

Original Research Article

ECONOMIC EVALUATION OF SMALLHOLDER HONEY PRODUCTION TECHNOLOGIES IN SOUTHWESTERN NIGERIA

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 (N1,204,116.61), Future Worth (N2,368,660.87), Annual Worth (N171,437.03) compared to others. The study concluded that the use of Kenyan Topbar hive and Hydraulic Press technology alternative provide higher profitability.

Keywords: *Beekeeping, Honey production technologies, Smallholder honey production, Engineering economy.*

1.0 Introduction

Africa is known to have about 10% of the total world's bee population with Nigeria as one of the largest reservoirs (Hussein, 2000). 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 (Famuyide et al., 2014). 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. 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 (Clauss, 1983).

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 (Olarinde et al., 2008). 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 (Adejare, 1990). In Nigeria, it was initiated at the International Institute of Tropical Agriculture (IITA) farms in Osun and Oyo States (Hussein, 2000) despite the long standing but uncertain record of crude bee-keeping practice traceable to the Zuma people of Zaria (Environmental Reporting Logistics System (ERLS), 1995).

According to Anineme (2007) 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 (Canadian Statistics, 2003). 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 (Canadian Statistics, 2003). 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 (Folayan and Bifarin, 2013). 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 (Folayan and Bifarin, 2013). 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 (Olagunju, 2000), the tyre hives, tank and mud/clay hives were identified as traditional hives technologies for honey production prevalent in the region (ERLS, 1995). 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. Adekunle et al. (2002) 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. However, there is a dearth of empirical documentation on the production technologies, their feasibilities and economic viabilities. Thus, it became imperative to assess the technological feasibility and economic viability of the six technology alternatives in this study.

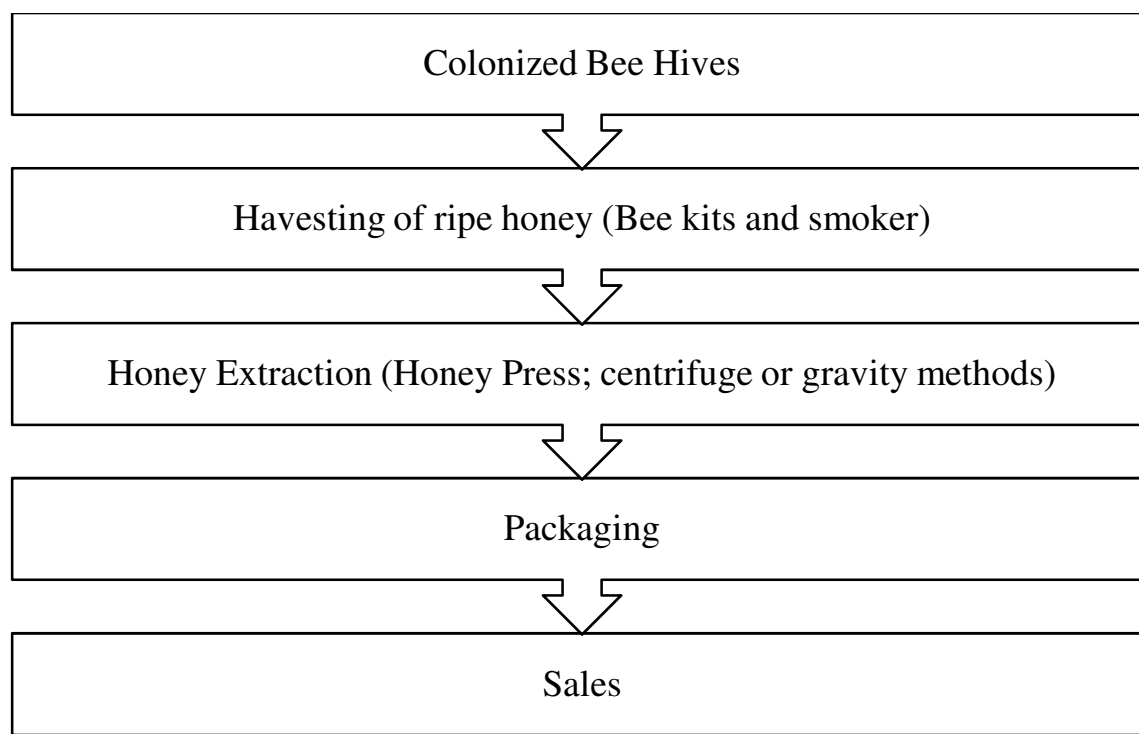
1.1 Honey Production Process

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 (Ayansola, 2003). The latter is a mechanical device for the removal of honey from the honey combs without destroying the combs (Halley et al., 1988).

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 Olagunju (2000) 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 ERLS (1995), the tyre hives, tank and mud/clay hives were identified as the traditional hives. These five 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.

86 METHODOLOGY

87 Engineering Economy, according to Kangyi (2006), is the application of economic principles to
 88 engineering problems, in comparing the comparative costs of two alternative capital projects or in determining the
 89 optimum engineering course from the cost aspect. It seeks to determine the time value of money, estimate the cash
 90 flows, quantitative measurements of profitability and comparison of alternatives. Interest rate is used to characterize
 91 money so that the effect of time is proportional to the total amount of money involved and positively related with the
 92 length of time. The process diagram in Figure 1 below shows the five stages in the production of honey. The bee
 93 hive is situated and left for honey bees to colonize and fill with all bee products. Honey, the bee product of interest
 94 to this study is harvested in combs using bee kits, smoker, etc. The ripe honey comb is taken through extraction to
 95 arrive at the packaged liquid honey content sold to consumers. The five processes are: Colonized Bee Hives,
 96 Harvesting of ripe honey (Bee kits and smoker), Honey Extraction (Honey Press; centrifuge or gravity methods),
 97 Packaging and Sales. The first three stages are fixed production process for honey and were grouped into various
 98 technology options with the operation and maintenance costs per year and revenue or income from the different
 99 combinations. Six production/extraction technology options were identified for this study. The technology
 100 combination/option is based on the production process of honey but with varying technology or tools for each stage
 101 of production. Option A is the combination of Langstroth hive and Centrifugal Extraction Technology, Option B is
 102 the combination of Kenyan Topbar hive and Hydraulic Press Extractor, Option C is the use of Kenyan Topbar hive
 103 and Screw Press Extractor technology, Option D is the use of Mud/Clay hive and Floating Extraction Technology,
 104 Option E is the Tyre and Squeezing Extraction Technology while Option F is the use of Tank as hive and Stone
 105 Press Technology. Average unit market price in the area, labour, transportation and packaging costs were collected
 106 and aggregated. Fixed cost, including the cost of bee hives, bee keeping kits, hand gloves, knife, cutlasses and sieves
 107 were also collected and used in analyzing costs and returns in honey production. Table 1 provides data on project
 108 design parameters. This systematic evaluation of the costs and benefits of proposed technical and business ventures
 109 through the application of economic analysis techniques in the comparison of investment alternatives helps to
 110 determine profitability of the venture (Thuesen et al., 1977).



111
112 **Figure 1:** Honey production process flow diagram

Source: Field Study (2014)

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) (Degarmo et al., 1990). As long as the present worth, PW is greater or equal to zero, $PW \geq 0$, the project is economically justified, if otherwise, the project is not acceptable.

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

where:

i = MARR (The MARR chosen for this study was based on the bank lending rate for the agricultural sector listed as 7% (CBN, 2013).

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 $FW \geq 0$. 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.

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

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 $AW \geq 0$, the project is economically attractive, if otherwise the project is not acceptable.

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

where:

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

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 (Degarmo et al., 1990). For this study it was calculated using this equation.

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

where Q = total volume of outputs per year.

151 Standard costs play an important role in cost control and other management functions such as measuring operation
152 performance by comparing actual cost with standard unit cost (Degarmo et al., 1990).

153

154 **Table 1: Operational Technology input variables for all alternatives**

	1	2	3	4	5	6
	Fixed Costs					
Hive Technology	Langstroth	K-Topbar	K- Topbar	Mud/Clay	Tyre	Tank
Extraction Technology	Centrifugal Extractor	Hydraulic Press	Screw Press	Floating Method	Squeezing	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	Hm ₁	Hm ₂	Hm ₃	Hm ₄	Hm ₅	Hm ₆
Harvest Management (Labour) (Hm)						
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

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156 2.1 Cost and Return

157 Using the average unit market price and equipment cost obtained from authorities of the Beekeeper
158 Association of Nigeria (BAN) in the study area, labour, transportation and packaging costs were collected and
159 aggregated. Fixed cost, including the cost of bee hives, bee keeping kits made up of protective clothing, hand gloves,
160 knife, cutlasses and sieves, were also collected and used in analyzing costs and returns in honey production. The
161 number of years of the technology i.e. the project life is estimated to be ten (10) years from the report of the survey.
162 The revenue has been estimated with an average of five (5) hives for the different hives types and harvest made once
163 in a year. The salvage value for the project was assumed to be 2% of total capital (Degarmo et al., 1990). The
164 straight line (SL) depreciation method was used for the study. SL method assumes that the loss in value is directly
165 proportional to the age of the asset (Degarmo et al., 1990).

166 2.2 Sensitivity Analysis

167 The profitability and viability decisions of technology alternatives derived from engineering economy
168 methods were further subjected to sensitivity analysis to determine the merit of each technology alternative.
169 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).

2.0 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.

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)

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. This indicates that the technology option is justified with the PW, FW and AW values greater than zero.

187 **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		21L
5 hives		105L
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		10yrs
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

188 **Source:** Field Survey (2013)

189 Table 4 shows the cash flow for Technology Option B which is the combination of Kenyan Topbar hive and
 190 Hydraulic Press having total expenditure as ₦91,703 and revenue at ₦2,000 unit price of a litre of honey to be ₦200,
 191 000. 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
 192 ₦171,437.03. This indicates that the technology option is justified with the PW, FW and AW values greater than
 193 zero as well.

194 **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	10yrs
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

195 **Source:** Field Survey (2013)

196 Technology Option C employs the use of the Kenyan Topbar hive and Screw Press to extract honey. Total cost of
 197 operation is estimated ₦64,000 naira; revenue at ₦2000 unit price of a litre of honey for first year is ₦180, 000 as
 198 shown in Table 5. The PW at the end of tenth year is ₦1, 122,459.66, FW is ₦2,208,031.60 and AW at the end of
 199 tenth year is ₦159,811.45. This indicates that the technology option is justified with the PW, FW and AW values
 200 greater than zero also.

201 **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	10yrs
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

202 **Source:** Field Survey (2013)

203 Table 6 presents the cash flow for Technology Option D which is the combination of Mud/Clay hive and Floating
 204 Extraction Technology. Total expenditure is ~~₦~~37,185 and revenue at ~~₦~~2,000 unit price of a litre of honey to be
 205 ~~₦~~70,000. The PW at the end of tenth year is ~~₦~~426,576.83, FW is ~~₦~~839,134.17 and AW at the end of tenth year is
 206 ~~₦~~60,734.06. This indicates that the technology option is economically viable with the PW, FW and AW values
 207 greater than zero.

208 **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	10yrs
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

209 **Source:** Field Survey (2013)

210 Table 7 shows the cash flow for Technology Option E which is the combination of Tyre hive and Squeezing
 211 Extraction Technology. Total expenditure is ~~₦~~36,100 and revenue at ~~₦~~2,000 unit price of a litre of honey to be
 212 ~~₦~~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
 213 ~~₦~~91,389.53. This indicates that the technology option is economically viable with the PW, FW and AW values
 214 greater than zero.

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216 **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	10yrs
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

217 **Source:** Field Survey (2013)

218 Table 8 shows the cash flow for Technology Option F which is the combination of Tank hive and Floating
 219 Extraction Technology. Total expenditure is ₦40,400 and revenue at ₦2,000 unit price of a litre of honey to be
 220 ₦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
 221 is ₦109,666.68. This indicates that the technology option is economically viable with the PW, FW and AW values
 222 greater than zero.

223 **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	10yrs
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

Source: Field Survey (2013)

3.1 Analysis of Economic Viability

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 PW, FW, and AW values of ₦1,204,116.61, ₦2,368,660.87 and ₦171,437.03 respectively, followed by use of Kenyan Topbar hive and Screw Press Extractor (Technology Option C) with PW value ₦1,122,459.66, FW value ₦2,208,031.60 and AW value of ₦159,811.45; then Technology Option A (Langstroth hive and Centrifugal Extraction Technology) with PW value ₦1,020,391.96, FW ₦2,007,241.12 and ₦145,275.89. The use of Kenyan Topbar hive and Hydraulic Press Extractor (Option B) has the highest viability because it has the highest value of PW, FW and AW (Table 9). However, Option F (use of Tank hive and Stone Press Technology) had the highest B/C ratio of 11.56 and 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 were positive, this shows that 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.

3.2 Sensitivity

Figures 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.

246 **Table 9: Cash flow of industrial production of Honey for the six technology options**
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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

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						
(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%						

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						
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

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						
(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

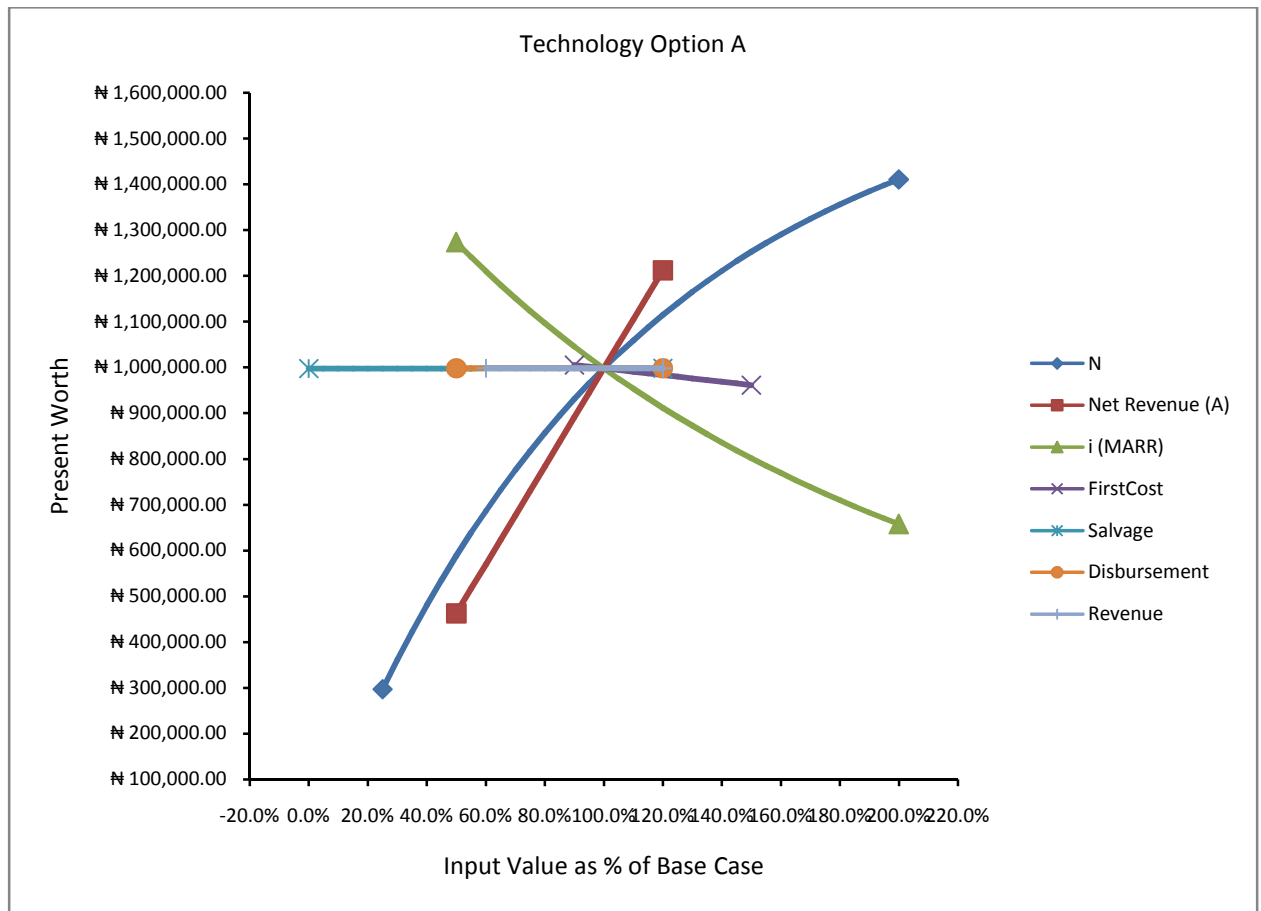


Figure 2: Spider Plot for Technology Option A

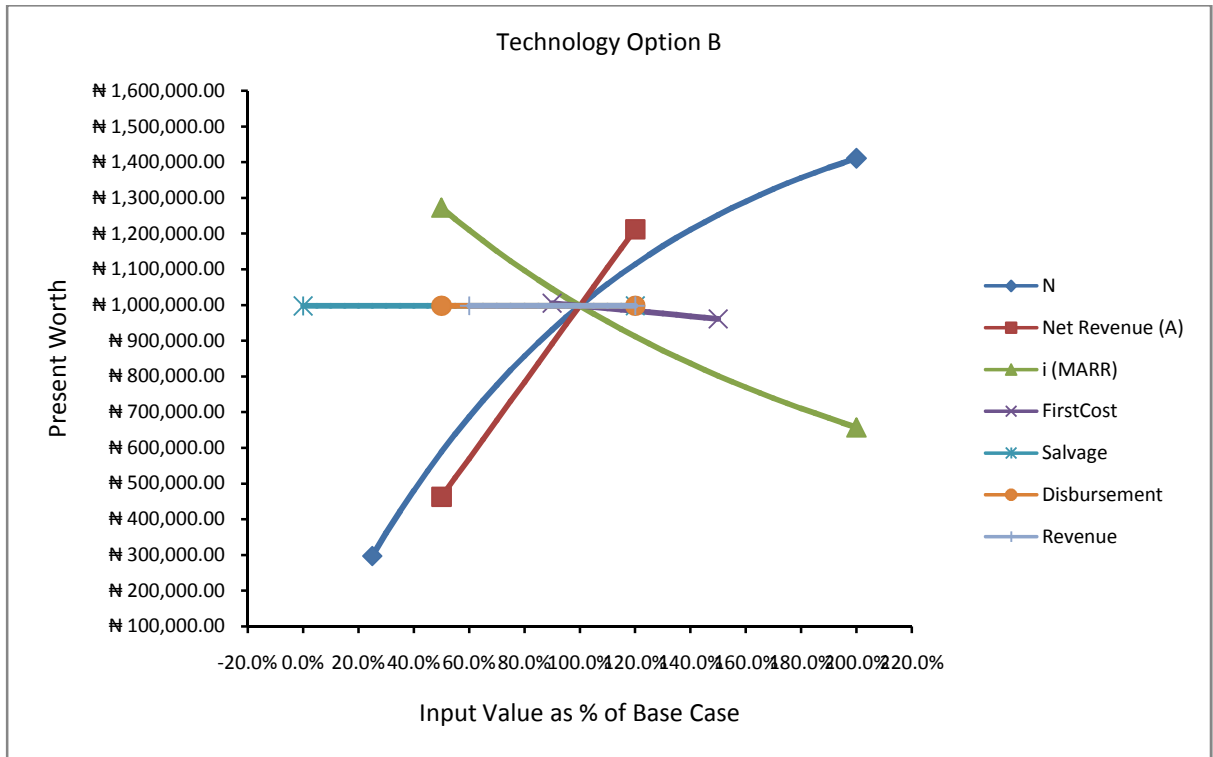


Figure 3: Spider Plot for Technology Option B

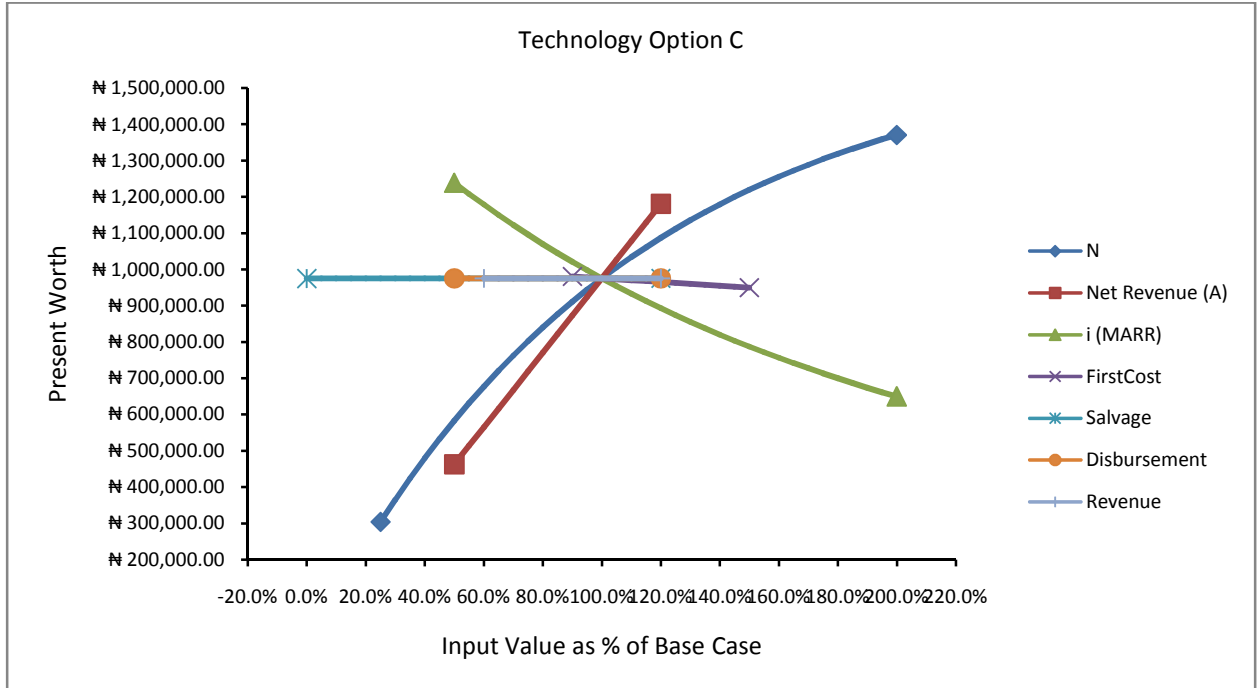


Figure 4: Spider Plot for Technology Option C

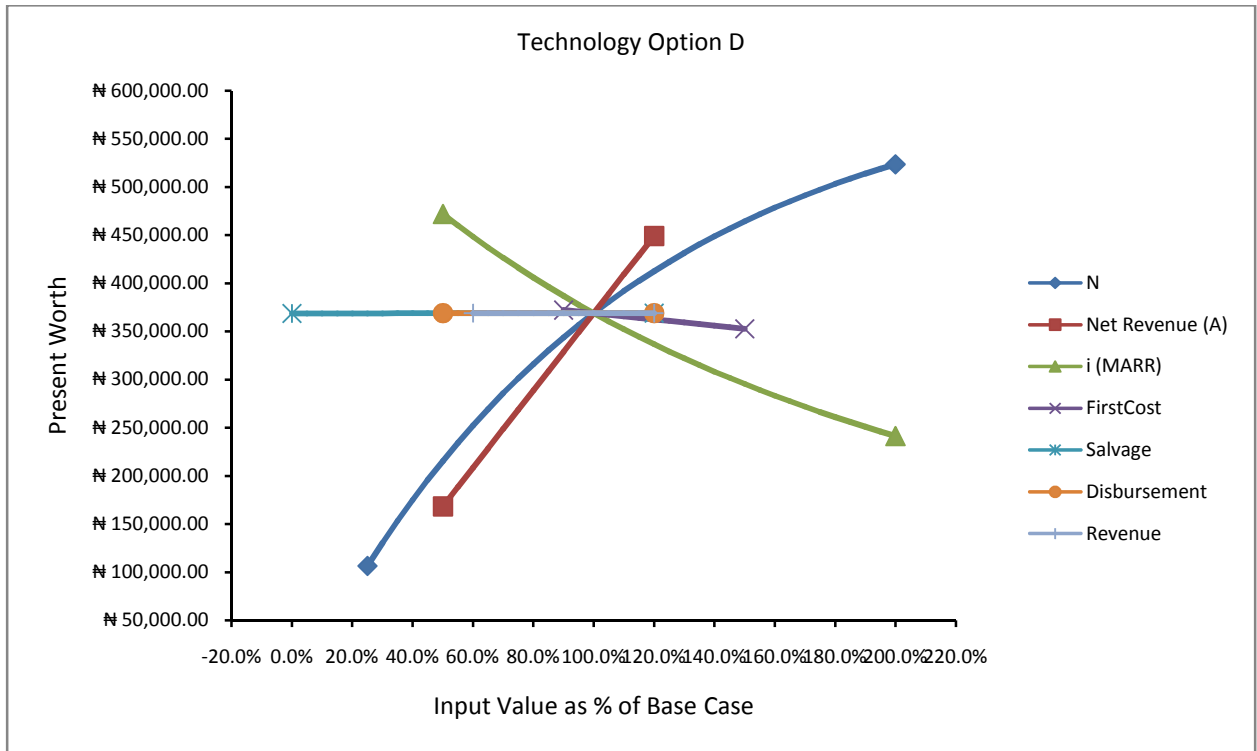


Figure 5: Spider Plot for Technology Option D

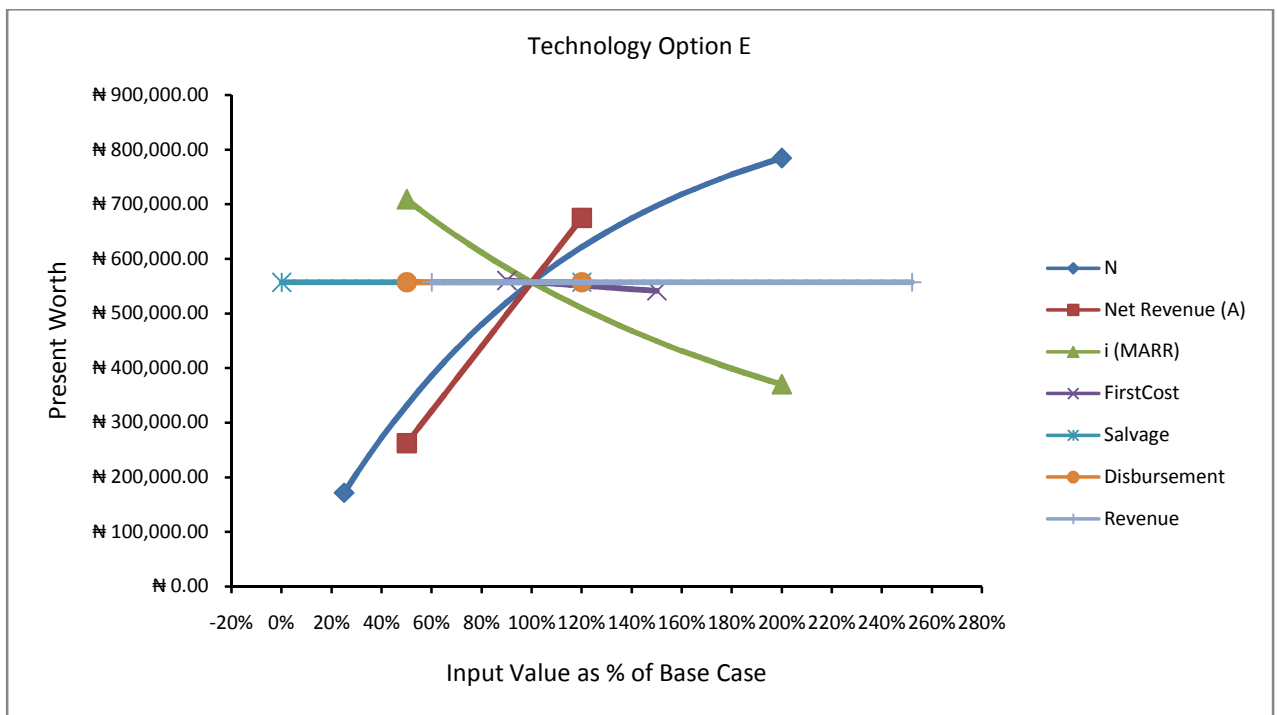


Figure 6: Spider Plot for Technology Option E

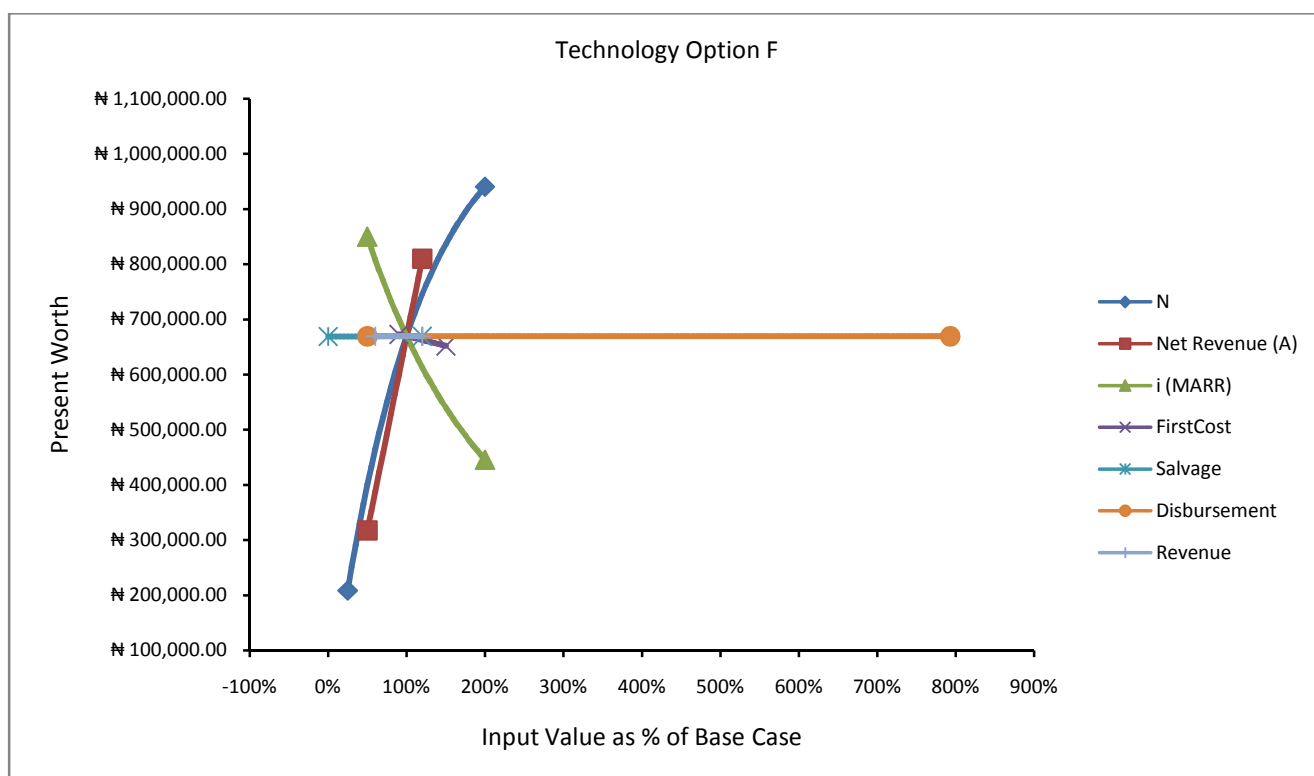


Figure 7: Spider Plot for Technology Option F

3.0 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.

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.

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.

4.2 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.

5.0 References

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