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Economic Evaluation of Smallholder Honey Production Technologies in Southwestern Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author MOI designed the study and the scope. Author TOO conducted the field work (administered the questionnaire), analysed the data and discussed the results. In addition, author TOO drafted the manuscript which was reviewed and properly organised (modified) by author BAO. The final corrections and modifications were effected by author TOO. All authors read and approved the final manuscript before submission for publication.

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ABSTRACT

The study analyses the economic viabilities of the production technology alternatives adopted by smallholder honey producers in Southwestern Nigeria. Economic data were collected from officials of the Bee-Keepers' Association of Nigeria in three purposively selected states in Southwestern Nigeria namely, Osun, Oyo and Ondo states. Average unit market price in the area, labour, transportation and packaging costs were collected and aggregated. Fixed costs, including the cost of bee hives, bee keeping kits, hand gloves, knife, cutlasses and sieves were also collected and used in analyzing costs and returns in honey production. Engineering economy analysis method was used to analyse the economic parameters. Six technology combinations/options with distinction in the hive and extraction technologies were identified and examined. The result shows that the technology option of Kenyan Topbar hive and Hydraulic Press extractor was the most viable at 7% MARR for a project life of ten years on investment bearing highest Present Worth (₦1,204,116.61), Future Worth (₦2,368,660.87), Annual Worth (₦171,437.03) compared to others. The study concluded that the use of Kenyan Topbar hive and Hydraulic Press technology alternative provide higher profitability.

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1. INTRODUCTION

Africa is known to have about 10% of the total world's bee population with Nigeria as one of the largest reservoirs [1]. The production of honey through bee keeping is becoming popular among small scale farmers. This is because farmers have resorted to making income in diverse ways [2]. In many parts of the world where crop growing is difficult or impossible because of insufficient or intermittent rainfall or where other rural livelihood options are limited, beekeeping is an alternative means of generating income to improve the quality of life of rural communities. A market study of the honey industry in Southern Africa established that the region has vast potential for honey production which currently is under-exploited. Majority of the honey used in this region is imported from outside Africa the organization of beekeepers is weak and has to be strengthened.

In Botswana during the 1980's government support was mainly geared towards pursuing the objective of food self sufficiency and they began to strengthen support towards the development of non-traditional farming activities such as horticulture, dairy, piggery, poultry production and beekeeping. One notable programme, which provided substantial support towards the development of nontraditional enterprises, was the Financial Assistance Policy (FAP), which operated during the 1982-2000 period. Its aim was to diversify the economy into activities other than cattle production, mining and the public sector, and to promote income generation, employment creation, import substitution and production for the export market [3]. Through the FAP scheme, hundreds of farmers received grants to start beekeeping projects. At the start of FAP, there were only 12 beekeeping projects nationwide. Today there are approximately 500 bee farmers in the country. The Government of Botswana on realizing the potential that beekeeping has, has recently commissioned a feasibility study whose aim is to develop a commercialization strategy for the beekeeping industry in Botswana. Beekeeping is less affected by erratic rainfall conditions and vagaries of weather compared to the growing of annual crops, as honeybees can produce honey following any opportunistic rainfall and subsequent flowerings.

Beekeeping activity had been started as early as November 1990 in Lesotho. It has been considered as potential source of commercial honey and also contributes to the protection of the environment and agricultural production through the pollination action of bees. The problem encountered by small scale beekeepers in Lesotho is the lack of thorough training on beekeeping, honey processing and honey marketing. Marketing of honey is very informal. Beekeepers market honey through informal channels. Farmers market honey direct to consumers. The consumers of honey include individuals and chemists. The major buyers of honey are the Husted Chemist and Allied Chemist. The chemists complain that they wish to purchase honey locally but the supply is usually not enough and is very irregular hence honey is imported into the country.

Beekeeping in Mozambique in general is considered to be an income generating activity that complements other activities practiced by farmers; it's a potential resource for development of small scale farmer and serves as an environmental protector. There is low motivation and weak participation in the beekeeping industry of Mozambique. Crude and local operating techniques are prevalently used, resulting in loss of bee colonies and dirty honey. The great potential for development of beekeeping and willingness of apiculturist in honey production in Mozambique can be explored by designing programs with concrete strategies and proposals that will improve actual production, leading to increased quality and quantity of production of honey, better marketing and information systems as well as the overall management. These proposal and strategies will improve the capacity of the existing institution, the beekeepers as well as create new functional structures [4].

Traditional beekeeping is a complementary farming activity with diverse socio-economic benefits to reduce the risk involved in depending solely on conventional crop and animal production as the only source of income [5]. Modern Bee-keeping practices had taken off much earlier and are quite popular in other large reservoirs of bee populations such as Egypt, Kenyan and Tanzania [6]. In Nigeria, it was initiated at the International Institute of Tropical Agriculture (IITA) farms in Osun and Oyo States

[1] despite the long standing but uncertain record of crude bee-keeping practice traceable to the Zuma people of Zaria [7].

According to [8] honey is so much in use and consequently in demand that it can be termed a money spinner. Apart from being delicious and nutritious, it has been found useful in many industries especially for pharmaceutical purposes. Beekeeping can rightly be seen as a veritable tool in reducing poverty and malnutrition. By keeping bees one can obtain a large quantity of honey and other products for home consumption and for commercial purposes.

Honey production has been identified as one of the most lucrative enterprises in many parts of the world, so much is its use and consequently it is in high demand. In the United States, for example, about 110 million kilogrammes of honey worth $24,200,000.00 is produced each year [9]. Ethiopia is the ninth highest honey producing country in the world with a total production estimated at 44,000 tonnes valued at US$76.6 (€57.6) million and is the largest producer and exporter of honey and beeswax in Africa. This means that bee products are very important as a source of foreign exchange [9]. The recently estimated annual honey production in Nigeria is over 2000 tonnes. The price of honey in Nigeria ranges from N100, 000 to N200, 000 per tonne. If Nigeria were to export the 2,000 tonnes of honey produced annually, that would fetch the nation 200 to 240 million naira per year. This earning is expected to increase with improved beekeeping in Nigeria [10]. Nigeria's production appears insignificant as it was not recognized by the Food and Agricultural Organization. Improvement of honey production will be a sure way of adding value to the agro-forestry sector if food security situation is to be fully realized and this can only be achieved where there is proper planning and adequate facts about the existing systems of production [10]. Apart from this, with the recent crash in crude price worldwide (on which Nigeria depends majorly for foreign exchange earnings), honey production could be a window of opportunity for rural prosperity and poverty reduction.

In Southwestern Nigeria, survey shows existing modern hive tools to be the Langstroth and Kenyan Topbar hives [11], the tyre hives, tank and mud/clay hives were identified as traditional hives technologies for honey production prevalent in the region [7]. Similarly, extraction tools such as the honey press centrifuge or gravity method for honey extraction used by modern beekeepers identified as centrifugal extractor and hydraulic jack or screw honey press are used in the region. [12] reported the use of basket, sun and kneading (termed as squeezing, floating and stone press methods) as traditional extraction techniques prevalent in the region.

There are various technology options 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. Engineering economy which is the application of economic techniques to the evaluation and design of engineering alternatives is used in this study to assess the viability, estimate their value, and justify the appropriateness of the various honey processing technologies employed by small holder honey producers in southwestern, Nigeria, mainly to provide information on the best technology alternative for honey production in the study area. Economic viability of six technology alternatives was examined.

1.1 Honey Production Process

The process of honey cultivation and harvesting thus increasing presents the need to rise to the challenges of the ever expanding honey demands by designing machines that will help the local farmers to meet the challenges. The recent increase in the demand for honey is as a result of its great economic importance which ranges from numerous uses as food to medical relevance. To meet this demand requires finding a way of extracting honey from the honey comb which should be different and more efficient from the existing traditional methods being employed by the local beekeepers. Honey is extracted either by squeezing it out of the combs using hand or honey extractor [13]. The latter is a mechanical device for the removal of honey from the honey combs without destroying the combs [14].

The production of honey involves three major stages after which packaging and sales of the product are done. These stages are the acquisition of the hives i.e. the box that houses the bees, harvesting of the ripe honey and extraction of the honey from the honey combs. According to [11] two bee hives have been identified as common modern hives among apiculturists in Nigeria. These are the Langstroth and Kenyan Topbar hives. However, in another study by [7], the tyre hives, tank and mud/clay hives were identified as the traditional hives. These fives hive types were used in this study. The harvesting procedure requires tools such as the bee suits, gloves, boots, smokers, knives, etc. These tools are generally called the bee kit.

2. METHODOLOGY

Engineering Economy, according to [15], is the application of economic principles to engineering problems, in comparing the comparative costs of two alternative capital projects or in determining the optimum engineering course from the cost aspect. It seeks to determine the time value of money, estimate the cash flows, quantitative measurements of profitability and comparison of alternatives. Interest rate is used to characterize money so that the effect of time is proportional to the total amount of money involved and positively related with the length of time. The process diagram in Fig. 1 below shows the five stages in the production of honey. The bee hive is situated and left for honey bees to colonize and fill with all bee products. Honey, the bee product of interest to this study is harvested in combs using bee kits, smoker, etc. The ripe honey comb is taken through extraction to arrive at the packaged liquid honey content sold to consumers. The five processes are: Colonized Bee Hives, Harvesting of ripe honey (Bee kits and smoker), Honey Extraction (Honey Press; centrifuge or gravity methods), Packaging and Sales. The first three stages are fixed production process for honey and were grouped into various technology options with the operation and maintenance costs per year and revenue or income from the different combinations. Six production/extraction technology options were identified for this study. The technology combination/option is based on the production process of honey but with varying technology or tools for each stage of production. Option A is the combination of Langstroth hive and Centrifugal Extraction Technology, Option B is the combination of Kenyan Topbar hive and Hydraulic Press Extractor, Option C is the use of Kenyan Topbar hive and Screw Press Extractor technology, Option D is the use of Mud/Clay hive and Floating Extraction Technology, Option E is the Tyre and Squeezing Extraction Technology while Option F is the use of Tank as hive and Stone Press Technology. Average unit market price in the area, labour, transportation and packaging costs were collected and aggregated. Fixed cost, including the cost of bee hives, bee keeping kits, hand gloves, knife, cutlasses and sieves were also collected and used in analyzing costs and returns in honey production. Table 1 provides data on project design parameters. This systematic evaluation of the costs and benefits of proposed technical and business ventures through the application of economic analysis techniques in the comparison of investment alternatives helps to determine profitability of the venture [16].

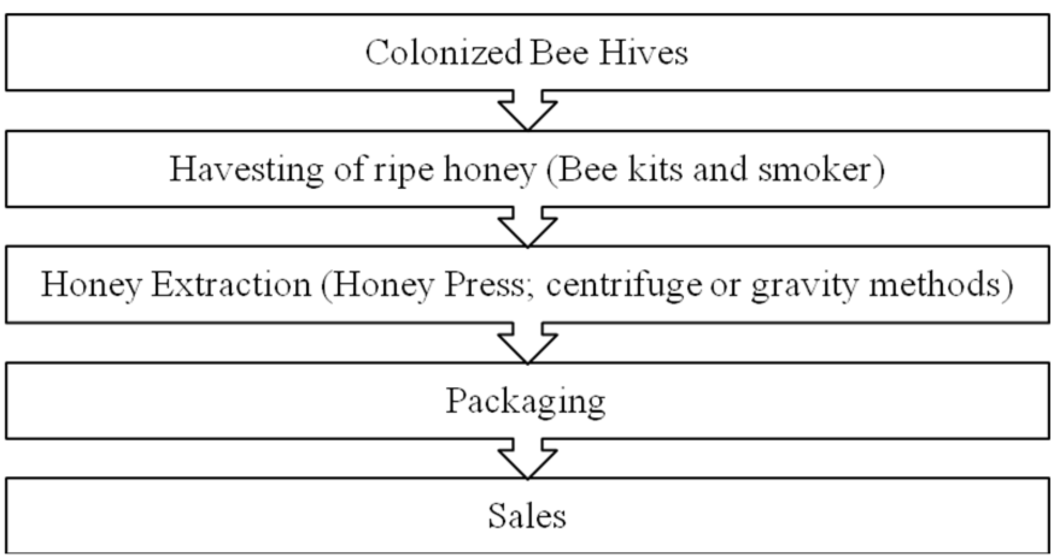

Fig. 1. Honey production process flow diagram
Source: Field study (2014)

Table 1. Operational Technology input variables for all alternatives

	1	**2**	**3**	**4**	**5**	**6**
			Fixed costs			
Hive technology Extraction Technology	Langstroth Centrifugal extractor	K-Topbar Hydraulic press	K- Topbar Screw press	Mud/Clay Floating method	Tyre Squeezing	Tank Stone press
			Working capital			
Bee – Keeping Kit (BK)	(BK_1)	(BK_2)	(BK_3)	(BK_4)	(BK_5)	(BK_6)
Maintenance of Hives, Kits and Extractors (Mt)	(Mt_1)	(Mt_2)	(Mt_3)	(Mt_4)	(Mt_5)	(Mt_6)
			Operation and maintenance cost/year			
Labour (L)	(L_1)	(L_2)	(L_3)	(L_4)	(L_5)	(L_6)
Management cost Harvest Management (Labour) (Hm)	Hm_1	Hm_2	Hm_3	Hm_4	Hm_5	Hm_6
Honey packaging (Hp)	Hp_1	Hp_2	Hp_3	Hp_4	Hp_5	Hp_6
Honey labeling (Hl)	Hl_1	Hl_2	Hl_3	Hl_4	Hl_5	Hl_6
Sales and distribution (Sd)	Sd_1	Sd_2	Sd_3	Sd_4	Sd_5	Sd_6
			Revenue			
Revenues from sales of honey and other bee products e.g wax, pollen, royal jelly, etc (Rs)	Rs_1	Rs_2	Rs_3	Rs_4	Rs_5	Rs_6
Volume of Production (in Litres) (Vp)	Vp_1	Vp_2	Vp_3	Vp_4	Vp_5	Vp_6

In this study, engineering economy analysis of the production technologies was done using the Present Worth (PW) method.

Present worth (PW): is the equivalent worth of all cash flows relative to a beginning point in time called the present. i.e. the present equivalent of cash inflows minus cash outflows to the base point at a minimum attractive rate of return (MARR) [17]. As long as the present worth, PW is greater or equal to zero, PW ≥ 0, the project is economically justified, if otherwise, the project is not acceptable.

$$PW = A\ (P/A, i\%, N) + S\ (P/F, i\%, N) - I \quad (1)$$

where:

i = MARR (The MARR chosen for this study was based on the bank lending rate for the agricultural sector listed as 7% [18].
N = Study period or life (years) of the project
S = Salvage value at period k.
I = Investment cost

Future Worth (FW): Future worth (FW) is the equivalent worth of all cash flows relative to an end point in time called the future. The project is desirable when FW ≥ 0. It was computed in the same way as the present worth method except that all inflows and outflows were discounted to a time in the future.

$$FW = -P\ (F/P, i\%, N) + A\ (F/A, i\%, N) + S \quad (2)$$

S, i, N are as defined above

Annual Worth (AW): It's the net yearly income derivable from a given piece of property, technology or project; its fair rental value for one year, deducting costs and expenses; the value of its use for a year. As long as the AW≥0, the project is economically attractive, if otherwise the project is not acceptable.

$$AW = R - E - CR \quad (3)$$

where:

$$CR = I\,(A/P, i\%, N) - S\,(A/F, i\%, N) \quad (4)$$

and;

I = Initial investment for the project
S = Salvage (residual) value at end of study period
N = The study period or project life
R = Revenue
E = Expenditure

Standard cost: Standard costs are representative cost per unit of output established in advance of actual production [17]. For this study it was calculated using this equation.

$$\text{Standard Cost} = AW/Q \quad (5)$$

where,

Q = total volume of outputs per year.

Standard costs play an important role in cost control and other management functions such as measuring operation performance by comparing actual cost with standard unit cost [17].

Benefit Cost Ratio B/C: This is the ratio of equivalent cash inflow to the equivalent of all cash out flow.

$$\text{Thus: } B/C = \frac{R+S(A/F,i\%,N)}{I(A/P,i\%,N)+E} \quad (6)$$

Where R, E and S are as defined above.

The project is worthwhile if B/C ≥ 1.

Break-Even Analysis: has been used to assess the economic feasibility of the production processes along with other indicators like net profit generated, annual fixed cost, and annual operating cost. The break-even point is the point at which revenue is exactly equal to costs and hence no profit is made and no losses are incurred. The selling price, fixed costs or operating costs will not remain constant resulting in a change in the breakeven. Hence, these should be calculated on a regular basis to reflect changes in costs and prices and in order to maintain profitability. The break-even production was calculated using the formula. The break-even point helps to know how many units/ litres of honey to be sold to break even i.e. the number of litres needed to make a profit of zero.

$$BP = TFC/\ (\text{Average farm price per unit} - \text{Average variable cost per unit}) \quad (7)$$

Where BP is the break-even production and TFC is the total fixed cost.

2.1 Cost and Return

Using the average unit market price and equipment cost obtained from authorities of the Beekeeper Association of Nigeria (BAN) in the study area, labour, transportation and packaging costs were collected and aggregated. Fixed cost, including the cost of bee hives, bee keeping kits made up of protective clothing, hand gloves, knife, cutlasses and sieves, were also collected and used in analyzing costs and returns in honey production. The number of years of the technology i.e. the project life is estimated to be ten (10) years from the report of the survey. The revenue has been estimated with an average of five (5) hives for the different hives types and harvest made once in a year. The salvage value for the project was assumed to be 2% of total capital [17]. The straight line (SL) depreciation method was used for the study. SL method assumes that the loss in value is directly proportional to the age of the asset [17].

2.2 Sensitivity Analysis

The profitability and viability decisions of technology alternatives derived from engineering economy methods were further subjected to sensitivity analysis to determine the merit of each technology alternative. Sensitivity is the relative magnitude of change in one or more elements of the engineering economy problem that will reverse a decision among many alternatives. It is the measure of merit (i.e. PW, FW, and AW) caused by one or more change in the estimated parameters. In carrying out this analysis, it was assumed that MARR remained constant at 7% except when sensitivity to changes in MARR was being measured. PW, FW, AW, and Standard costs of the projects were determined at various MARR (2.5%, 5%, 10% and 15%), study period/project lives (3 years, 5 years, 10 years and 20 years) and total capital costs (2% decrease, 5% decrease, 5% increase, and 10% increase).

3. RESULTS AND DISCUSSION

Table 2 shows the cost parameters for each hive and extraction technology, the cost of operation (working capital) and maintenance cost. Engineering economic methods using the economic parameters presented in Table 2 is calculated for all six technology options.

3.1 Analysis of Economic Viability

Technology Option A employs the use of the Langstroth hive to house the bee and centrifugal extractor to extract honey, total cost of operation is estimated at ₦241, 688, revenue at ₦2000 unit price of a litre of honey for ten years is ₦210,000 (Table 3). The PW at the end of tenth year is ₦1, 020,391.96, FW is ₦2, 007,241.12 and AW at the end of tenth year is ₦145, 275.89. The decision rule says as long as the PW, FW and AW values are greater or equal to zero exclusively, the project or technology is economically attractive and recommended for investment, if otherwise, the project is not acceptable. For Langstroth hive and centrifugal extractor combination, the technology combination in honey production is justified with the PW, FW and AW values greater than zero. Table 4 shows the cash flow for Technology Option B which is the combination of Kenyan Topbar hive and Hydraulic Press having total expenditure as ₦91, 703 and revenue at ₦2, 000 unit price of a litre of honey to be ₦200, 000. The PW at the end of tenth year is ₦1, 204,116.61, FW is ₦2, 368,660.87 and AW at the end of tenth year is ₦171, 437.03. Technology Option C which employs the use of the Kenyan Topbar hive and Screw Press to extract honey follows a similar trend with total cost of operation estimated as ₦64, 000; revenue at ₦2000 unit price of a litre of honey for first year is ₦180, 000 and PW at the end of tenth year is ₦1, 122,459.66, FW: ₦2, 208,031.60 and AW at the end of tenth year is ₦159, 811.45 as shown in Table 5. With PW, FW and AW values greater than zero, the combination of the press extractors and the Kenyan topbar hive indicates that the technology options are justified and worth the investment. This supports the work of [12] where he reported that the use of the press is preferred over the traditional technologies however it is not readily available in the Nigeria market.

Table 2. Cost parameter

Equipments (tools)	Cost (₦)
Kenyan Topbar	5,000
Langstroth Hive	30,000
Tank	6,000
Mud/Clay	1,500
Tyre	3,000
Bee Keeping kit	20,000
Centrifugal Extractor	150,000
Screw Press (15 Litres Capacity): Average cost	20,000
Hydraulic Press (15 Litre Capacity): Average Cost	42,500
Stone Press	5,000
Sieves and Bowls (Floating Method)	3,000
Sieves and Bowls (Squeezing Method)	3,000
Working capital	
Others (Bucket, Cutlass, Smoker)	6,000
Maintenance cost/year	
Centrifugal extractor	3,000
Hydraulic Press	1,000
Screw Press	1,000
Replacement of sieves and bowls	1,000
Tank	1,000
Economic parameters	
MARR (Subject to general bank interest rate, Year 2013)	7%
Number of years of technology	10 yrs
Depreciable life of asset	10 yrs
Annual depreciation costs = (Book Value – Salvage Value)/Depreciable Life of Asset	
Book value = Cost of technology alternative	

Source: Field survey (2013)

Table 3. Cash flow for technology option A: Langstroth hive and centrifugal extraction technology

Cost parameters		Amount (₦)
Capital expenditure		
Fixed Cost:	Langstroth hive	30,000
	Centrifugal extractor:	150,000
	Bee-keeping Kit	20,000
Working capital		6,000
Sub total		**206,000**
Operating expenditure (Labour/Hive/Yr):		12,500
Maintenance/Replacement:		3,000
Annual depreciation cost		20,188
Subtotal		**35,688**
Total		**241,688**
Revenue		
Litres/Hives		21 L
5 hives		105 L
Sales of honey (at 2,000/litre)		210,000
Subtotal		**210,000**
Salvage value (2% of total Capital):		4,120
MARR		7%
N = Study period or Life of Project		10 yrs
Profitability index		
Standard Cost		1,614.18
Present Worth PW		1,020,391.96
Future worth FW		2,007,241.12
Annual worth AW		145,275.89
Benefit cost ratio (B/C)		3.23
Break Even Point (BP)		124.08 Litres

Source: Field survey (2013)

Table 4. Cash flow for technology option B: Kenyan Topbar hive and hydraulic press extractor

Cost parameters		Amount (₦)
Capital expenditure		
Fixed cost:	K-Topbar	5,000
	Hydraulic Press:	42,500
	Bee-keeping Kit	20,000
Working capital		6,000
Sub total		**73,500**
Operating Expenditure (Labour/Hive/Yr):		10,000
Maintenance/Replacement:		1,000
Annual Depreciation Cost		7,203
Subtotal		**18,203**
Total		**91,703**
Revenue		
Litres/Hives		20
5 hives		100
Sales of Honey (at 2,000/litre)		**200,000**
Subtotal		**200,000**
Salvage Value (2% of total Capital):		1,470
MARR		7%
N = Study period or Life of Project		10 yrs
Profitability Index		
Standard Cost		1,904.85
Present Worth PW		1,204,116.61
Future worth FW		2,368,660.87
Annual worth AW		171,437.03
Benefit cost ratio (B/C)		6.98
Break Even Point (BP)		40.43 Litres

Source: Field survey (2013)

Table 5. Cash flow for technology option C: Kenyan topbar hive and screw press extractor

Cost parameters		Amount (₦,)
Capital expenditure		
Fixed Cost:	K-Topbar	5,000
Screw Press:		20,000
	Bee-keeping Kit	20,000
Working capital		6,000
Sub total		**51,000**
Operating Expenditure (Labour/Hive/Yr):		7,000
Maintenance/Replacement:		1,000
Annual Depreciation Cost		5,000
Subtotal		**13,000**
Total		**64,000**
Revenue		
Litres/Hives		18
5 hives		90
Sales of Honey (at 2,000/litre)		**180,000**
Subtotal		**180,000**
Salvage Value (2% of total Capital):		1,020
MARR		7%
N = Study period or Life of Project		10 yrs
Profitability Index		
Standard Cost		1,775.68
Present Worth PW		1,122,459.66
Future worth FW		2,208,031.60
Annual worth AW		159,811.45
Benefit cost ratio (B/C)		8.8871
Break Even Point (BP)		27.48 Litres

Source: Field survey (2013)

Table 6 presents the cash flow for Technology Option D which is the combination of Mud/Clay hive and Floating Extraction Technology. Total expenditure is ₦37, 185 and revenue at ₦2, 000 unit price of a litre of honey to be ₦70, 000. The PW at the end of tenth year is ₦426, 576.83, FW is ₦839, 134.17 and AW is ₦60, 734.06. Similarly, Table 7 shows the cash flow for Technology Option E a combination of Tyre hive and Squeezing Extraction Technology. Total expenditure is ₦36, 100 and revenue at ₦2, 000 unit price of a litre of honey to be ₦100, 000. The PW at the end of tenth year is ₦641, 888.55, FW is ₦1, 262,682.36 and AW at the end of tenth year is ₦91, 389.53. This indicates that the technology option is economically viable with the PW, FW and AW values greater than zero. Table 8 shows the cash flow for Technology Option F a combination of Tank hive and Floating Extraction Technology. Total expenditure is ₦40, 400 and revenue at ₦2, 000 unit price of a litre of honey to be ₦120, 000. The PW at the end of tenth year is ₦770, 260.37, FW is ₦1, 515,207.44 and AW at the end of tenth year is ₦109, 666.68. This indicates that the technology option is economically viable with the PW, FW and AW values greater than zero.

The economic viability analyses carried out at a MARR of 7% and project life of 10 years shows that of the six honey production technology options, Option B (Kenyan Topbar hive and Hydraulic Press Extractor) is the most viable having highest PW, FW, and AW values (Table 9), followed by use of Kenyan Topbar hive and Screw Press Extractor (Technology Option C) then Technology Option A (Langstroth hive and Centrifugal Extraction Technology). However, Option F (use of Tank hive and Stone Press Technology) had the highest Benefit to Cost ratio (B/C) of 11.56 which is slightly higher than Option E of 11.55, followed by Option C with 8.89 and Option D with 7.52. Since the entire profitability indices are positive, honey production using all these technology options are worth the investment, thus confirming the honey production enterprise is viable at 7% MARR with technology combinations of the Kenyan Topbar hive and the Hydraulic Press Extractor being the most profitable.

At an average farm size of five (5) hives but varying production volume (Litres/Hive) depending on the technology option employed (21L, 20L, 18L, 7L, 10L and 12L for Technology combinations A, B, C, D, E and F respectively), the break even units can be achieved after complete sales of the first year's harvest for all the production technology combinations except for technology combination A which will require upto one and half years honey product sales to break even and begin to maintain huge profit. This analysis further supports the viability of small scale honey production technology within the region examined.

3.2 Sensitivity

Figs. 2–7 present the spider plots of the sensitivities of the six technology options to percentage changes in the input parameters. Input variables Annual revenue, First cost, Study life (N), Salvage value, Annual disbursement, MARR and Net revenue were used. The present worth increases with percentage increase in the net revenue and project life. It decreases with percentage increase in MARR and First Cost but remained constant for annual disbursement, revenue and salvage value. Similar trends were observed for all the other alternatives.

4. SUMMARY AND CONCLUSION

This study carried out an engineering economy analysis of small holder honey production technologies in Southwestern Nigeria. It involved economic analysis of the various technologies to establish their viability. In addition, sensitivity analyses were carried out for all the technology options with a view to determining the best technology alternative.

The six technology combinations/options with distinction in the hive and extraction technologies that were identified and examined were Option A: Langstroth hive and Centrifugal Extraction Technology; Option B: Kenyan Topbar hive and Hydraulic Press Extractor; Option C: Kenyan Topbar hive and Screw Press Extractor; Option D**:** Mud/Clay hive and Floating Extraction Technology; Option E: Tyre and Squeezing Extraction Technology; Option F: Tank hive and Stone Press Technology.

The economic viability analyses which were carried out at a MARR of 7% and project life of ten years showed that of the six honey production technology options, Option B (Kenyan Topbar hive and Hydraulic Press Extractor) is the most viable, followed by use of Kenyan Topbar hive and Screw Press Extractor (Technology Option C), then Technology Option A (Langstroth hive and Centrifugal Extraction Technology). Since the entire profitability indices were positive, this shows that honey production using all these technology options is a worthy investment. This confirms that honey production enterprise is viable at 7% MARR with technology combination of the Kenyan Topbar hive and the Hydraulic Press being the most profitable.

Table 6. Cash flow for technology option D: Mud/clay hive and floating extraction technology

Cost parameters		**Amount (₦)**
Capital expenditure		
Fixed cost:	Mud/Clay	1,500
	Stone Press:	5,000
	Bee-keeping Kit	20,000
Working capital		6,000
Sub total		**32,500**
Operating Expenditure (Labour/Hive/Yr):		500
Maintenance/Replacement:		1,000
Annual Depreciation Cost		3,185
Subtotal		**4,685**
Total		**37,185**
Revenue		
Litres/Hives		7
5 hives		35
Sales of Honey (at 2,000/litre)		**70,000**
Subtotal		**70,000**
Salvage Value (2% of total Capital):		650
MARR		7%
N = Study period or Life of Project		10 yrs
Profitability Index		
Standard Cost		674.82
Present Worth PW		426,576.83
Future worth FW		839,134.17
Annual worth AW		60,734.06
Benefit cost ratio (B/C)		7.52
Break- Even Point		17.42 Litres

Source: Field survey (2013)

Table 7. Cash flow for technology option E: Tyre and squeezing extraction technology

Cost parameters	Amount (₦)
Capital expenditure	
Fixed cost: Tyre	3,000
Sieves and Bowls (Floating Method)	3,000
Bee-keeping Kit	20,000
Working capital	6,000
Sub total	**32,000**
Operating Expenditure (Labour/Hive/Yr):	-
Maintenance/Replacement:	1,000
Annual Depreciation Cost	3,100
Subtotal	**4,100**
Total	**36,100**
Revenue	
Litres/Hives	10
5 hives	50
Sales of Honey (at 2,000/litre)	**100,000**
Subtotal	**100,000**
Salvage Value (2% of total Capital):	640
MARR	7%
N = Study period or Life of Project	10 yrs
Profitability Index	
Standard Cost	1,015.44
Present Worth PW at the end of year 1	641,888.55
Future worth FW at the end of year 1	1,262,682.36
Annual worth AW at the end of year 1	91,389.53
Benefit cost ratio (B/C)	11.55
Break Even Point	16.68 Litres

Source: Field survey (2013)

Table 8. Cash flow for technology option F: Tank hive and stone press technology

Cost parameters	Amount (₦)
Capital expenditure	
Fixed cost: Tank	6,000
Sieves and Bowls (Floating Method)	3,000
Bee-keeping Kit	20,000
Working capital	6,000
Sub total	**35,000**
Operating Expenditure (Labour/Hive/Yr):	1,000
Maintenance/Replacement:	1,000
Annual Depreciation Cost	3,400
Subtotal	**5,400**
Total	**40,400**
Revenue	
Litres/Hives	12
5 hives	60
Sales of Honey (at 2,000/litre)	**120,000**
Subtotal	**120,000**
Salvage value (2% of total Capital):	700
MARR	7%
N = Study period or Life of Project	10 yrs
Profitability Index	
Standard Cost	1,218.52
Present Worth PW	770,260.37
Future worth FW	1,515,207.44
Annual worth AW	109,666.68
Benefit cost ratio (B/C)	11.56
Break Even Point	18.32 Litres

Source: Field survey (2013)

Table 9. Cash flow of industrial production of Honey for the six technology options

S/No.		Description of item	Amount alternative A	Amount alternative B	Amount alternative C	Amount alternative D	Amount alternative E	Amount alternative F
a.	**Capital expenditure**							
	(i)	Langstroth Hive	30,000	-	-	-	-	-
	(ii)	K-Topbar Hive	-	5,000	5,000	-	-	-
	(iii)	Mud/Clay Hive	-	-	-	1,500	-	-
	(iv)	Tyre	-	-	-	-	3,000	-
	(v)	Tank	-	-	-	-	-	6,000
	(vi)	Centrifugal Extractor:	150,000	-	-	-	-	-
	(vii)	Hydraulic Press:	-	42,500	-	-	-	-
	(viii)	Screw Press	-	-	20,000	-	-	-
	(ix)	Stone Press	-	-	-	5,000	-	-
	(x)	Sieves and Bowls (Floating Method)	-	-	-	-	3,000	3,000
	(xi)	Bee-keeping Kit	20,000	20,000	20,000	20,000	20,000	20,000
	(xii)	Working Capital	6,000	6,000	6,000	6,000	6,000	6,000
		Sub-total	**206,000**	**73,500**	**51,000**	**32,500**	**32,000**	**35,000**
b.	**Annual disbursement**							
	(i)	Operating Expenditure (Labour/Hive/Yr):	12,500	10,000	7,000	500	-	1,000
	(ii)	Maintenance/Replacement:	3,000	1,000	1,000	1,000	1,000	1,000
	(iii)	Annual Depreciation Cost	20,188	7,203	5,000	3,185	3,100	3,400
		Sub-total	**35,688**	**18,203**	**13,000**	**4,685**	**4,100**	**5,400**
c.	**Revenue**							
	(i)	Litres/Hives	21L	20L	18L	7L	10L	12L
	(ii)	5 hives	105L	100L	90L	35L	50L	60L
	(iii)	Sales of Honey (at 2,000/litre)	210,000	200,000	180,000	70,000	100,000	120,000
	(iv)	Salvage Value	4,120	1,470	1,020	650	640	700
d.	**Net Revenue A (ciii-b)**		**174,312**	**181,797**	**167,000**	**65,315**	**95,900**	**114,600**
e.	**MARR = 7%**							
f.	**Life of the Project = 10 years**							
g.	**Profitability Index**							
	(i)	Standard Cost	1,614.18	1,904.85	1,775.68	674.82	1,015.44	1,218.52
	(ii)	Present Worth	1,020,391.96	1,204,116.61	1,122,459.66	426,576.83	641,888.55	770,260.37
	(iii)	Future worth FW	2,007,241.12	2,368,660.87	2,208,031.60	839,134.17	1,262,682.36	1,515,207.44
	(iv)	Annual worth AW	145,275.89	171,437.03	159,811.45	60,734.06	91,389.53	109,666.68
	(v)	Benefit cost ratio (B/C)	3.23	6.98	8.89	7.52	11.55	11.56

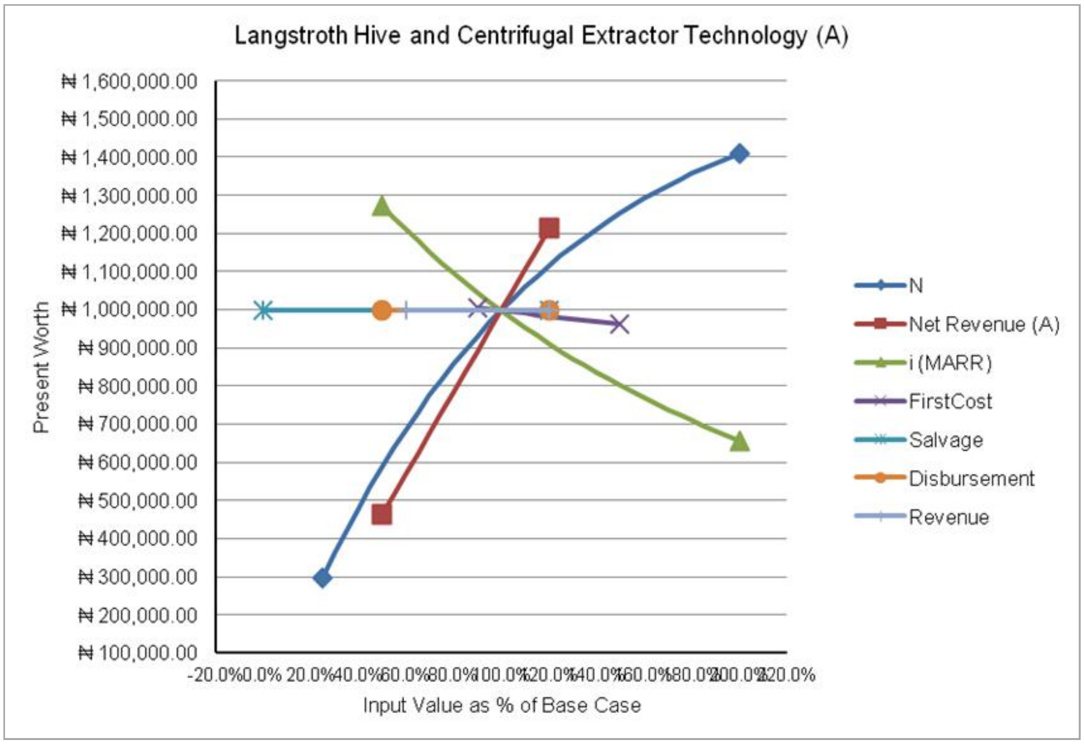

Fig. 2. Spider plot for technology option A

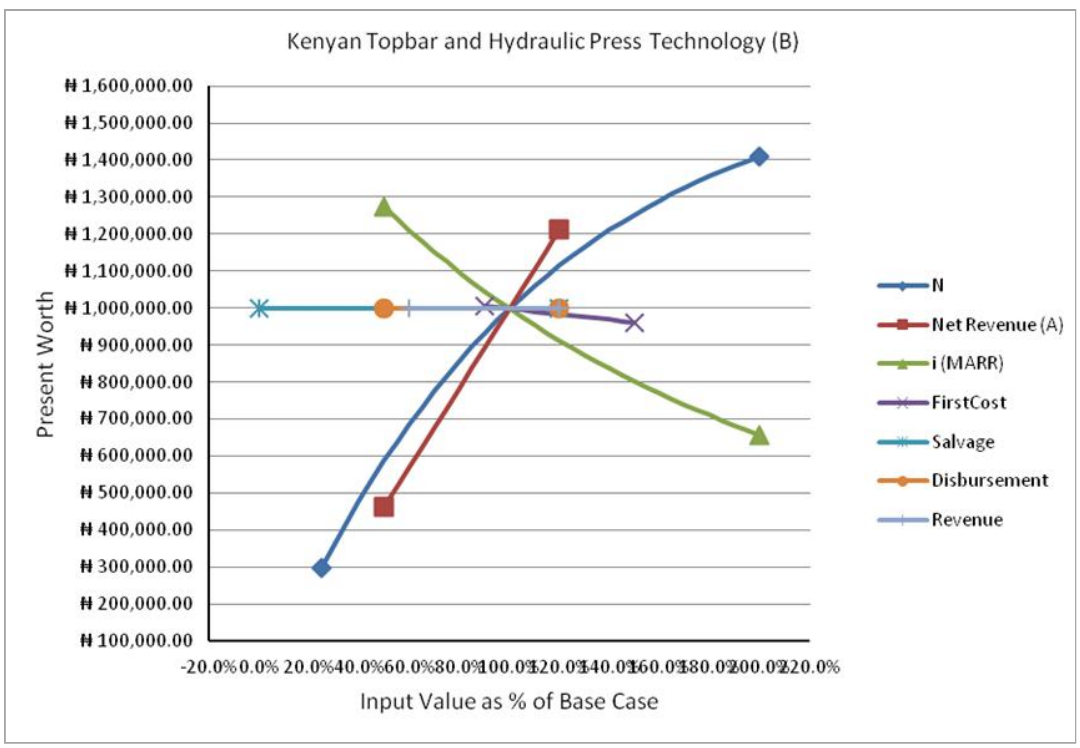

Fig. 3. Spider plot for technology option B

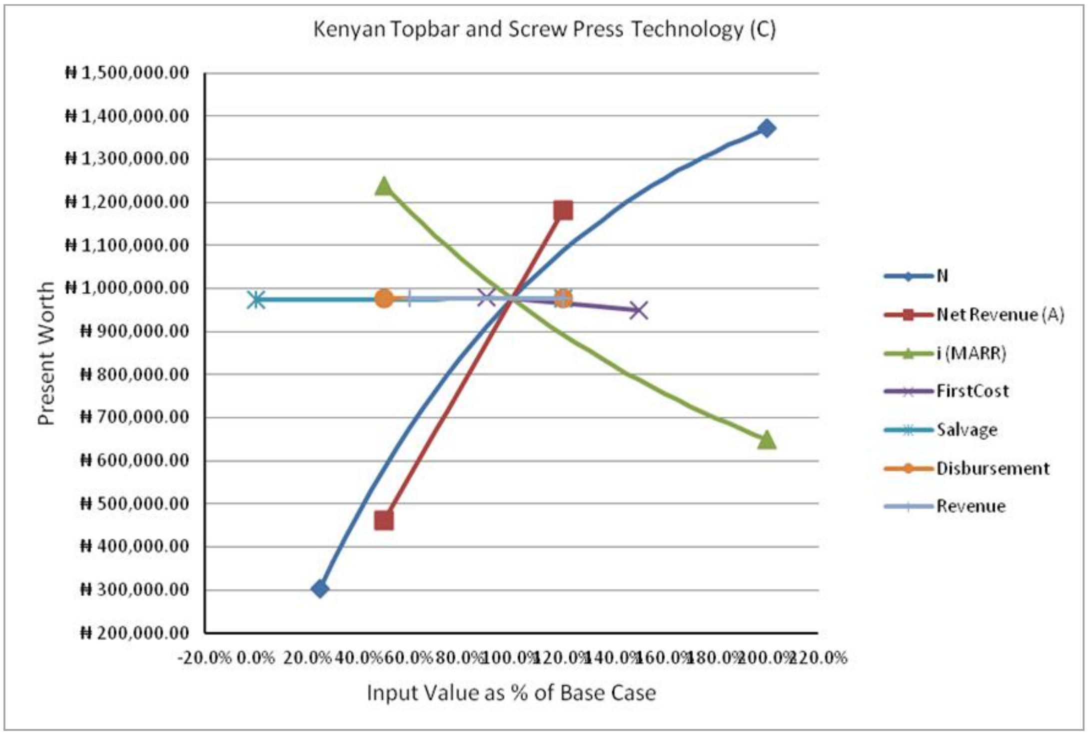

Fig. 4. Spider plot for technology option C

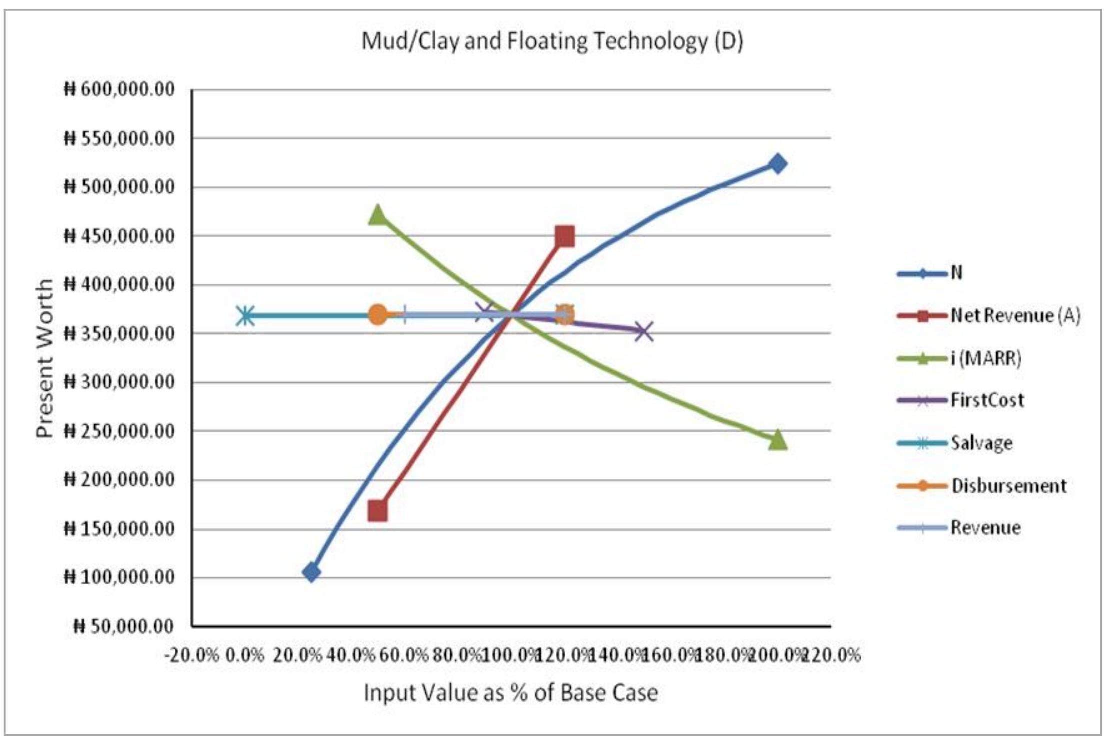

Fig. 5. Spider plot for technology option D

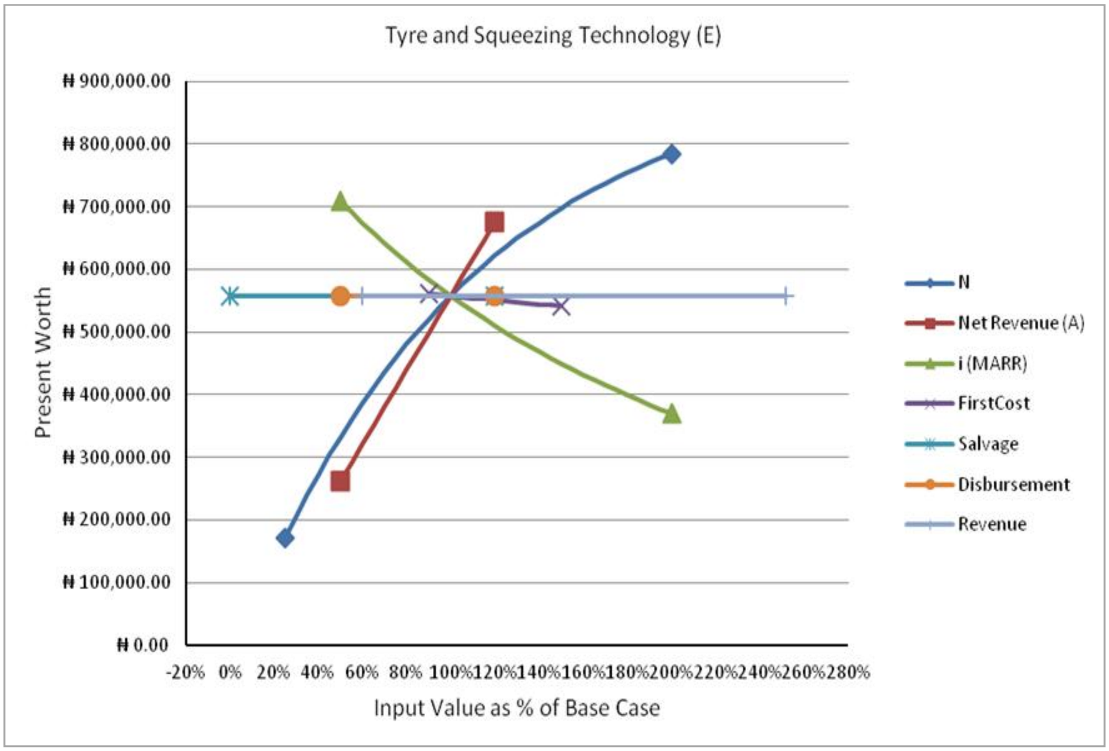

Fig. 6. Spider plot for technology option E

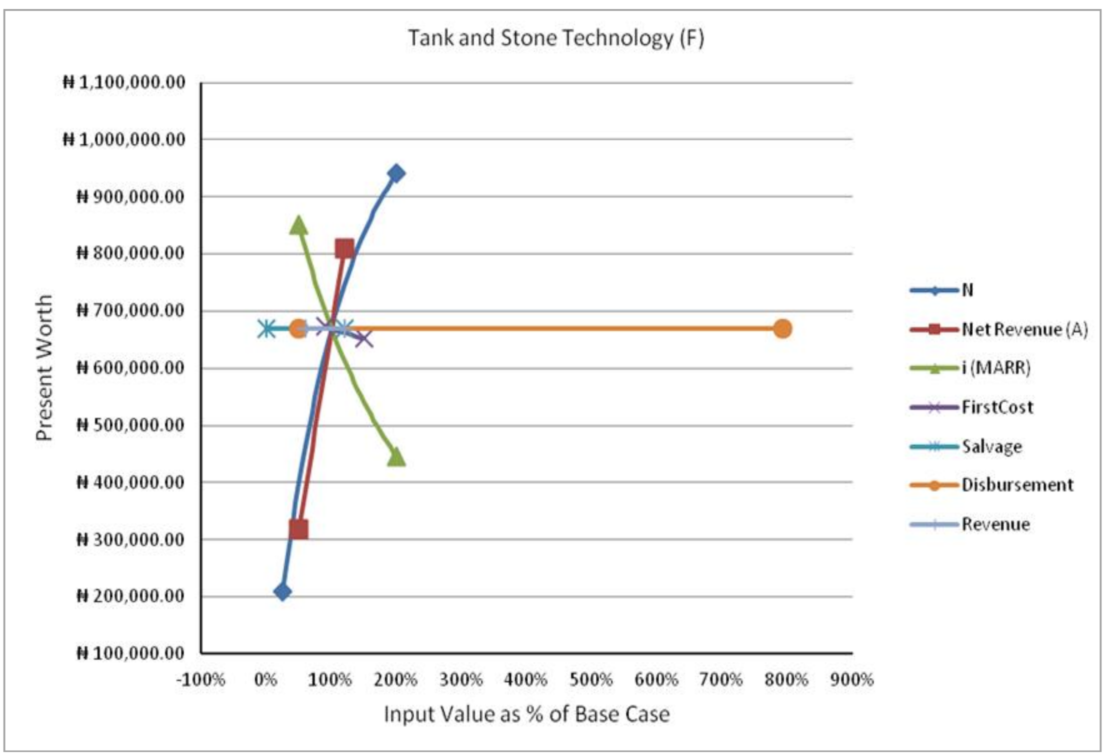

Fig. 7. Spider plot for technology option F

The sensitivity analysis shows that with increase in study period and reduction or decrease in total capital cost, the PW increases hence all technology options examined are more profitable as the project life increases. Furthermore, at reduced interests (MARR) the PW reduces for all the technology options.

[19], on a study of cost and returns for modern beekeeping and the problems affecting honey production under this modern system, randomly selected beekeepers in four Local Government Areas in a state in Nigeria. He reported that beekeepers were faced with problems such as bush burning, lack of capital, lack of technical assistance and so on. Budgetary analysis revealed that the variable costs were responsible for about seventy percent of the total costs. Net revenues realized per hive per harvest were found to be minimal for Langstroth and Top-bar hives compared with Langstroths method of beekeeping which was more profitable and the use was encouraged. He concluded that Langstroth method of beekeeping is more profitable and the use should be encouraged. However, this study reveals that with the right combination of extraction/hive technology, bee keeping for honey production venture is profitable though capital intensive.

In summary, the entire profitability indices for all the technology options for small scale honey production in the selected states in Southwestern Nigeria were sensitive to changes in MARR, project life (study period) and total capital costs. From these analyses, honey production is highly profitable and is an extremely good investment for private investors as well as the state and federal governments.

4.1 Conclusion

The study concluded that the engineering economics of small scale honey production at MARR of 7% and ten years project life is profitable and viable for all the available technology options for the production of honey. Honey bee-keeping also has great potential for wealth creation and can improve the living conditions of the citizenry.

5. RECOMMENDATIONS

Considering the high level of unemployment in Nigeria, especially among youths and graduates, honey production could be a good source of economic empowerment. The above would require attracting unemployed youths through provision of soft loans and training. This should be carried out at the three tiers of government i.e. federal, state and local government levels. The local government level is even more critical as it has the potential of addressing poverty and unemployment among the vulnerable, especially women. Since the findings of this study have revealed that honey production using any of the available technologies is viable, unemployed youths, rural women and actively retired adults can engage in the practice.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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