



Development of Improved Compact Cornmill for White Corn

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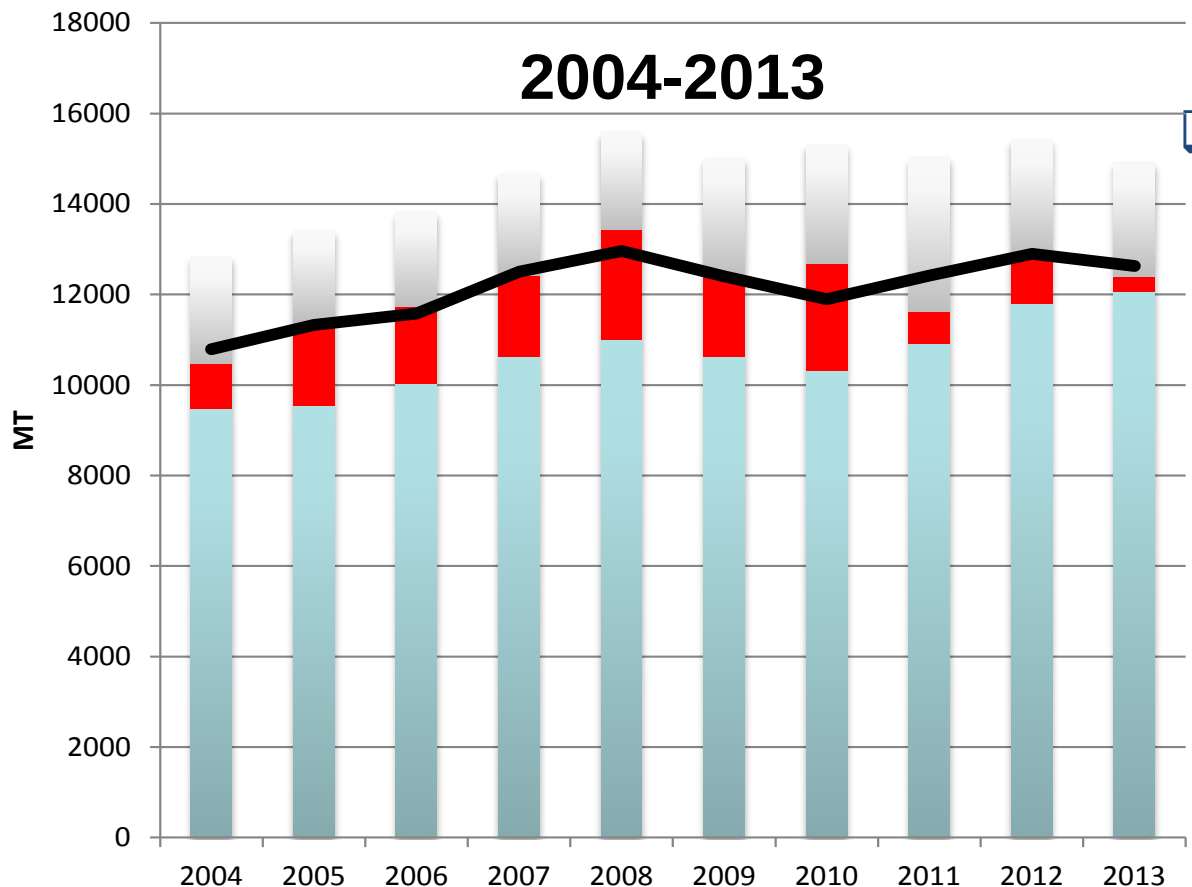
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Department of Agriculture, Philippines**



❑ Rice is the food staple for about half of the world's 7 billion people. Around 90% of the rice produced is consumed in Asia, home to more than two-thirds of the world's poor and hungry.



❑ Rice is thinly traded in the world market, accounting for only around 6% of the total world production in 2010.



The Philippines is the 8th largest rice producer in the world, accounting for 2.8% of global rice production. However, the Philippines was also the world's largest rice importer in 2010.

Sufficiency Levels (%)	81.9	85.8	81.3	93.9	92.1	97.2
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■ Production
 ■ Imports
 ■ Beginning Stocks
 — Total Demand



- ❑ The population of the Philippines is estimated at 97 million. Its annual growth rate of around 2% – among the world's highest.
- ❑ Philippine population: 97million (2010)



- ❑ The government aggressively implemented the **Food Staple Sufficiency Program** in 2010 to increase rice production, maintain per capita consumption of rice and **increase consumption** of other staple foods such as **CORN**.

IMPORTANCE OF WHITE CORN



White corn serves as main food staple of about 15% of the total population (mostly in major islands of Visayas and Mindanao) in the form of corn grits.



❑ The poor quality of corn grits is one of the major causes of the diminishing consumption of white corn in the country from 20% in 1980s to 15% of the total population nowadays.

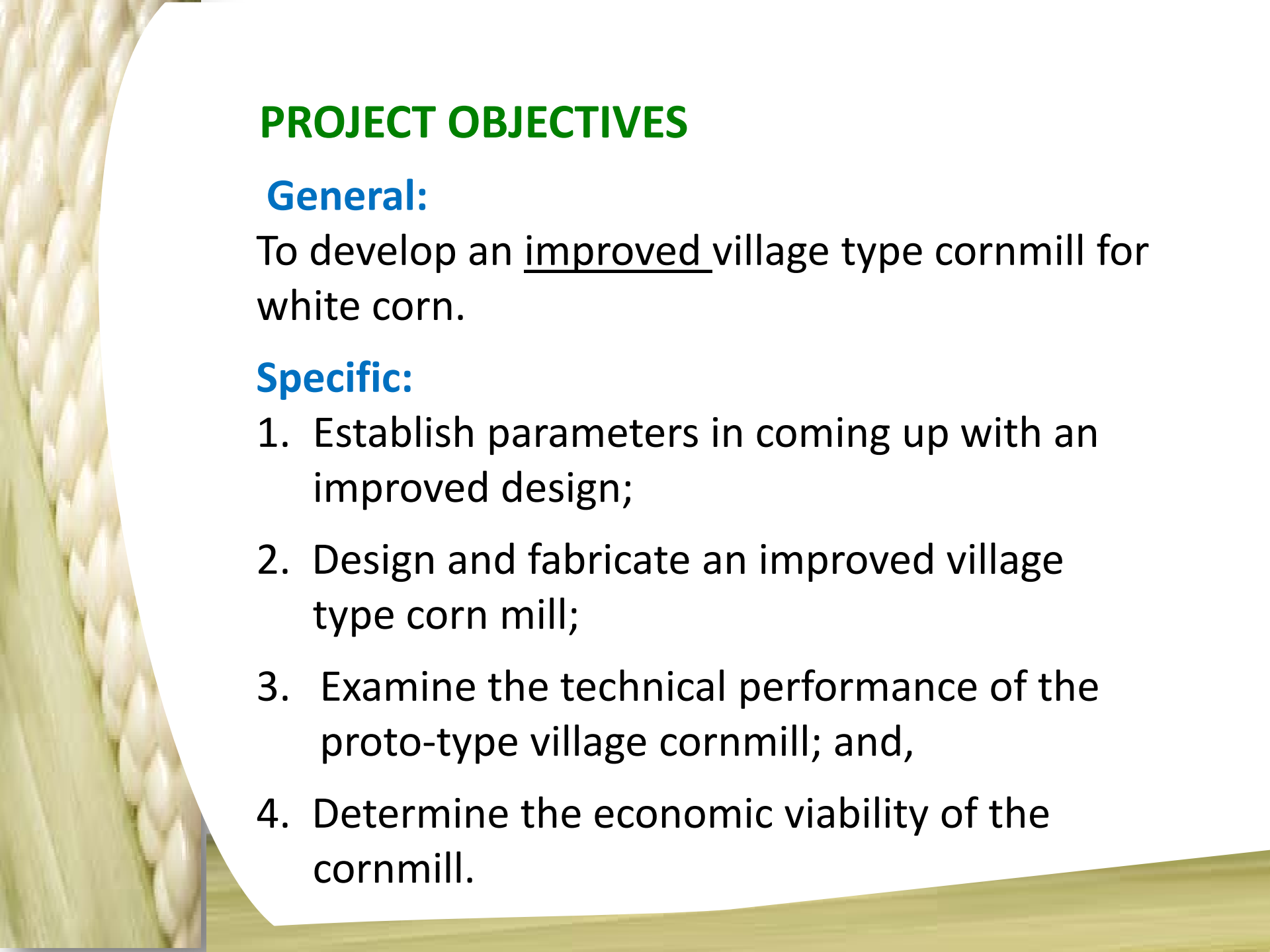


❑ The poor quality of corn grits can be attributed to the **poor performance of available corn mill in the country.**





Why there is a need to develop
a village-type corn mill?



PROJECT OBJECTIVES

General:

To develop an improved village type cornmill for white corn.

Specific:

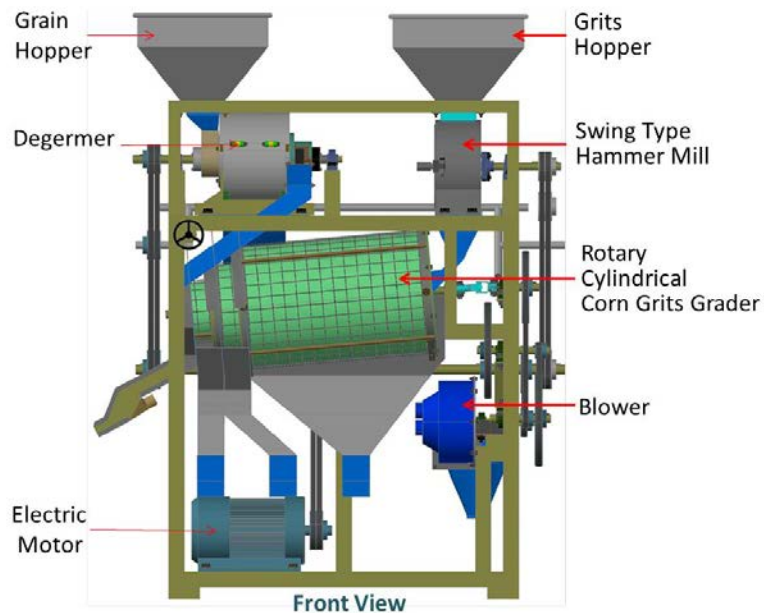
1. Establish parameters in coming up with an improved design;
2. Design and fabricate an improved village type corn mill;
3. Examine the technical performance of the proto-type village cornmill; and,
4. Determine the economic viability of the cornmill.

METHODOLOGY

**Evaluated the
Performance of
Existing Cornmills**



METHODOLOGY



**Came up with a
New Design of
Village-Type
Cornmill**

METHODOLOGY



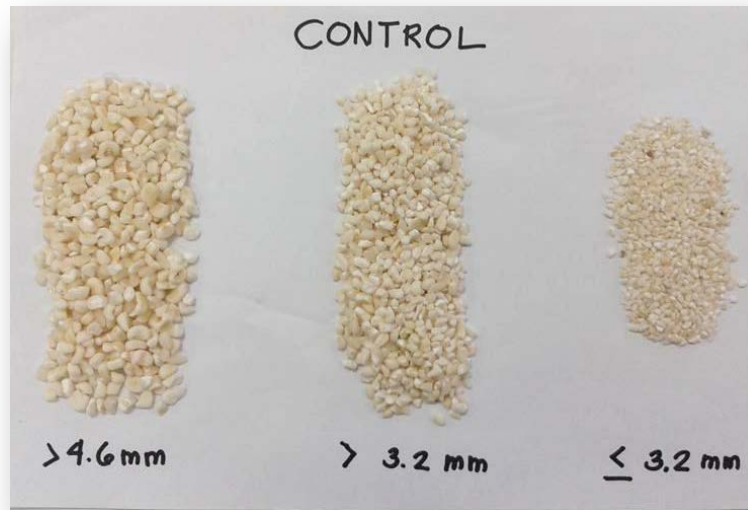
**Fabricated the
Prototype Unit**

METHODOLOGY



**Subjected the
Prototype Unit to
Laboratory Tests**

METHODOLOGY



**Conducted Physical
Analysis on the
Output of the
Prototype Unt**

METHODOLOGY



**Modified/
Improved the
Design to Achieve
the Desired Output**

METHODOLOGY



**Subjected the
Prototype Unit to
Field Testing**

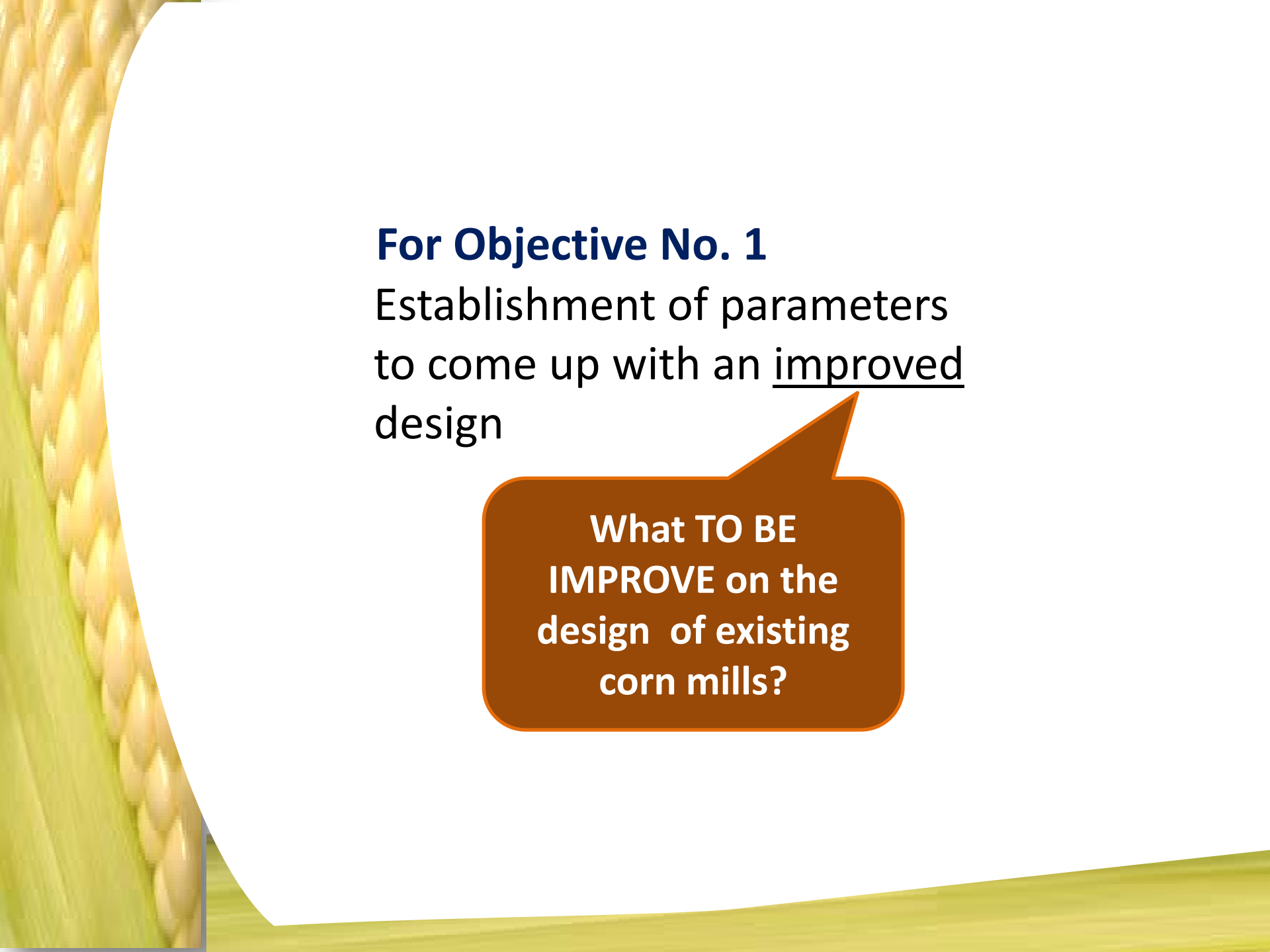
METHODOLOGY



**Modified/
Improved the
Design to Achieve
the Desired Output**



RESULTS



For Objective No. 1

Establishment of parameters
to come up with an improved
design

**What TO BE
IMPROVE on the
design of existing
corn mills?**

Results of performance evaluation of commercial village cornmill

Type of Cornmill	Input Cap. (kg/h)	Output Cap. (kg/h)	Main Product Rec. (%)	Degermination E. (%)
A	109.70	29.71	54.80	87.79
B	121.75	13.06	24.80	85.70
C	65.06	14.55	64.70	50.65
D	69.88	14.51	67.80	56.22

1st Design Consideration

Lower than 64%



Low milling recovery



High postharvest losses



Lower supply of corn grits in the market



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com

2nd Design Consideration

evaluation of commercial village

Type	Main	Degermi-	Labor	Power/fuel
Cor				

Lower than 80%



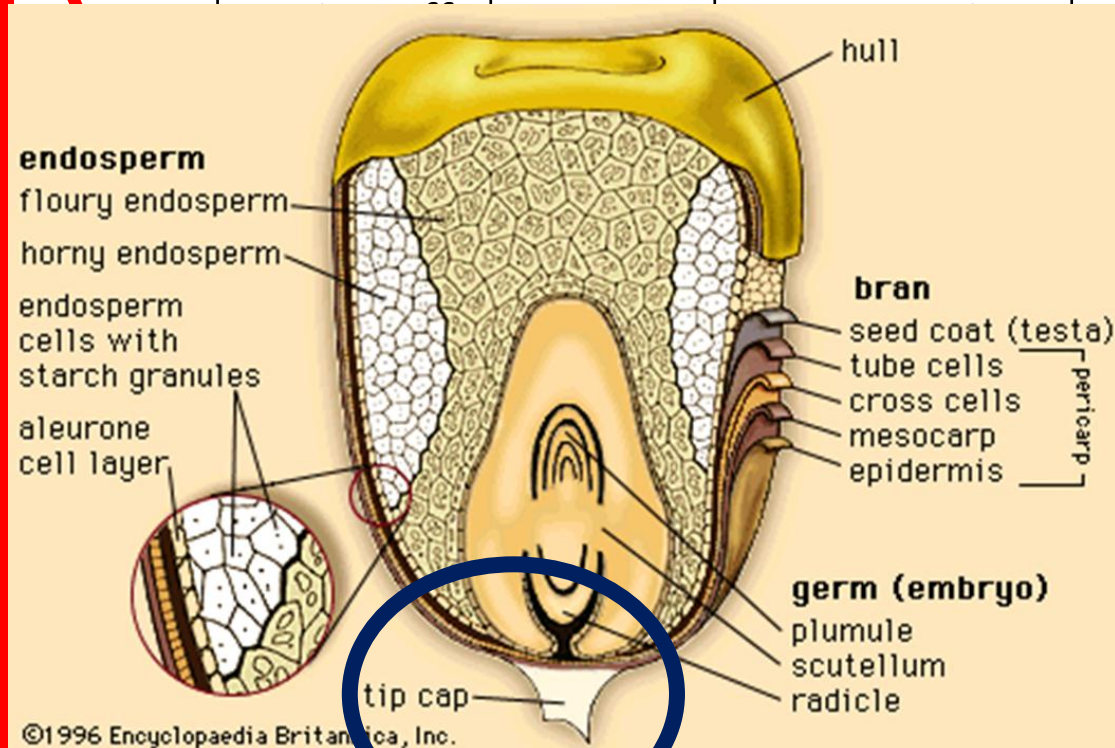
High presence of
Impurities
(tip cap, hull & germ)
in the corn grits



Displeasure
on the part of
consumers to eat
corn



Shift to rice



Results of performance evaluation of commercial village cornmill

Type of Cornmill	Input Cap. (kg/h)	Output Cap. (kg/h)	Main Product Rec. (%)	Power/fuel consumption
A	109.70	29.71	54.80	L/h diesel
B	121.75	13.06	24.80	3.06 kW/hr
C	65.06	14.55	64.70	L/h diesel
D	69.88	14.51	67.80	L/h diesel

**3rd Design
Consideration**

**Low output
capacity of
existing
cornmills**



Results of performance evaluation of commercial village cornmill

Type of Cornmill	Input Capacity (kg/hr)
A	109
B	121
C	65
D	69

4th Design Consideration

High production cost per kg output of corn grits due to low output capacity of village-type corn mill

Assumptions:

Output Capacity (kg/hr)	29.7
Product Recovery (%)	54.8
Diesel Consumption (li/hr)	1.32
Labor Requirement	1
Operating hours/day (hr/day)	8
Wage Rate (Peso/day)	200

Operating Cost Per Kg Output

Labor Cost	0.84
Fuel Cost	2.00
Total Cost	2.84



Results of performance evaluation of commercial village cornmill

Type of Cornmill	Input Cap. (kg/h)	Output Cap. (kg/h)	Main Product Rec. (%)	D
A			30	
B			30	
C			70	
D			30	

5th Design Considerations

How small is a village-type cornmill to become viable?

Assumptions:	
Output Capacity (kg/hr)	29.7
Product Recovery (%)	54.8
Diesel Consumption (li/hr)	1.32
Labor Requirement	1
Operating hours/day (hr/day)	8
Wage Rage (Peso/day)	200
Operating Cost Per Kg Output	
Labor Cost	0.84
Fuel Cost	2.00
Total Cost	2.84



6th Design Consideration

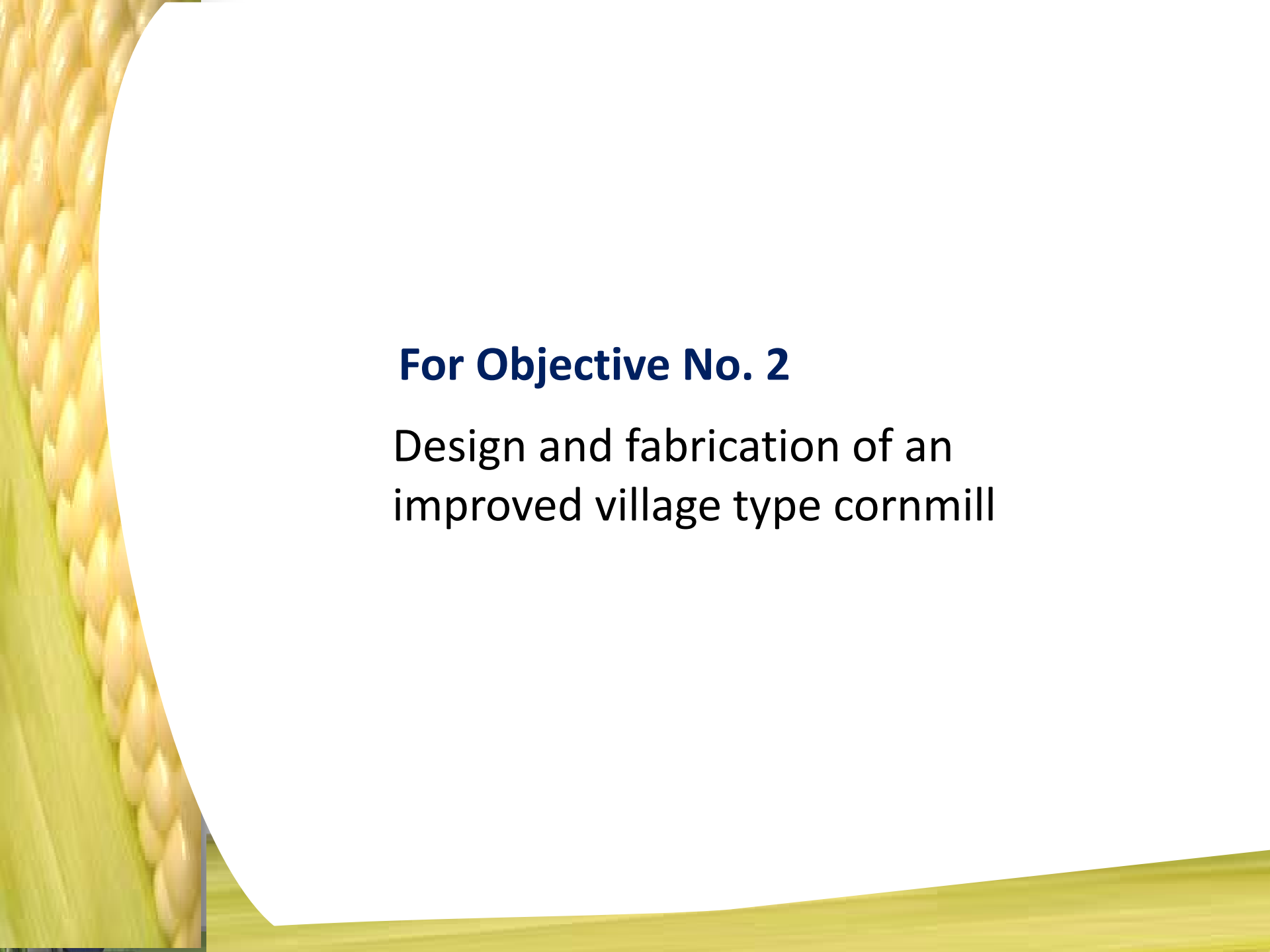
How to satisfy the demand of the market ?



7th Concern

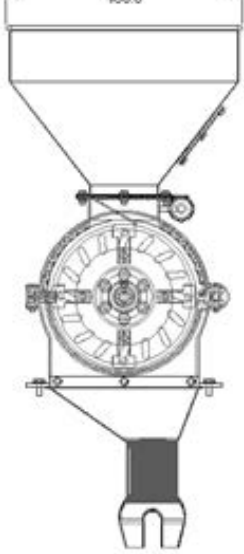
What we will do
for those harvest
that are highly
contaminated with
aflatoxin?



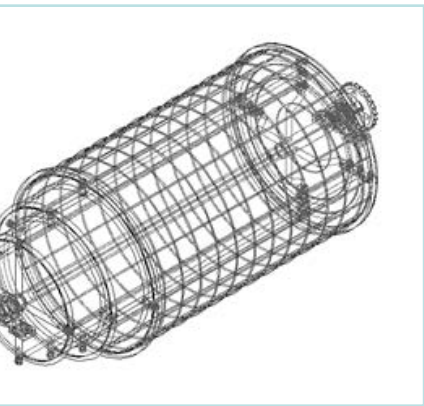


For Objective No. 2

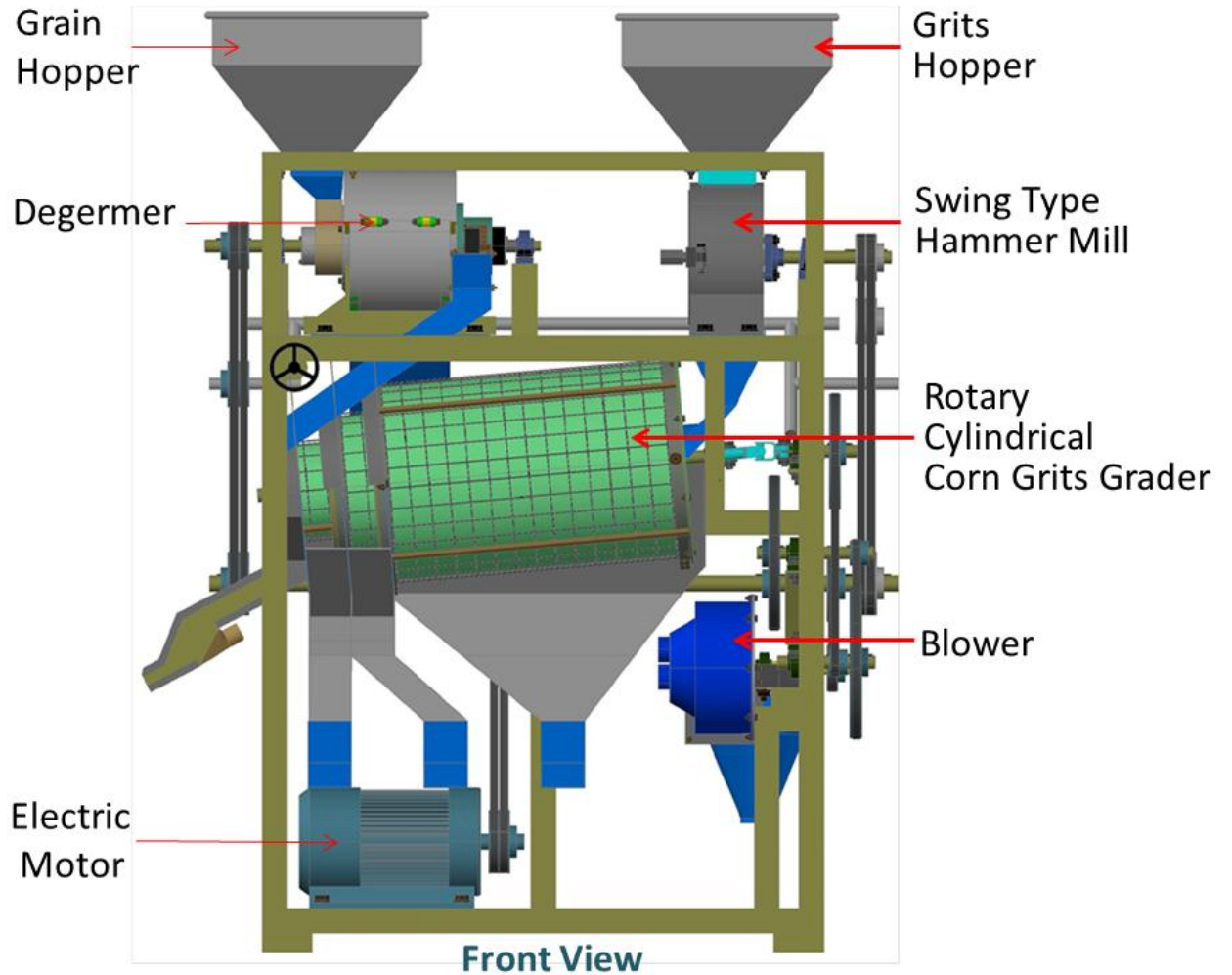
Design and fabrication of an
improved village type cornmill



Degermer and milling Components



Grader Assembly



PROCESS FLOW



DEGERMER



HAMMER MILL

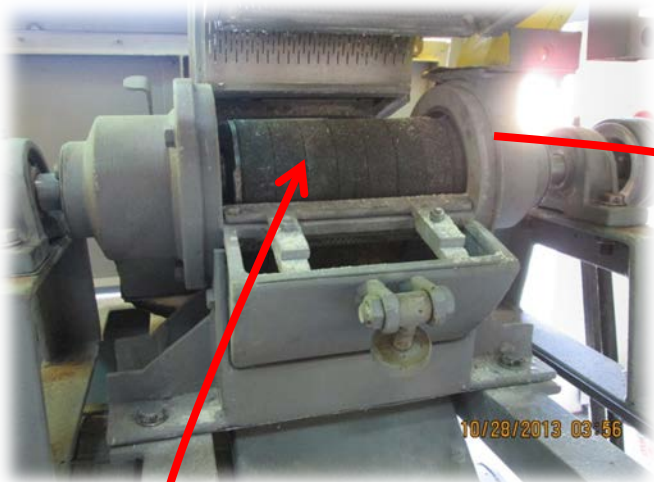


GRADER





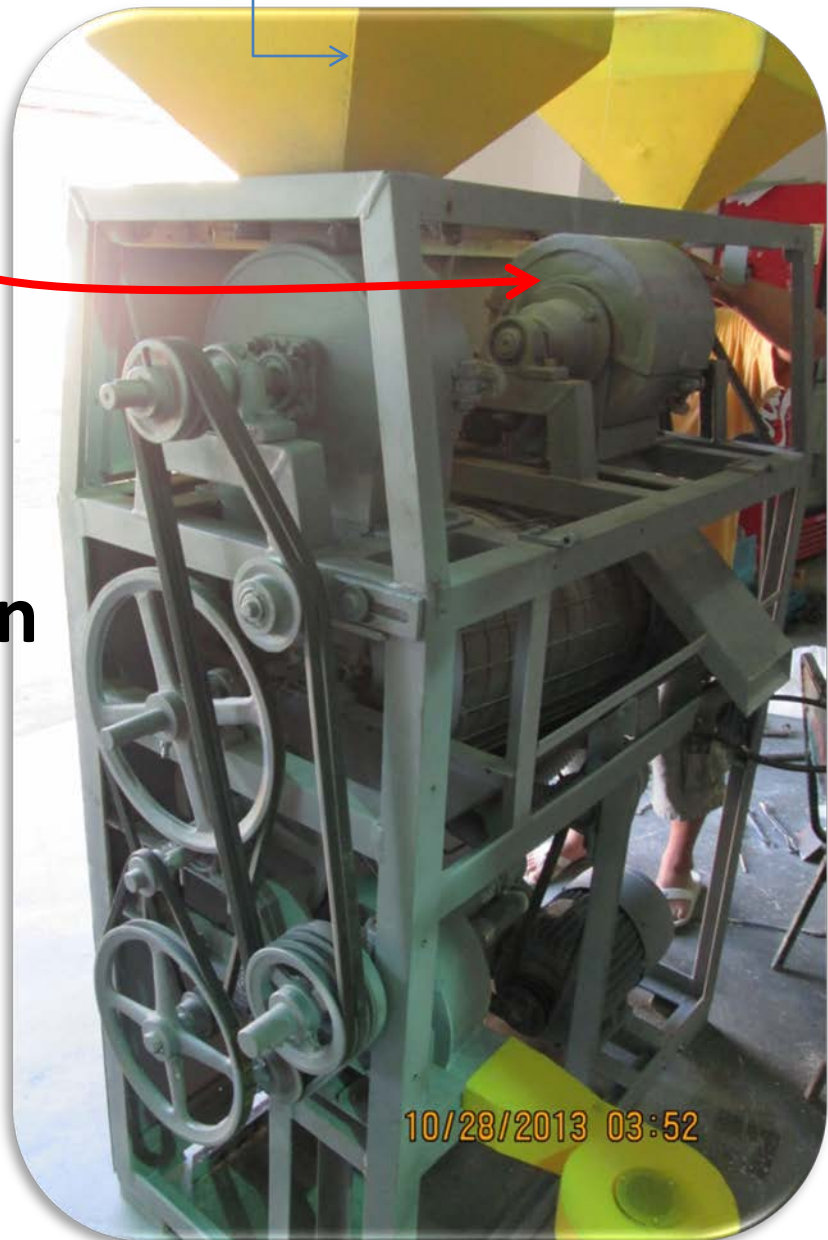
Fabrication of the cornmill machine incorporating the different design of each cornmill component



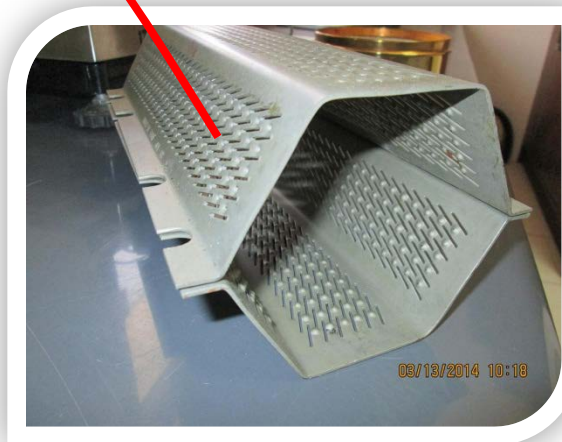
Degermination Assembly



After Field Testing

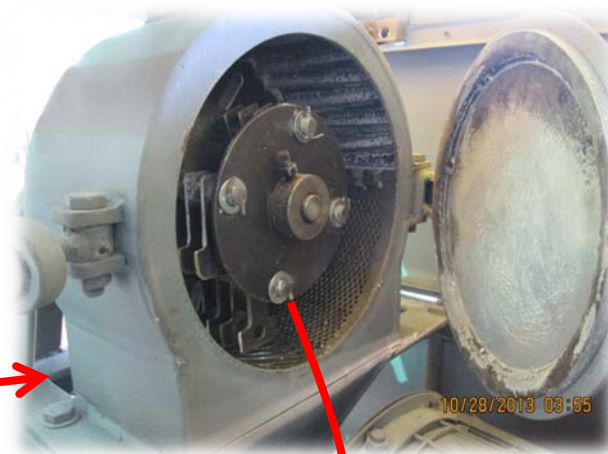


DEGERMER ASSEMBLY



Performance of Emery Stone with Dented Screen Huller

Parameters	Emery Stone	Dented Screen Huller
Ave. Milling Recovery (%)	71.27	80.00
Ave. Degermination Eff. (%)		
- After Degerming	66.16	18.48
- After hammer milling and grading	91.45	94.73
Ave. Input capacity (kg/h)	257.55	201.65
Ave. Output Capacity (kg/h)	85.50	149.23
Ave. Milling Capacity (kg/h)	119.90	181.73



**Size Reduction
Assembly**

2 Size Reduction Assembly





Performance of the hammer mill with different number of spokes

Parameters	22 spokes	36 spokes
Ave. Input Capacity (kg/h)	495.13	453.83
Ave. Output Capacity (kg/h)	104.56	125.60
Ave. Milling Capacity (kg/h)	121.35	155.16

CORN MILL GRADER

Specifications:

Screens

#10 : Slotted Sheet (2mm)

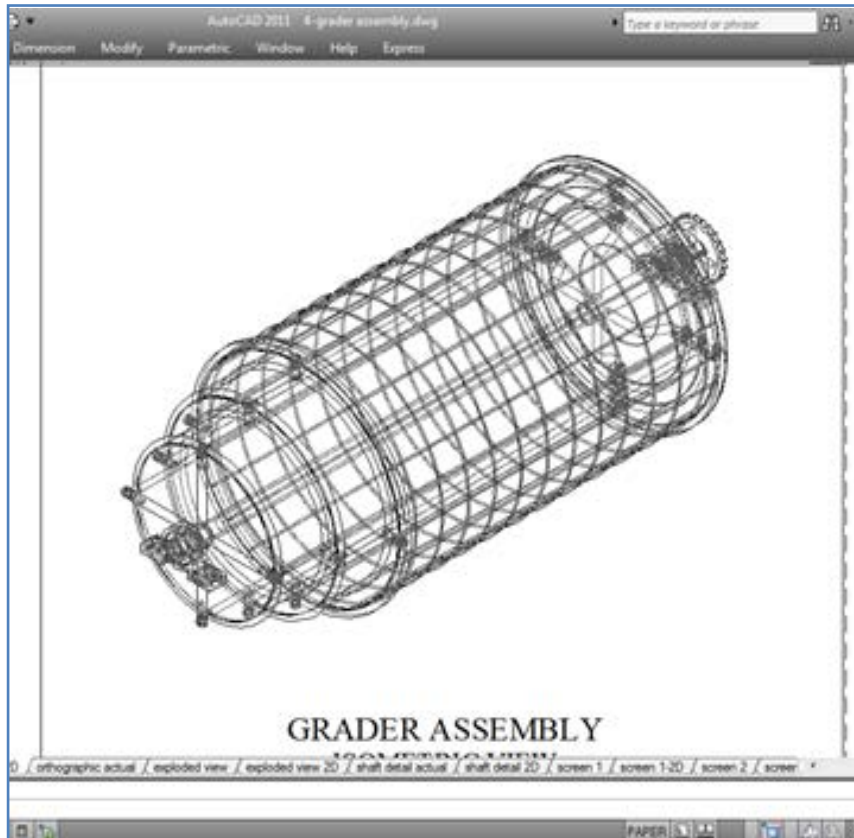
#14 : Slotted Sheet (1.4mm)

#18 : Wire Mesh (0.74mm)

Speed : 50 RPM

Dimensions

(L x W x H) mm : 1,105 x 695 x 879



CORN MILL GRADER

Specifications:

Screens

#10 : Slotted Sheet (2mm)

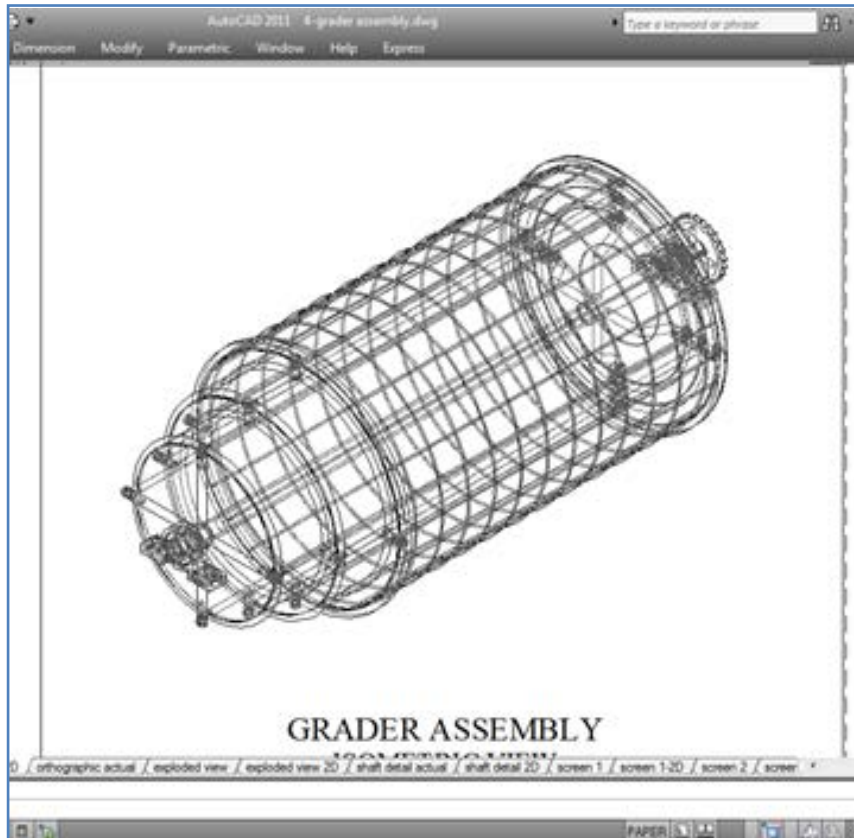
#14 : Slotted Sheet (1.4mm)

#18 : Wire Mesh (0.74mm)

Speed : 50 RPM

Dimensions

(L x W x H) mm : 1,105 x 695 x 879





For Objective No. 3

Examine the technical performance
of the proto-type village cornmill



Performance Test Result of the PHilMech Developed Compact Cornmill

- Output Capacity: 160.8 kg/h
- Output Recovery: 64.7%
- Degerming Efficiency: 94.7%
- Prime Mover: 5 hp, Single-phase
- Labor Requirement: 1 person
- Power Consumption: 4.17KW/hr
- Overall Dimensions:
 - Length: 157 cm
 - Width: 116 cm
 - Height: 192 cm
- Overall Weight : 476 kg

Aflatoxin content of corn grits and corn by products after milling, ppb

	Trial 1	Trial 2	Ave.
Corn Grain	334	329	331.5
Degermed/Cracked Corn	27	30	28.5
By Product (Hull, Germ, Tip Cap)	647	633	640.0
Grits No. 10 & 12	5	5	5.0
Grits No. 14, 16 & 18	19	18	18.5
Corn Flour	48	51	49.5



Corn on cobs



Corn grains



Cracked corn



Corn grits # 12



For Objective No. 4

Determine the economic
viability of the cornmill

Economic Analysis



Basic Assumptions

Input Capacity (kg/hr)	250	kg/hr
Output Capacity @64% recovery (kg/hr)	160	kg/hr
Operating time per year (hrs)	960	hrs
No of days per year (days @ 4 hrs/day)	240	4 hrs/day
Total Capacity per year (kg/yr)	153,600	kgs/yr
Investment Cost (pesos)	300,000	pesos
Power Requirement (kw/hr)	6.26	KW/hr
Lifespan of cornmill (year)	12	years

I. Fixed Cost Per Year

37,500

Depreciation Cost

22,500

Repairs and Maintenance

15,000

II. Variable Cost Per Year

144,079

Electricity Cost

84,079

Labor Cost (1 Operator)

60,000

III. Total Cost per Year

181,579

IV. Cost of Milling Per kg Output (P/kg)

1.18

= US\$26/t

V. Profit (P/kg)

0.82

= US\$18/t

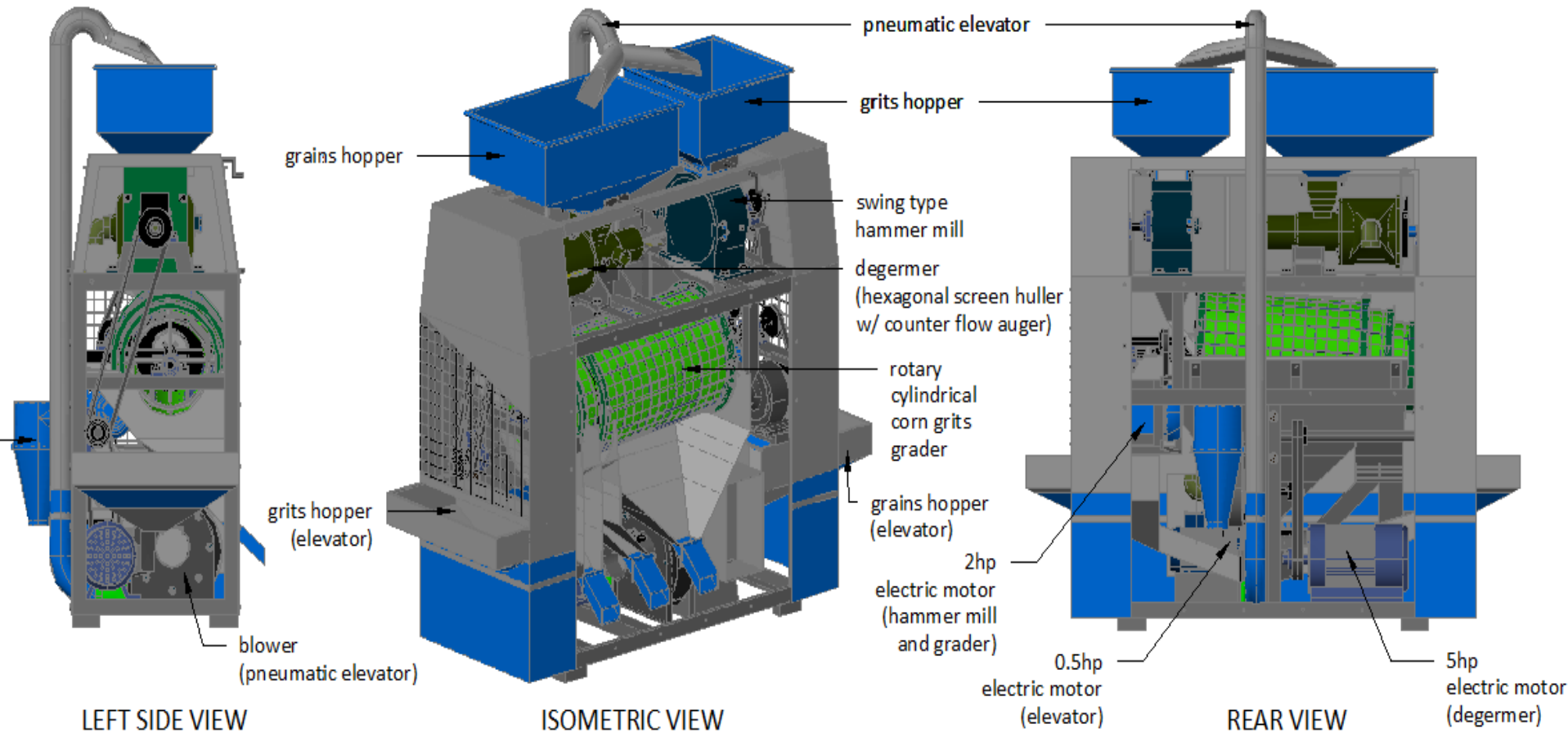
VI. Payback Period (Yrs)

2.39

VII. Financial Internal Rate of Return (%)

71.85

PHilMech Compact Cornmill



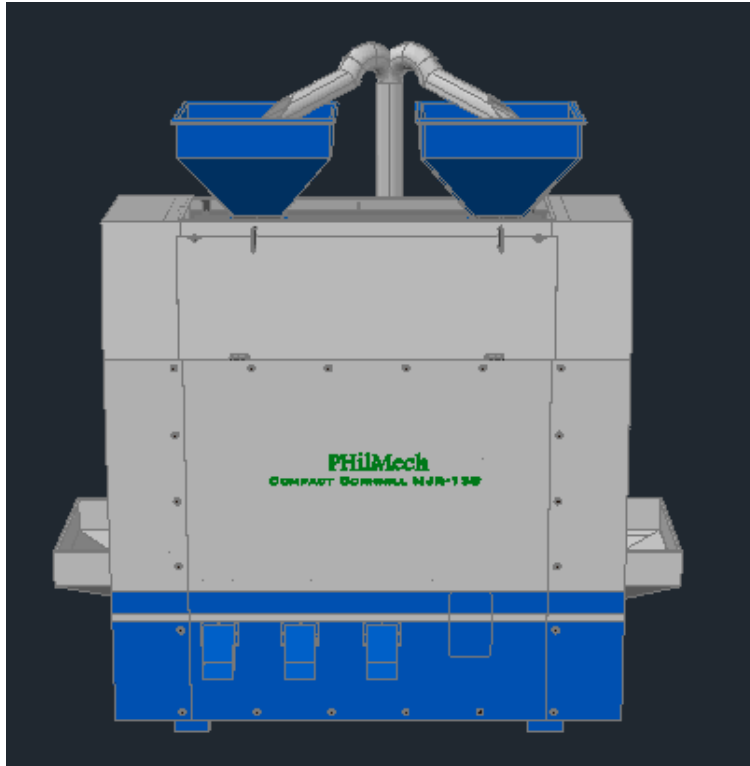


SUMMARY & CONCLUSION

SUMMARY AND CONCLUSION

- This research has successfully designed and developed an innovative compact cornmill.
- The technical performance of the cornmill have fully satisfied the minimum product recovery of 64% and minimum degermer efficiency of 80% as set by PAES.
- The developed cornmill is economically viable given a financial internal rate of return of 54.5% and payback period of 2.4 years. The computed cost of milling per kilogram output is only Php1.18/kg (US\$26/t).

Potential Impact of the Developed Technology



Output

- ✓ Higher grits recovery
- ✓ Higher degerming efficiency
- ✓ Salvage reject corn grain due to aflatoxin contamination
- ✓ Low operating cost per kg output

Impact (4A's)

- ➔ **Adequacy** of corn grits supply
- ➔ **Accessibility** of good quality corn grits
- ➔ **Availability** of sufficient and safe supply of corn grits
- ➔ **Affordability** of corn grits in the market

Effect

Induced consumption of corn as food

Food Sufficiency in the country

Reduced pressure to the government in producing the food requirements of the country



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FOR DEGERMER



**FOR HAMMER MILL &
GRADER**



**FOR PNEUMATIC
ELEVATOR**

Brand name	: TECO Elec. & Mach. Co., Ltd.	HITACHI	TECO Elec. & Mach. Co, Ltd.
Type	: Single-phase Induction Motor	Single-phase Condenser Motor	Single-phase Induction Moto
Rated power	: 5 HP (3.7kW) @ 1750 RPM	2 HP (1.49 kW) @ 1730 RPM	0.5 HP (0.37 kW) @ 3470 RPM
Current	: 26 A	10 A	3.2 A
Voltage	: 220 V	220 V	220 V
Frequency	: 60 Hz	60 Hz	60 Hz