0.872
	Quality of Output	-0.380	0.950	-0.162	-0.400	0.703

Model Summary for impact of factors on the choice of centrifugal honey extractor

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.930(a)	0.866	0.687	0.84293

a. Predictors: (Constant), Quality of Output, Ease of Operation, Efficiency, Maintenance, Cost, Yield (Output quantity), Ease of Acquisition, Availability of spare parts

Table 7: Impact of Factors on the Choice of Hydraulic Press

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta	B	Std. Error
2	(Constant)	3.311	1.400		2.365	0.032
	Efficiency	-0.665	0.406	-0.440	-1.640	0.122
	Ease of Acquisition	-1.159	0.484	-0.909	-2.393	0.030
	Ease of Operation	1.730	0.538	1.203	3.219	0.006
	Yield (Output quantity)	-0.731	0.420	-0.460	-1.739	0.103
	Availability of spare parts	-0.656	0.532	-0.442	-1.234	0.236
	Cost	-0.601	0.260	-0.565	-2.308	0.036
	Maintenance	0.354	0.329	0.256	1.078	0.298
	Quality of Output	1.107	0.566	0.546	1.955	0.070

Model Summary for impact of factors on the choice of hydraulic press

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.751(a)	0.563	0.330	0.91285

a Predictors: (Constant), Quality of Output, Availability of spare parts, Maintenance, Efficiency, Yield (Output quantity), Cost, Ease of Operation, Ease of Acquisition

Table 8: Impact of Factors on the Choice of Screw Press

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta	B	Std. Error
3	(Constant)	4.348	1.201		3.621	0.001
	Efficiency	-0.380	0.398	-0.176	-0.955	0.349
	Ease of Acquisition	-1.208	0.384	-0.873	-3.148	0.004
	Ease of Operation	1.248	0.459	0.819	2.717	0.012
	Yield (Output quantity)	-0.333	0.413	-0.173	-0.807	0.428
	Availability of spare parts	0.044	0.451	0.026	0.098	0.923
	Cost	-0.682	0.270	-0.547	-2.520	0.019
	Maintenance	0.253	0.303	0.151	0.834	0.413
	Quality of Output	-0.002	0.567	-0.001	-0.003	0.997

Model Summary for Impact of factors on the choice of screw press

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.727(a)	0.529	0.372	0.90636

a Predictors: (Constant), Quality of Output, Ease of Acquisition, Efficiency, Maintenance, Yield (Output quantity), Cost, Availability of spare parts, Ease of Operation

Table 9: Impact of Factors on the Choice of Floating / Sieving Extraction Technology

		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
Model		B	Std. Error	Beta	B	Std. Error
4	(Constant)	1.102	2.032		0.542	0.625
	Efficiency	1.277	1.077	0.692	1.185	0.321
	Ease of Acquisition	-1.071	0.831	-1.460	-1.288	0.288
	Ease of Operation	0.643	0.761	0.758	0.844	0.461
	Yield (Output quantity)	0.534	0.670	0.427	0.797	0.484
	Availability of spare parts	0.593	1.275	0.606	0.465	0.673
	Cost	-0.334	0.424	-0.413	-0.788	0.488
	Maintenance	0.287	0.391	0.331	0.733	0.517
	Quality of Output	-0.895	1.269	-0.619	-0.706	0.531

Model Summary for Impact of factors on the choice of floating/sieving technology

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.879(a)	0.772	0.163	0.76367

a Predictors: (Constant), Quality of Output, Ease of Acquisition, Efficiency, Yield (Output quantity), Maintenance, Cost, Ease of Operation, Availability of spare parts

Model 5: Choice of the Squeezing Technology by Respondents

The result in Table 10 indicates that the independent variables can explain 78.5% of the variations in the use of squeezing technology as indicated by the R^2 value. The result of the t-test reveals that all the factors except efficiency (t = -1.606; p >0.05), availability of spare parts (t = -1.048; p >0.05), and maintenance (t = 0.192; p >0.05) contribute significantly to the use of this method of extraction technology.

The Model holds for:

$$Y_5 = b_0 + b_1X_1 + b_2X_2 + b_3X_3 \ldots b_8X_8 \quad (8)$$

Y_5= Squeezing technology, b_0=constant

$$Y_5 = 5.103 - 0.409X_1 + 0.999X_2 - 1.027X_3 + 0.371X_4 - 0.306X_5 + 0.371X_6 + 0.027X_7 - 0.413X_8 \quad (9)$$

A unit increase in ease of acquisition will cause use of squeezing technology to increase by 0.999 units keeping all the other variables constant. A unit increase in ease of operation will cause use of squeezing technology to decrease by 1.027 units. Similarly, a unit increase in cost will cause use of squeezing technology to extract honey to increase by 0.371 units keeping all the other variables constant.

Table 10: Impact of Factors on the Choice of Squeezing Extraction Technology

		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
Model		B	Std. Error	Beta	B	Std. Error
5	(Constant)	5.103	0.564		9.049	0.000
	Efficiency	-0.409	0.254	-0.537	-1.606	0.134
	Ease of Acquisition	0.999	0.225	1.921	4.449	0.001
	Ease of Operation	-1.027	0.182	-1.802	-5.655	0.000
	Yield (Output quantity)	0.371	0.135	0.572	2.736	0.018
	Availability of spare parts	-0.306	0.292	-0.511	-1.048	0.315
	Cost	0.371	0.122	0.664	3.038	0.010
	Maintenance	0.027	0.143	0.046	0.192	0.851
	Quality of Output	-0.413	0.231	-0.490	-1.793	0.098

Model Summary for Impact of factors on the choice of squeezing extraction technology

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.886(a)	0.785	0.642	0.29754

a Predictors: (Constant), Quality of Output, Ease of Operation, Efficiency, Maintenance, Yield (Output quantity), Cost, Ease of Acquisition, Availability of spare parts

Conclusions and Recommendations

The results obtained revealed that Kenyan Topbar hive is the most (72%) acceptable in the study area while only few (0.8%) used the mud pot hive. Of all the extraction technologies considered, the press method (hydraulic (55%) and screw (50%)) were most preferred with little preferences (5.8%, 7.6%) for the Stone Press and Floating technologies respectively. Improvement in both hive and extraction technologies increases with time (Hives 2013: 62.1%, 2009: 3.3%; Extraction 2013: 50.7%, 2009: 1.7%) meaning more innovations were carried out in recent times than in preceding years. Minor innovations were mostly (81.5%) carried out in the study area. Ease of acquisition, ease of operation, yield, availability of spare parts, cost and quality of output of the technologies were factors that influenced the adoption of these technologies.

The following recommendations are given based on the findings of this study:

i. Facilitation of access to microcredit opportunities for smallholder beekeepers and potential investors. This will create wealth, eradicate poverty and reduce crime in Nigeria.

ii. The scope of this study could also be extended to other states in the country. Further work is suggested on the economic viability of large scale honey production in Nigeria.

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