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Development of Motor Driven Banana Chipper

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ABSTRACT

This study was conducted to design and fabricate a motor-driven banana chipper, and evaluate the chipping performance variability of the fabricated machine.

Performance evaluation was based only on its capacity in kg/hr with thickness requirement of 2 to 3mm and the chips must be whole and relatively uniform. The developed machine was tested three times using 10 kilograms of banana per trial. The machines' viability was assessed using measures of project worth such as payback period and return on investment (ROI).

Performance evaluation revealed that the chipping capacity of the developed chipper is ranging from 240 to 260 kg/hr which is higher than that of the existing chippers that has a capacity between 100 to 160 kg/hr only.

Investment analysis also showed that the machine is viable. The total fabrication cost is P32,313.00 and the return on investment and payback period is 362.53 % and 3.3 months respectively.

Keywords: banana chipper, chipping capacity, motor-driven banana chipper

INTRODUCTION

The demand of processed or semi-processed banana chips for local and for export consumption is still growing and has a very large market (Ediindia.org, 2007). In the world market, the Philippine banana chips is one of the most sought after edible goods because of its nutritional value Thus, banana chips has a bright potential in the international market. However, the international market requires strict compliance to quality standards, thus the banana chips industry must continually improve product quality by improving processing equipment to sustain the growth of banana chips industry.

Most of the banana chips entrepreneurs still use the manual method because of the absence of low-cost, locally available and efficient chipping machine. Existing foreign-invented chipping machines are very expensive, difficult to acquire, with low efficiency chipping performance. On the other hand, the manual process is low in capacity, very tedious & labor intensive, not safe to operator and results to inconsistent chip thickness. Hence, a motor-driven banana chipper is designed to address these problems.

METHODOLOGY

The resources used in developing the motor-driven WPU banana chipper and their corresponding cost are shown in Table 1.

Table 1. Investment cost of developing the WPU banana chipper.

Item	Quantity	Unit	Unit Price (Php)	Total Price (Php)
Materials:				
1 Gauge # 16 stainless sheet	1/6	sheet	8000.00	1,333.00
Gauge # 22 stainless sheet	1.5	sheet	5000.00	7,500.00
11/2 x 1 1/2 x ¼" angled bar	4	length	600.00	2,400.00
Stainless knife	2	pc	300.00	600.00
1" ǿ solid steel shafting	3	ft	250.00	750.00
½ hp, capacitor start, single phase electric motor	1	unit	5500.00	5,500.00
1" ǿ pillow block bearing	2	pc	600.00	1,200.00
1" x 2" ǿ Type B, single pulley	1	pc	250.00	250.00
1" x 3" ǿ Type B, single pulley	1	pc	350.00	350.00
1" x 8" ǿ Type B, single pulley	1	pc	500.00	500.00
40" Type B, V-belt	1	pc	400.00	400.00
44" Type B, V-belt	1	pc	500.00	500.00
1" x 3/1/4" stainless bolt w/ nut	40	pc	15.00	600.00
¼" x 1" rivets	1	box	600.00	600.00
Ordinary welding rod	5	kg	90.00	450.00
Switch	1	pc	300.00	300.00
Wire	7	m	40.00	280.00
Automotive paint	1	qt	400.00	400.00
Rust converter	1	qt	400.00	400.00
Sub-total				24,313.00
Labor				8,000.00
INVESTMENT COST				**31,313.00**

Design Considerations

The design criteria used in the development of the machine are the following:

1. The machine parts should be available locally.
2. Machine is durable and economical.
3. The machine can be fabricated in local machine shops.
4. Higher chipping capacity and chipping efficiency than the existing machines used in the country.
5. Safe and easy to operate.
6. Easy maintenance and operation.
7. Adjustable blade height and replaceable

Target Design Features

Chipping Capacity	:	250 – 300 kg/hr
Prime Mover	:	½ hp single phase electric motor
Number of operator	:	1 or 2
Transmission system	:	belt and pulley
Chips thickness	:	set at standard 2 to 3 mm (adjustable)
Number of inlet hoppers	:	12
Blade	:	2 pieces, stainless blade
Chipping disk	:	20" diameter, made of stainless
Length	:	0.95 m
Width	:	0.8 m
Approximate weight	:	30 kg
Frame	:	1 ½" x 3/16" angled bar
Inlet and outlet hopper, side & top cover	:	Stainless sheet

Fabrication

Prior to fabrication. a detailed drawing was first made as to the design considerations. It was constructed by the following order of activities; a) the frame, b) chipping assembly, c) inlet and outlet hoppers, d) transmission system, and e) cover.

Machine Description

The designed chipper is generally a cabinet type (Figure 1). Its height is 0.9 meters while its length and width is 1 m and 0.5 m, respectively. The frame is made up of angular bars. The chipping disk consists of two stainless blades arranged radially. There are 12 hoppers with 6.3 cm and 5.1 cm diameters size. These hoppers and the cover are made of stainless sheets. Its transmissions system consists of belts and pulleys and is driven by a ½ hp electric motor.

Fig. 4. The motor-driven WPU banana chipper.

Evaluation and Testing

The designed chipper was pre-evaluated to determine the right blade orientation, blade sharpening angle and the optimum angular speed of the chipping disk that give the best chips quality that meet the standard chips requirement. The thickness requirement is between 2 to 3 mm, must be whole and the cut surface must be smooth according to the Banana Chips Processors Cooperative in Maligaya, Aborlan, Palawan.

Chipping capacity, average thickness, and the relative chipping efficiency were the factors considered in the test. Three trials with ten kilograms per trial were used. The following formulas were used in the testing and evaluation:

1. Chipping capacity, C

$$C = \frac{W}{T}$$

Where;

W = weight of chips, kg
T = time spent in chipping, hr
C = capacity, kg/hr

2. Average thickness, T_a

$$T_a = \frac{T_t}{S}$$

Where;

T_t = total thickness, mm
S = number of samples

Data Analysis

The chipping performance of the developed banana chipper was evaluated by comparing its chipping capacity to existing banana chipper.

Measures of project worth were used to determine the viability of the designed chipper. This includes the determination of the total cost (fixed and variable), gross and net income and the computation of payback period and the rate of return on investment (ROI).

The following assumptions and formula are used in the analysis.

Assumptions:

1. Operation : 6 hours/day
2. Capacity: 360,000 kg/yr
3. Price of pulp: P0.50/kg
4. Labor Cost: P200.00/day
5. Repair and Maintenance: 5% of Original Cost
6. Depreciation method: Straight line method
7. Life Span: 10 years
8. Salvage Value: 10% of Original Cost
9. Rent from machine use: P 0.50/kg
10. Interest on Capital: 20 % of Original Cost

Formulas:

Fixed cost = $D + I$

Where:

D = depreciation
I = interest on investment

Variable cost = $F+L+M+O$

Where:

F = fuel/electricity
L = labor
M = maintenance
O = lubricants

Total cost = Fixed cost + Variable cost
Gross income = Capacity x Price of pulp
Net income = Gross income – Total cost
Payback period = Purchase cost / Net income
Return on investment = Annual Net Income / Total investment

RESULTS AND DISCUSSION

Machine Performance

The machine capacity is ranging from 240 to 260kg/hr and an average of 251.63 kg/hr as shown in Table 2. The chips qualities met the standard requirement with thickness ranging from 2 to 3 mm, whole chip and relatively uniform.

Table 2. Chipping capacity (kg/hr) of the banana chipper

Trial	Chipping Capacity(kg/hr)
1	258.8
2	245.4
3	250,7
Total	754-9
Mean	251.63

Comparative Performance

As shown in Table 3, the fabricated chipper showed better chipping performance compared to the existing banana chippers. The BS banana chipper, which is foreign-invented and next in rank, is still significantly lower in capacity than the new one. It has the same power source, a 1/2 hp electric motor. It is followed by the Agustin Banana chipper which has a capacity ranging from 100 to 130 kg per hour. The Nayre chipper and manual method have nearly similar capacity of 12-16 kg/hr and 8-12 kg/hr, respectively. The table shows that the developed chipper is more efficient than other existing banana chippers.

Table 3. Capacities of banana chippers (kg/hr)

Chipper	Capacity (kg/hr)
Developed Machine	240-260
BS Banana Chipper	140-160
Agustin Banana Chipper	100-130
Nayre Banana Chipper	12-16
Manual Chipping	8-12

Investment Analysis

The net income per year amounted to P 117,144.60. The return on investment and payback period is 362.53 percent and 3.3 months payback period respectively (Table 4). The analysis reveals that the machine is viable and quickly recoups cost of investment.

Table 4. Economic analysis of the designed chipper

Particular		Value (Php)
I. Investment Cost		32,313.00
Materials	24,313.00	
Labor	8,000.00	
II. Annual Operational Cost		
A. Fixed Cost		9,370.77
Depreciation	2,908.17	
Interest	6,462.60	
B. Variable Cost		53,484.63
Labor	48,000.00	
Repair and Maintenance	1,615.65	
Electricity	3,222.72	
Lubricant	646.26	
III. Volume of chips per year	360,000 kg/yr	
IV. Gross Income (at P0.50/kg)		180,000.00
V. Net Income		117,144.60
VI. Return on Investment		362.53 %
VII. Payback Period		0.27 yr or 3.3 months

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