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SEQUENTIAL DEVELOPMENT OF PALM OIL INDUSTRY USING RE-INVESTMENT METHOD FOR SMALL SCALE PRODUCTION FIRM

[1]Imoukhuede, K. A. & [2]Ologunagba, F.O
[1]Department of Mechanical Engineering Technology. Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.
[2]Department of Agricultural and Bio-Environmental Engineering Technology, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.
Email: bidek2@gmail.com, francolog2@yahoo.com

ABSTRACT
A model was developed for sequential development of palm oil industry using re-investment method for a small-scale production firm for sequential procurement of palm oil production facilities based on the expected capacity or demand. The major constraint identified that determined the level of sequential development was demand capacity. Based on this demand capacity, mathematical functions were developed for sequential argumentation in order to determine the optimal period(s) of meeting the expecting demand or capacity based on loan from financial institutions, which are government, bank and co-operative societies. The major indices used in the model were compound interest and periods the loans were taken and redeemed. The objective function was formulated to determine those constraint variables based on optimal periods. Other constraints considered were sales, investment, purchase, operations, layout, maintenance, manpower and packaging cost incurred from the machine introduced. Based on the revenue and cost scenarios, the objective functions were evaluated using interest factors, the interest functions were formulated from the algorithms based on compound interest. The developed model was validated by entering process data of a small scale palm-oil production firm into the model. The expected capacity or demand was met in different periods from the loan recorded from government, bank and cooperative society.

Keywords: Industry, model, palm-oil, re-investment, small-scale

INTRODUCTION

Manufacturing has always been the key to success among nations in the world economy. A responsive manufacturing system working in harmony with the rest of an enterprise has a major impact on its competitiveness; it plays a vital role in the successful introduction of new products or continuous improvement of existing products in response to demands of the market. According to Sharma (2006), manufacturing is said to consists of a series of interrelated activities and operations involving design, material selection, and quality assurance. Ogunkoya and Aderoba (2010) defined small industrial units as industries with limited scale manufacturing operations, producing a product or few products with limited level of employment and investment. Reviewed literature also revealed that small-scale farmers dominate the oil palm industry in most West African countries. In Nigeria, over 70% of the annual production of palm oil are produced by small-scale processors (Ataga et al, 1993; Badmus, 2002; Owolarafe and Oni, 2011).

The process of converting the verbal description and numerical data into mathematical expressions which capture the relevant relationships, goals and restrictions is known as modeling, and the resulting mathematical description is called model (Pike and Guilding, 1994). The study and analysis of physical processes (including most industrial process systems) have geared many researchers such as Cha et al (2000), Aderoba (2001), Offiong (2002), Idris and Aderoba (2002) and Lee (2005) to mention a few, towards model development in various areas of engineering field. It is worthwhile to report that such models have been found to give a very good representation of the various stochastic and deterministic conditions of the process/system been modeled.

In a developing country like Nigeria, most of our palm oil industries are being operated on small-scale and there is the need to develop a model that will lead to the sequential development of the industry using reinvestment method in order to provide a framework for the survival of the small scale industries in a developing economy. Decisions are made during the engineering design phase of this product development. The decision-making processes ranges from the manufacturing to marketing to financing decisions, which will help in the development of the model. The decisions also involve material plant facilities, the in-house capabilities of company personnel and the effective use of capital assets such as buildings and machinery. The major task is the plan for the acquisition of equipment (fixed asset) that will enable the firm to produce products economically, and engineering economic decision involves the investment, which is usually made in a lump sum at the beginning of the project, and there is a stream of cash benefits that are expected to result from the investment over a period of future years.

In such a fixed asset investment, funds are committed in the expectation of earning a return in the future. In the case of a bank loan, the future returns takes the form of interest plus repayment of the principal which is known as the loan cash flow but in the case of the fixed asset, the future returns takes the form of cash generated by productive use of the asset. The representation of these future earnings along with the capital expenditures and annual expenses (such as wages, raw materials, operating costs, maintenance costs and income taxes) is the project cash flow.

Businesses from time to time need to make substantial investments in plant, equipment or buildings. It is often the case that the returns from the new investment will be small relative to the size of the investment, such that several years may elapse before the returns can repay the investment. Thus, the knowledge of percentage returns on investment is essential to determine the most effective use of capital. Therefore a model was developed for sequential development of palm oil industry using re-investment method for a middle-scale production firm for sequential procurement of palm oil production based on the expected capacity or demand.

RESEARCH METHODOLOGY

This research work involve the use of a local palm oil production firm to formulate a model. From the perspective of palm oil production, the processes involved are purchasing of raw material (bunch reception), threshing (removal of fruits from the bunches), sterilization, digestion, pressing, clarification and storage. Though as technology advances, some of the processes and machines used are being modified. All these modifications were dealt with in the model formulation of a palm oil production industry in a developing economy.

When considering the operation of the plant over a periods of time. It is expected that prices and demand of palm oil in various markets would fluctuate over the planning horizon. These fluctuations along with other factors such as new environmental regulations or technology obsolescence might necessitate the decrease or complete elimination of the production of some palm oil, while requiring an increase or introduction of others. Thus, there may be some additional new decisions variables such as capacity expansion of existing processes, installation of new processes, and shutdown of existing processes. Moreover, owing to the broadening of the planning horizon, the effect of discount factors and interest rates will become prominent in the cost and price functions, and thus the planning objective is clear to maximize the net present value instead of the short term profit or revenue.

Model Formulation

Looking at the problem in this assumption that is given. Assuming a given network of processes and palm oil, and characterization of future demands and prices of the palm oil, operating and installation costs of the existing as well as potential new processes, An operational and capacity planning policy that would maximize the net present value can be found.

Indices

i = The set of number of processes (NP) that constitutes the network,
(i = 1--- NP).
j = The set of number of palm oil (NO) that interconnects the processes,
(j = 1 --- NO)
L = The set of number of markets (NM) that are involved
(L = 1 --- NM).
t = The set of number of time periods (NT) of the planning horizon.
(t = 1 --- NT).
m = The set number of machines being maintained (MM)
(M = 1 --- MM).
K = The set number of raw material (RM) for the process
(k = --- RM)

Notations

CMI = cost of machine introduced/installed
CL = Cost of layout
CM = Cost of manpower
COM = Cost of operating machines
CMM = Cost of maintaining machines
COP = Cost of packaging
COT = Cost of transportation
NLS = Number of litre sold
CPL = Cost per litre
VOP = Volume of product produced
NPV = Net present value
INVT = Cost of investment
OPER = Cost model for the operation
SAL = SALES
PURC= Purchase made
COL = Cost of having layout => fixed
COR = Cost of raw material.
NOTE:- CPL :- cost per litre varies depending on the demand

Variables

Eit = units of expansion of process i at the beginning of period t.
Pjlt = units of palm oil j purchased from market i at the beginning of period t.
Qit = total capacity of process i in period t. The capacity of a process is expressed in terms of its main product.
Sjlt = units of palm oil j sold to market l at the end of period t.
Wit = operating level of process i in period t expressed in terms of output of its main product.

Functions

INVTit (Eit) :- The investment model for process i in period t as a function of the capacity installed or expanded.
OPERit (Wit) :- The cost model for the operation of process i over period t as a function of the operating level.
SALEjlt (sjlt) :- The sales price model for palm oil j in market l in period t as a function of the sales quatity.
PURCjlt (Pjlt) :- The purchase price model for palm oil j in market l in period t as a function of the purchase quantity.

Development of The Profit Model

The basic relationship between profit, revenue and cost of any product is as stated below:-

Profit (Loss) = Revenue – Cost
OR

$$NPV = \sum_{t=1}^{t=NT} SAL - \sum_{t=1}^{t=NT} PUR - \sum_{i=1}^{NP} [INVT_{it}] E_{it} - \sum_{i=1}^{NP} [OPER_{it}]$$

where

$$INVT = \sum_{i=1}^{NM} CMI + \sum_{i=1}^{NM} COL + \sum_{t=1}^{NT} CM$$

$$OPER_{it} = \sum_{i=1}^{NM} COM + \sum_{i=1}^{NM} CMM + \sum_{P=1}^{NP} COP + \sum COT$$

$$PURC = \sum_{K=1}^{RM} COR + Transport$$

$$SAL = \sum_{t=1}^{NT} NLS \times CPL$$

Where

Eit = Units of expansion of process I at the beginning of period t.
CMI = Cost of machine introduced/installed
CL = Cost of layout
CM = Cost of manpower
COM = Cost of operating machines
CMM = Cost of maintaining machines
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COL = Cost of having layout => fixed
COR = Cost of raw material.

Algorithm of Profit Reinvestment Model

This model is now subject to the following conditions.

Assumption:- As new machine comes in, to determine reinvestment for the following machine, it i assumed that it is no more having a re-occurrence.

INVT = ϕ (CMI, COL, CM) is subject to the following constraints:-

GOL	=	Government loan
PPY	=	Profit of previous year
LFB	=	Loan from bank
LFC	=	Loan from cooperative society
SFF	=	Sharing formula of factors of funding
SFF	=	f (% PPY; LFB; GOL; LFC) = 1
SFF	=	%(PPY; LFB;GOL; LFC) = 1
CMI	=	ϕ (% (PPY, LFB, GOL, LFC)

Let PPY = P = % profit of previous year
P + 1 = % (PPY + GOL)
P + 2 = % (PPY + GOL + LFB)
P + 3 = % (PPY + GOL + LFB + LFC)
With these notations
CMI, Cost of machine introduced ≤
$\sum$ % (PPY + GOL + LFB + LFC).
AS IN

```
10    IF CMI < P, then re-invest for that year
      with P.
20    IF CMI > P (message: Do you still want
      to continue in re-investment).
30    Next P + 1
40    IF CMI > P + 1
50    Next P + 2
60    IF CMI > P + 2
      Next P + 3
70    Checkbox will be introduced
      CHECKBOX ⇒ Compare
      CMIp+1 with VOP ≤ Q Litres
      VOP = Volume of products
      Qlitres = Quantity to be produced
80    IF @ P + 1, VOP ≤ Q litres
      Go To 50 ELSE 110
90    Next P
100   Go To 80 ELSE 110
110   STOP
```

For condition PPY = P ⇒ Profit of previous year. This is subject to the following model

Let i = interest rate
t = time (no of years) = n
b = amount (principal)
when t = 1 then it implies b =

$$X^{t=1} = b \quad \ldots\ldots\ldots \quad (1)$$

2^{nd} year t = 2

$$X^{t=2} = b + bi \quad \ldots\ldots \quad (2)$$

3^{rd} year, when t = 3

$$X^{t=3} = b\,(1+i) + i\,[\,b(1+i)] \quad \ldots(3)$$
$$= b\,(1+i)\,(1+i)$$
$$= b\,(1+i)^2$$
$$t_1 = b\,(1+i)$$
$$t_2 = b\,(1+i)^2$$
$$t_3 = b\,(1+i)^3$$
$$t_4 = b\,(1+i)^4$$
$$t_5 = b\,(1+i)^5 \quad \ldots\ldots\ldots \quad (4)$$

Therefore,

$$t_n \Rightarrow F = b\,(1+i)^n \quad \ldots\ldots \quad (5)$$

On a general note the general formula is

$$X^1 = L + PPY \quad \ldots\ldots \quad (6)$$

Where

X^1 = amount to be invested
L = Loan

PPY = Profit of the previous year including interest generated in the bank.

The Loan can be categorize into three
Which are (i) Government loan
(ii) Loan from bank
(iii)Loan from individual (cooperative society).

A. Loan Modeling

The model for the loan will be same but the interest rate will differ.

The model for the loan is deduced below

Amount given At n=1 is

$$a = \frac{LR}{N} + L = L(\frac{R}{N} + 1) \quad \ldots\ldots \quad (7)$$

Amount given at n=2 will be

$$b = \left[(\frac{LR}{N} + L)\frac{R}{N}\right] + (\frac{LR}{N} + L) \quad \ldots(8)$$

$$b = a(\frac{R}{N} + 1)$$

Amount given at n=3 is

$$c = \frac{bR}{N} + b = b\,(\frac{R}{N} + 1) \quad .....(9)$$

Amount given at n= 4

$$d = \frac{CR}{N} + C = C\,(\frac{R}{N} + 1) \quad ....(10)$$

Where L = loan, R = Rate, N = No of years

$$i = \text{interest} = \frac{LR}{N}$$

When N = 1

$$a = L\,(\frac{R}{N} + 1)$$

When N = 2

$$b = \frac{LR^2}{N^2} + \frac{LR}{N} + \frac{LR}{N} + L$$

$$b = \frac{LR^2}{N^2} + \frac{2LR}{N} + L \quad ....(11)$$

$$b = L[\frac{R^2}{N^2} + \frac{2R}{N} + 1]$$

When N = 3

$$C = L\left(\frac{R^2}{N^2} + \frac{2R}{N} + 1\right)\frac{R}{N} + L\left(\frac{R^2}{N^2} + \frac{2R}{N} + 1\right)$$

$$C = \frac{LR^3}{N^3} + \frac{2LR^2}{N^2} + \frac{LR}{N} + \frac{LR^2}{N^2} + \frac{2LR}{N} + L \quad ...(12)$$

$$C = L\left(\frac{R^3}{N^3} + \frac{3R^2}{N^2} + \frac{3R}{N} + 1\right)$$

$$C = L\left(\frac{R^3}{N^3} + \frac{3R^2}{N^2} + \frac{3R}{N} + 1\right)$$

When N = 4

$$d = L\left(\frac{R^3}{N^3} + \frac{3R^2}{N^2} + \frac{3R}{N} + 1\right)\frac{R}{N} + L\left(\frac{R^3}{N^3} + \frac{3R^2}{N^2} + \frac{3R}{N} + 1\right)$$

$$d = \frac{LR^4}{N^4} + \frac{4LR^3}{N^3} + \frac{4LR^2}{N^2} + \frac{4LR}{N} + L \quad .... (13)$$

$$d = L\left(\frac{R^4}{N^4} + \frac{4R^3}{N^3} + \frac{4R^2}{N^2} + \frac{4R}{N} + 1\right)$$

Therefore the amount in N^{th} year will be

$$N^{th}\ year = L\left(\frac{R^n}{N} + \frac{NR^{n-1}}{N^{n-1}} + \frac{NR^{n-2}}{N^{n-2}} + \frac{NR^{n-3}}{N^{n-3}} + \cdots \frac{NR^{n-(n-1)}}{N^{n-(n-1)}} + 1\right)$$

VALIDATION OF THE MODEL

In order to effectively implement the developed model, two-production cycle times were considered on yearly basis. i.e. when the production took place when no machine packaging cost were introduced i.e. starting from the cradle and also when machines, packaging cost and also some developments were introduced. The above sample scenarios were considered using the manual approach and the developed software.

Profit Computation using Manual Approach

Year I

i. A one man business
ii. Starting from cradle
i. Bought raw materials
ii. No machine used
iii. Use mortar and pestle

For each production, assumptions are made for the value used

Lets assume that mortar and pestle = ₦500
Raw material = ₦10,000
Transportation for the raw material = ₦200
Fire wood = ₦50
Pounding / Firewood braking = ₦100
Raw material purchased = 10,000kg.
For each processes of product ⇒ 10,000kg = 1,000 litres of palm oil.

Solution Procedures

$$INVT = \sum_{i=1}^{NM} CMI + \sum_{i=1}^{NM} COL + \sum_{i=1}^{NT} CM$$

CMI = cost of machine introduced/installed = ₦500
COL = Cost of Layout:- since it is from the cradle there is no layout.
COL = 0
CM = Cost of Manpower:- this is the cost used for the firewood = ₦150
INVT = ₦[500 + 0 +150] = ₦ 650
Eit = 0

$$OPER_{it} :- \sum_{i=1}^{NM} COM + \sum_{i=1}^{NM} CMM + \sum_{p=1}^{NP} COP + \sum COT$$

COM = Cost of Operating Machines:- the cost used in pounding/breaking the firewood = ₦200.
CMM:- Cost of Maintaining the Machines:- since it is from the cradle there is no machine maintenance = 0

COP:- Cost of Packaging:- No packaging method is introduced from the cradle = 0

COT:- Cost of Transportation = ₦200.

OPER = ₦ (200 + 0 + 0 + 200) = ₦400.

$$PURC:- \sum_{k=1}^{RM} COR + Transport$$

COR:- Cost of Raw material = ₦10,000

Transportation = ₦200

PURC = ₦(10,000 + 200) = ₦10,200

$$SAL = \sum_{t=1}^{NT} NLS \times CPL$$

NLS = Number of litre sold = 800litres were sold.

(Assumption) out of 1000litres produced from palm oil.

CPL = Cost per litre:- we assume ₦50 per litre i.e. CPL = ₦50/litre

SAL = [800 X ₦50] = ₦40,000

$$NPV = \sum_{t=1}^{t=NT} SAL - \sum_{t=1}^{t=NT} PUR - \sum_{i=1}^{NP} INVT_{it}]E_{it} - \sum_{i=1}^{NP}[OPER]_{it}$$

NPV = (-650 x 0) –400 + 40,000 – 10,200

NPV = ₦ (- 400 + 29,800)

NPV = ₦ 29,400

= GAIN

The following machines will be taken into consideration:

i. Palm fruit extractor
ii. Palm kernel press
iii. Oil extracting machine
iv. Boiler
v. Separating machine/Refinery machine

These machines are source locally and the cost of varies depending on the manufacturer. The average cost of each are given below:

i. Palm fruit extractor – ₦ 40,000
ii. Palm kernel press - ₦ 70,000
iii. Oil extraction machine - ₦ 150,000
iv. Boiler - ₦ 75,000
v. Separation machine/Refinenary machine = ₦ 90,000

In the first year the profit made is ₦ 29,400. This profit is not enough to buy any of the available machines. Therefore, the money has to be reinvested.

30% of the (NPV) profit will be used for the maintenance of the process or the industry.

$$\frac{30}{100} \times ₦29,400$$

= ₦ 8820

The remaining profit will be reinvested

= ₦29,400 - ₦ 8,820

= ₦ 20,580

Since CMI cost of machine installation is greater than the profit of the previous year then reinvest by going to (P + 1) which indicate that loan can be collected Government. The Government gives loan to small - k scale industry.

P + 1 = (PPY + GOL)

P + 1 = (Profit of previous year + Government loan)

Let us assume that the Government loan = ₦ 30,000

P + 1 = ₦ (20,580 + ₦ 30,000)

P + 1 = ₦ 50,580

Year II

$$NPV = \sum_{t=1}^{t=NT} SAL - \sum_{t=1}^{t=NT} PUR - \sum_{i=1}^{NP}[INVT_{it}]E_{it} - \sum_{i=1}^{NP}[OPER_{it}]$$

Capital = ₦ 50,580

Mortar and Pestle is been eliminated by the purchase of palm fruit extractor at the rate of ₦ 40,000.

For each production, assumptions are made for the value used

Palm fruit extraction = ₦ 40,000

Raw material = ₦ 20,000

Transportation for the raw material = ₦ 2,000

Firewood = ₦ 10,000

Firewood breaking = ₦ 500

Cost of operating the machine = ₦ 1000/month

Raw material = 15,000kg

For each processed of product ⇒ 15,000kg

= 15,000litres of palm oil.

Solution Procedures

$$INVT = \sum_{i=1}^{NM} CMI + \sum_{i=1}^{NM} COL + \sum_{i=1}^{NT} CM$$

CMI = cost of machine introduced/installed = ₦40,000

COL = Cost of Layout:- ₦5,000

CM = Cost of Manpower:- this is the cost used for the firewood

= ₦1000/month

= ₦1000 X 12 = ₦12,000 per annum

INVT = ₦[40,000 + 5,000 +12,000] = ₦ 52,000.

$E_{it} = 1$

$$OPER_{it} :- \sum_{i=1}^{NM} COM + \sum_{i=1}^{NM} CMM + \sum_{P=1}^{NP} COP + \sum COT$$

COM = Cost of Operating Machines = ₦12,000

the cost used in pounding/breaking the firewood = ₦500.

= ₦12,500

CMM:- Cost of Maintaining the Machines:- assumed to be ₦200 per month for maintenance = ₦2,400

COP:- Cost of Packaging:- = ₦1,000

COT:- Cost of Transportation = ₦1,000.

OPER = ₦ (24,000 + 2,400 + 1,000)

= ₦28,400

$$PURC = \sum_{k=1}^{RM} COR + Transport$$

COR:- Cost of Raw material = ₦20,000

Transportation = ₦2,000

PURC = ₦(20,000 + 2,000) = ₦22,000

$$SAL = \sum_{t=1}^{NT} NLS \times CPL$$

NLS = Number of litre sold = 5,000litres were sold. (Assumption) out of 6,500litres produced from palm oil.

CPL = Cost per litre:- we assume ₦65 per litre

i.e. CPL = ₦65/litre

SAL = [5000 X ₦65] = ₦325,000

$$NPV=\sum_{t=1}^{t=NT}SAL-\sum_{i=1}^{t=NT}PUR-\sum_{i=1}^{NP}[INVT_{it}]E_{it}-\sum_{t=1}^{NP}[OPER_{it}]$$

NPV = (-57,000 x 1)–28,400 + 325,000 – 22,000

NPV = ₦ 217,600

Since CMI > P + 1

We now go to P + 2 that is

P + 2 = [PPY + GOL + LFB]

(The iterative process continues depending on the duration of investment)

DISCUSSION

In the course of the analysis, several techniques for the introduction of machines and other equipment of a production system were highlighted in order to meet the expected capacity output or demand. The overall procedure entails introducing profit from the previous year, loans from Government, bank and cooperative society into the model so that the expected capacity output can be met. These results from the model are depicted in the profit computation using manual approach in year I and year II respectively.

The result on year I shows that for the input parameter when the company purchases a fixed asset such as equipment, it makes an investment and through this investment, funds have been committed in the expectation of returns. However, it wis evident from above that the more machines introduced, the more expected capacity output or demand increases.

The results on year I and year II show that as more capital are reinvested in the business through the collection of loans from bank, Government and cooperative society, more machines or equipment are purchased and this really help in the target i.e. the expected capacity output or demand are met on the long run.

CONCLUSION

The development of a model for the sequential development of palm oil industry in a small scale is very essential. A major reason being that through the introducing of loan and profit acquired from the previous year. The expected capacity output or demand is met and because of the need to keep initial capital investment to a bare minimum, it is imperative that un-necessary mechanized unit operations are eliminated. Work that can be done manually without overly taxing profitability should be, thereby taking advantage of surplus labour and creating a stream of wages and salaries in the local community.

RECOMMENDATIONS

Sequential development of palm oil industry in a small scale using reinvestment method for economical and qualitative production and for the expected capacity to be met by using this type of model developed will sustain her for profitability in the short run and eventually sustain her for profitability and competitiveness in the long run. It is therefore recommended that having operation model for production is not enough to meet the expected capacity or demand. Other factors besides cost of raw materials and cost of labour, machines introduced that increase the total cost of production needs to be taken care of in location of an industry. For instance, prime mover power is a major consideration as most villages do not have electricity and hence the diesel engine is the main source of power. Thus, the cost and maintenance of this power source would eliminate most small-scale processors.

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