PHilMech

Compact Corn Mill Engine-driven Model

An Operator's Manual

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Department of Agriculture
PHILIPPINE CENTER FOR POSTHARVEST DEVELOPMENT AND MECHANIZATION
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2021

PREFACE

This manual is prepared as part of the research project "Corn Grits Processing Enterprise Showcasing the PHilMech Compact Cornmill Technologies" for individuals, farmers' groups and cooperatives whom are willing to venture into corn grits processing by adopting the PHilMech corn mill technology. The production of this manual is part of PHilMech's effort to further bring agriculture to the forefront through the development and promotion of locally-made technologies, such as the PHilMech compact corn mill.

This operators' manual contains the most recent and updated information pertaining to the PHilMech compact corn mill, compiled to provide adopters and operators with a thorough understanding of the capabilities and operation of the PHilMech Compact Corn Mill. This operators' manual cannot be regarded as a substitute to the actual instruction and training, but must be seen as an addition to the training and guide for the overall usage of the machine. It is strongly recommended that this manual be read carefully with all cautions noted and observed before placing the corn mill into operation.

Every effort has been made to make the operation of the corn mill as simple, safe, reliable and trouble-free as possible. Should a malfunction occur, refer to the troubleshooting section of this manual for possible causes and its corrective measures. If problem persists, call the attention of the supplier of your unit.

BALDWIN G. JALLORINA, Ph.D.
Director IV

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INTRODUCTION

The Philippine Center for Postharvest Development and Mechanization (PHilMech) developed an improved village-type compact corn mill for corn to produce good quality grits. This corn mill addresses the lack of available efficient corn mill in the country. It also provides business opportunities to small business enterprise given its low capital requirement and high financial viability.

Features and Specifications of the Technology

- Compact yet powerful with input capacity of 300-350 kg/hr
- Produces good quality corn grits with higher milling recovery
- Utilizes a diesel engine as prime mover
- Has a corn kernel pre-cleaner for the continuous operation

- Significantly reduces aflatoxin contamination of corn grits to safe level
- Sorts different sizes of corn grits
- Allows simultaneous operations
  (sorting, cleaning and size reduction) of during operation
- Requires minimal working space (5m x 4m)

Technical Specifications	
Milling Capacity	240-260kg/hr
Input Capacity	300-350 kg/hr
Product Recovery	64.7-72.3%
Degerming Efficiency	81.2-94.0%
Prime Mover	20 hp water-cooled horizontal diesel engine
Fuel Consumption	2.73 L/hr
Corn Grits Sizes	Grits No. 6-8,10-12 and 14-18
Labor Requirement	2-3 persons

Award-winning Technology

Region 3 Outstanding Research

2015 DOST Regional Invention Contest

National Outstanding Creative Research

2016 DOST National Invention Contest

UNIVERSAL SYMBOLS FOR SAFETY

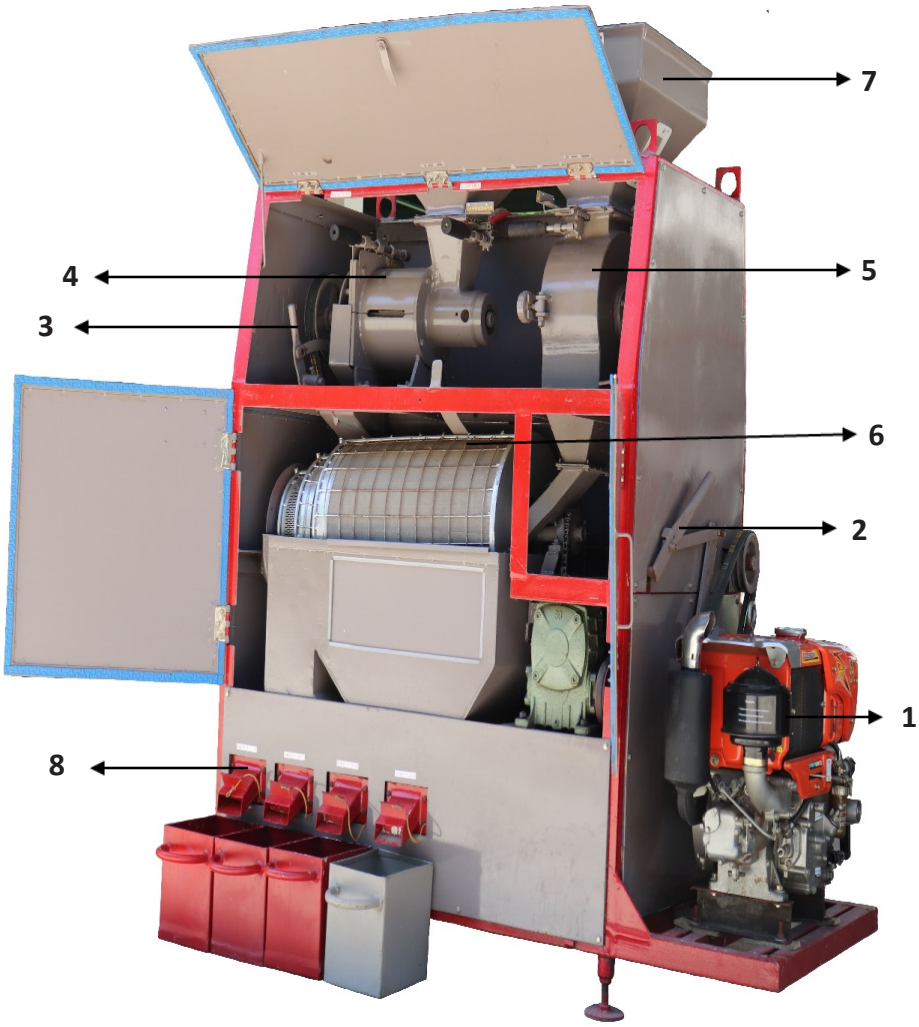
The safety alert symbol is used to identify safety information about hazards that can result in personal injury.

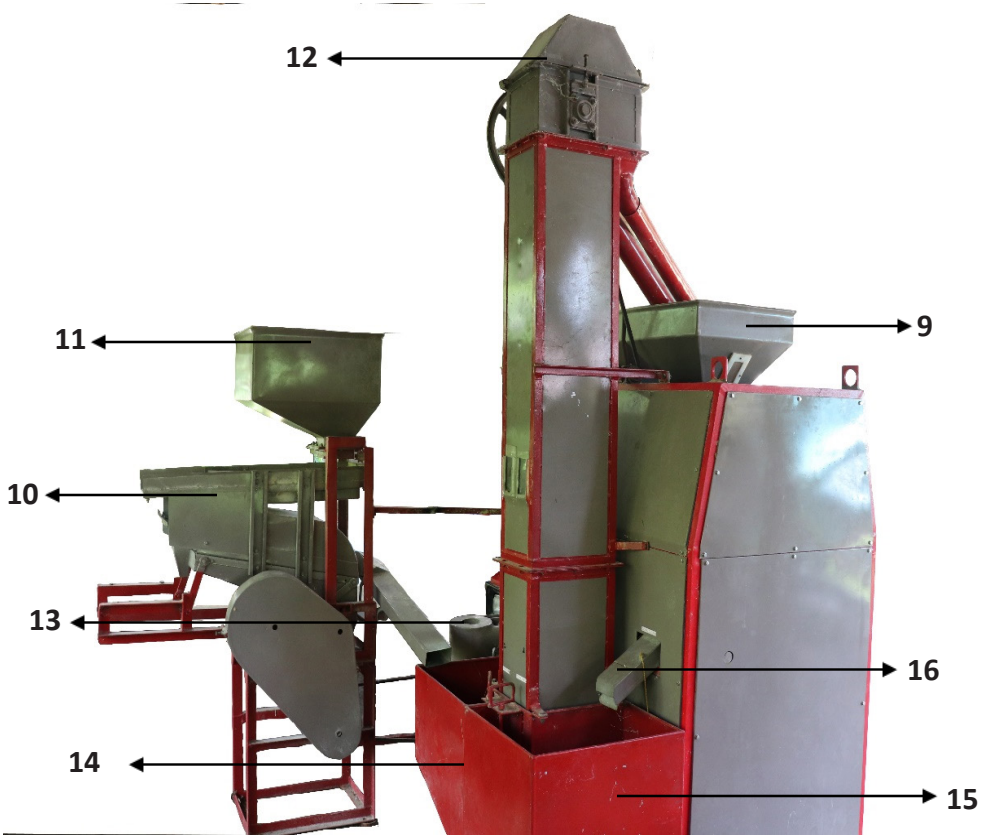
A signal word **(DANGER, WARNING or CAUTION)** is used with the alert symbol to indicate the likelihood and the potential severity of injury. In addition, a hazard symbol may be used to represent the type of hazard.

As a guide to the operation of the Engine-driven PHilMech Compact Corn Mill, various universal symbols have been utilized on the assemblies and controls. The symbols are shown below with an indication of their meaning.

SIGN	SIGNIFICATION
	**WARNING, DANGER, CAUTION** • indicates a hazard which, if not avoided will result in serious physical injuries or represent a type of hazard. **ATTENTION** • indicates a situation that could result to damage to the product.
	**FLAMMABLE** • at risk of fire or explosion which can cause severe burns or serious physical injuries.
	**HOT SURFACE** • at risk of getting in contact with heaten-up surface by continuous operation
	**TOXIC FUMES** • at risk of taking in irritating or hazardous vapors, dust and/or smoke.
	**MOVING PARTS** • at risk of getting in contact, entangled, cut and/or crushed by moving parts of the machine.

Parts of the Engine-driven Compact Corn Mill





1 – Engine
2 – Main Transmission Lever
3 – Degermer Transmission Lever
4 – Degermer Assembly
5 – Rotary Mill Assembly
6 – Rotary Sorter Assembly
7 – Degermed Corn Input Hopper
8 – Corn Grits Outlet Chutes
9 – Corn Grains Input Hopper
10 – Pre-cleaner
11 – Pre-cleaner Input Hopper
12 – Elevator Assembly
13 – Cyclone
14 – Cleaned Corn Grains Hopper
15 – Degermed Corn Hopper
16 – Degermed Corn Outlet Chute

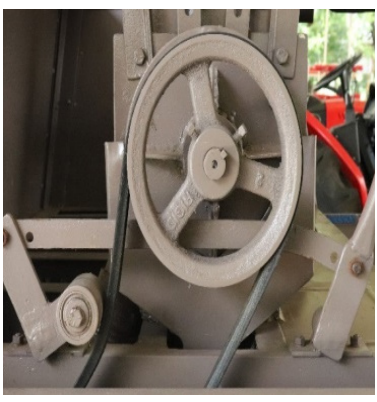
Functions of the Different Components of the Corn Mill

1. Engine

The engine serves as the prime mover of the whole corn mill system. It is the main source of power as it burns fuel to produce mechanical motion to initiate the operation of the corn mill system.

2. Transmission System

The transmission system transfers the mechanical power generated by the engine to the main shaft, which propels the corn mill system. This system is comprised of pulley combinations, fan belts and levers to engage/disengage the transmission of torque for the machine to run. The main parts of the transmission system are the main transmission lever and degermer transmission lever.



3. Pre-cleaner Assembly

The pre-cleaner has two major parts, namely the winnower and destoner. The winnower removes large foreign particles with its perforated screen. Also, it removes corn stover, corn cobs and other light impurities by being blown away. The destoner, on the other hand, removes small stones.

4. Elevator Assembly

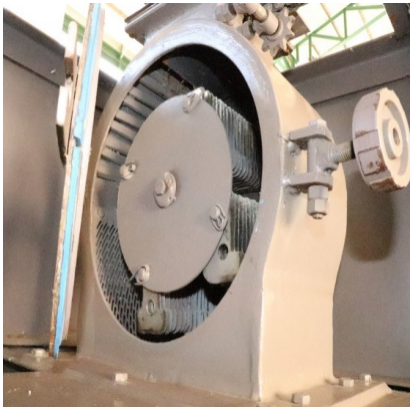
The elevator transports the corn kernels and degermed/cracked corn to the degermer and rotary mill, respectively. This eliminates the inconvenience of loading the corn kernels and degermed/ cracked corn to the hopper at the top of the machine

5. Degermer Assembly

The primary function of the degermer assembly is to efficiently remove the germ, hull and tip cap from the endosperm of the corn kernel.

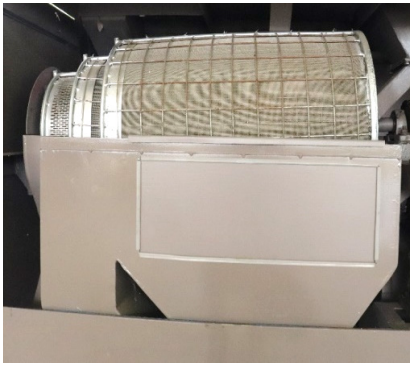
6. Rotary Mill Assembly

The rotary mill assembly breaks the sizes of the degermed/ cracked corn kernels into smaller pieces to produce corn grits.



7. Rotary Sifter Assembly

The rotary sorter assembly sorts the different sizes of corn grits and segregate the corn flour from the corn grits



INSTALLATION

To ensure the efficient and proper operation of the compact corn mill and pre-cleaner, it should be properly installed. Here are a few pointers before installing the pre-cleaner:

• The machine should be installed under a shed to protect it from adverse conditions.

• Make sure to install it on a flat, concrete surface.

• Make sure that the area is not prone to air drafts so as not to disrupt the operation.

Installation of the Pre-cleaner

1. Position the pre-cleaner in such a way the outlet chute is directed towards the clean corn grains hopper of the compact corn mill.

2.Once positioned, mark the floor using the holes at the foot of the frame for the drilling of holes. This will be basis for the placement of the sleeve anchor. Move the pre-cleaner to the side afterwards.

3. Drill the marked points to a depth of about 3 inches using a 3/8” drill bit. Remove the small particles and dust from the drilled hole.

4. Put one sleeve anchor to each hole, with the threaded part at the top. Carefully pound the sleeve anchor into the hole. Once the sleeve anchors are already inserted to the hole and already stable, remove the bolt of each sleeve anchor. Set aside the removed bolts.

5. Carefully position the pre-cleaner to the newly installed sleeve anchors by inserting the head of the bolts to the holes of the foot of the frame.

6. Once positioned, the pre-cleaner is now ready to be anchored to the concrete. Place the nut on the threaded shaft. Twist the nut clockwise until it reaches the foot of the frame. Add washers to the bolt before anchoring the machine, if necessary.

Installation of the Compact Corn Mill

IMPORTANT NOTE: Make sure that it is placed on level concrete flooring.

1. Using a hydraulic lifter, move the compact corn mill to its position in the processing area.

2. Once positioned, make sure that the compact corn mill is level with respect to the ground. Check using a level meter or a clinometer.

3. If the compact corn mill is not level with respect to the ground, adjust the stand of the corn mill using a wrench.

SAFE OPERATION

Careful operation is one's best insurance against an accident.
All operators, no matter how much experience to similar machines they have, should read this before operating the PHilMech Compact Corn Mill.

BEFORE OPERATING THE ENGINE-DRIVEN PHILMECH COMPACT CORN MILL,

- **K**now your corn mill and its limitations. Do not use this corn mill unless you are **fully trained**.
- **H**ave a **"Safety First"** mindset **ALWAYS**. Be wary of the hazards that go with operating the machine.
- **D**o not operate the corn mill under the influence of alcohol, medication, controlled substance or while fatigued.
- **N**ever wear loose, torn or bulky clothing while operating the corn mill. It may catch on moving parts leading to the risk of an accident.
- **D**o not modify the corn mill. Unauthorized modification may affect the function of the corn mill, which may result in personal injury.

SAFETY FOR CHILDREN

Tragedy can occur if the operator is not alert to the presence of children. Children generally are attracted to machines and the work that they do.

1. Never assume that children will remain where you last saw them.

2. Keep children away of the processing area and under the watchful eye of another responsible adult.

3. Never carry children near the machine. They may be in danger or interfere with the operation.

4. NEVER allow children to operate the machine even under adult supervision.

SAFETY PRECAUTIONS

Before the Operation

IMPORTANT NOTE: ALWAYS do precautionary checks before operations to prevent accidents and malfunction of the machine.

1. Make a thorough inspection of the corn mill, engine and pre-cleaner. Look out for the following items:

a. Oil leaks
b. Loose bolts
c. Damaged belts
d. Cracks on pulleys
e. Accumulated dirt
f. Foreign materials on hoppers

2. Remove obstructions around the processing area. Obstructions may hinder and endanger the operators during operation.

3. Check the guards for moving parts if placed properly. Properly attached guards to prevent accidents caused by moving parts.

4. Clean the processing area before and after the operation.

ALL ABOUT FUEL

Fuel, particularly diesel, is used to power the machine to commence operation. Considered as a flammable substance, it should be handled with care at all times.

IMPORTANT NOTE: Diesel, or fuel in general, are extremely flammable and explosive. Fire or explosion can cause severe burns. **ALWAYS** handle with care.

When adding fuel

• The engine should be turned off. In the case of refueling in the middle of operation, let the engine cool for at least 5 minutes before removing the fuel cap.

• Do not overfill the fuel tank. Fill the tank to approximately 2 inches below the top of the neck.

• Keep fuel away from sparks, open flames, pilot lights, heat and other ignition sources.

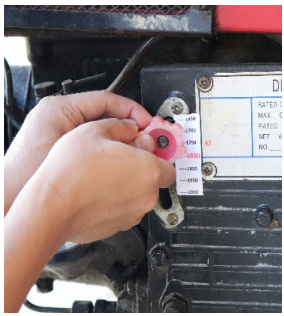
• Check fuel lines, tank, cap and fittings routinely for cracks or leaks. Replace if necessary.

• If fuel spills, wait until it evaporates before starting engine.

STARTING OF THE ENGINE

IMPORTANT NOTE: Make sure the main transmission lever and degermer transmission lever are disengaged.

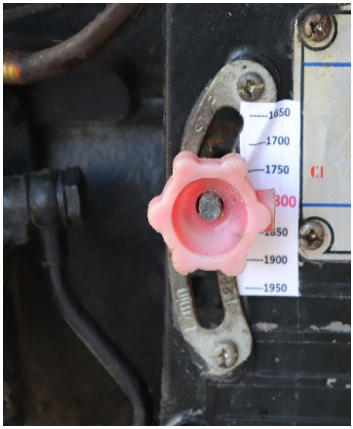
1. Position the throttle lever to near full before starting the engine



2. Using the designated key, start the engine by inserting the key to the electric engine starter and turning the key clockwise. This gradually starts the engine. Slowly let go as soon as the engine started.

3. Slowly adjust the throttle lever to low idle position and allow the running-in of the engine.

4. Adjust the throttle lever to the line indicator, which is at approximately 1800rpm±50.



5. In the event that the engine does not start, release the electric engine starter by turning the key counter clockwise. Allow the electric engine starter to cool down for 20 seconds. Once the engine starter has cooled down, repeat Steps 2 through 4.

IMPORTANT NOTE: Make sure that the flywheel and starter motor have stopped their rotation before turning on the electric engine starter.

ENGINE SAFETY REMINDERS

Starting the engine

1. Ensure the fuel cap, radiator cap and air cleaner are in place and secured.

2. Check the connection of the battery to the engine starter.

CORN MILL SYSTEM OPERATION

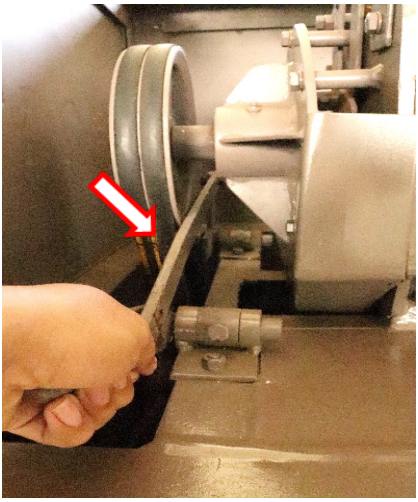
1. Load the corn kernels to the pre-cleaner.

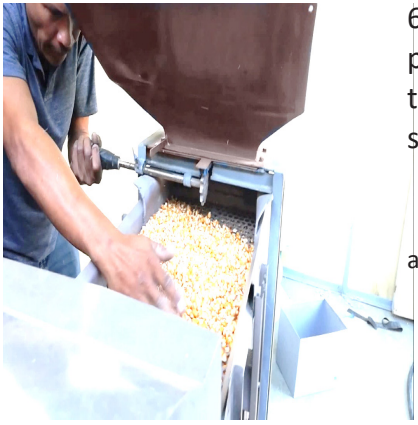
2. Set the opening of the outlet gate of the degermer at 2.5cm by turning the outlet gate knob counter-clockwise.

3. Turn on the engine (Refer to **Starting of Engine Procedures**; pages 15-16).

4. Set the main transmission lever downward to a locked position to engage the transmission from the engine to the main shaft.

5. Set the degermer transmission lever downward to a locked position to engage the degermer to the main shaft.



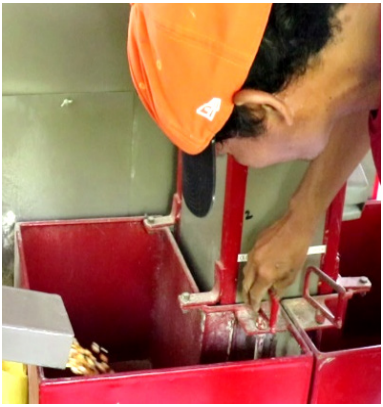


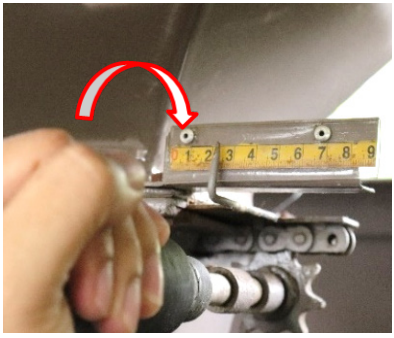
6. Open the feeding shutter of the pre-cleaner hopper by 1 cm by turning the adjustment knob counterclockwise to start the operation.

Note: At this setting, the pre-cleaner will achieve an outpucapacity of 300-350 kg/hr.

7. Open the feeding shutter of the cleaned corn grains hopper by 3 cm by turning the adjustment knob clockwise to allow transport of grains via the elevator to the corn grains input hopper.

Note: At this setting, the input capacity of the elevator for cleaned corn grains will be at 300-350 kg/hr.



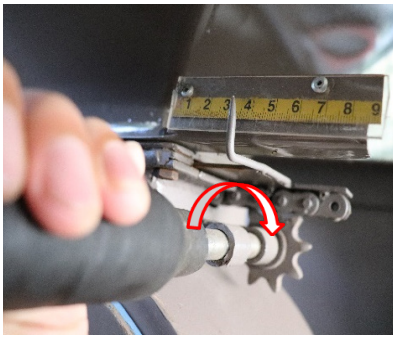


8. Open the feeding shutter of the corn grains input hopper by 2.5 cm by turning the adjustment knob clockwise to commence degermination.

Note: At this setting, the degermer will achieve an input capacity of 300-350 kg/hr.

9. Open the feeding shutter of the degermed corn hopper by 2 cm by turning the adjustment knob clockwise to allow transport of grains via the elevator to the degermed corn input hopper.

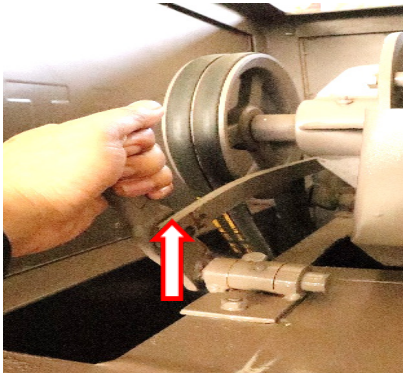
Note: At this setting, the input capacity of the elevator for degermed corn will be at 300-350 kg/hr.



10. Open the feeding shutter of the degermed corn input hopper by 3 cm by turning the adjustment knob clockwise to commence size reduction.

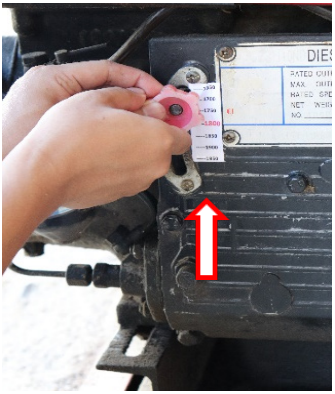
Note: At this setting, the hammer mill will achieve an input capacity of 300-350 kg/hr.

11. Position the metal containers in front of each corresponding outlet chutes for the collection the corn grits products.



12. Once all cleaned corn grains have been processed to degermed corn, the degermer transmission lever can be disengaged.

13. Once all degermed corn have been milled and all products have been collected, set the main transmission lever upward to disengage the transmission from the engine to the main shaft.



14. Slowly move the throttle lever to low speed to render the engine to stop. The engine should go out itself.

15. Close the all the feeding shutters of the pre-cleaner, cleaned corn grains hopper, corn grains input hopper, degermed corn hopper and degermed corn input hopper.

16. Clean the metal containers and store properly.

17. Clean the processing area after the operation.

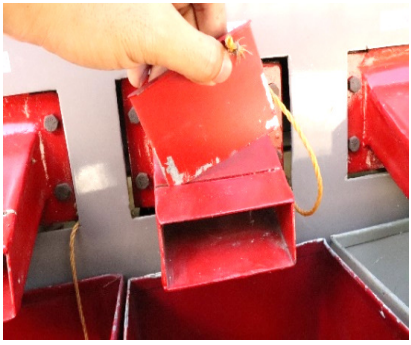
18. Disconnect the battery and put into safe storage.

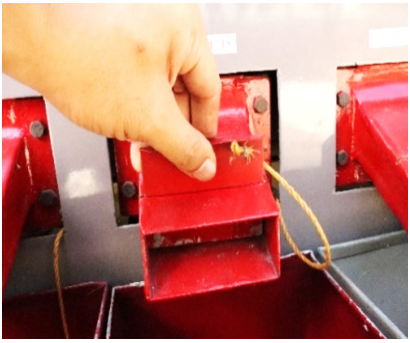
Important Reminders during Operation

1. Check the sack for by-product (bran and germ) collection, attached to the cyclone separator if it is already full.

One indication to take note is if the corn bran/germs is coming out of the cyclone separator. Adjust its position to allow the bran and germ to flow properly or place a new sack to collect the by-products.

2. Utilize the metal stoppers of the outlet chutes.





During product collection, in the event that a metal container is full, insert the metal stoppers to the slot at the top of each outlet chute to close the chute. This allows the transfer of collected products to sacks. Simply remove the metal stoppers to resume collection of products.

MAINTENANCE

The word “maintenance” does not always mean “to repair”. It is the constant follow up of regular processes to keep the equipment in working condition. If one prioritizes effort and time on maintenance, the equipment shall continue to be efficient for a long time.

Engine Care

• Check the engine coolant, lubricating oil and oil filter. Renew the lubricating oil every 6 months of operation or when the lubricant oil becomes dirty.

• Check for cracks and loose clamps in the cooling system hoses.

• ALWAYS fill the radiator full of pure potable water. ALWAYS check the water levels before using the engine.

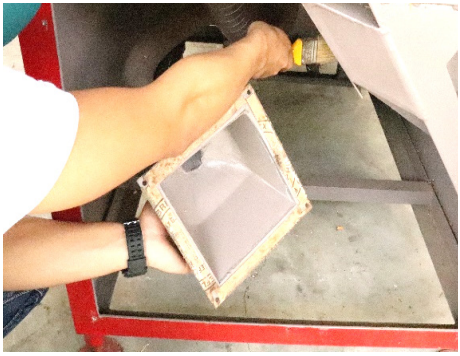
• ALWAYS make sure that the battery to be used is fully charged.

• ALWAYS disconnect the battery and put in a safe storage area. Cover the terminals to prevent corrosion.

PRE-CLEANER AND CORN MILL MAINTENANCE

1. Periodically check for loose bearings, set screws, bolts and nuts for all moving parts of the corn mill. Tighten and replace them, if necessary.

2. Regularly clean the suction blower of dust, corn flour and other foreign materials.



3. Lubricate all bearing with good quality general purpose grease for every one (1) ton of corn samples processed.

4. Clean and remove corn flour accumulated in the degermer assembly for every one (1) ton of corn samples processed.

5. Clean occasionally the grader mechanism using nylon or industrial brush.

6. Retouch or paint corroded parts of the corn mill.

7. ALWAYS close all feeding openings on the pre-cleaner and corn mill to prevent infestation of insects and rodents.

8. Regularly clean the industrial magnet by removing the build-up of materials. Wipe the surface of the magnet using a damp cloth.

MAINTENANCE

PROBLEM	CAUSE	REMEDY
ENGINE		
Engine is difficult or fails to start	• Empty fuel tank. • Fuel is dirty or contaminated. • Fuel supply hose damaged or not properly attached. • Loose or rusty plug wires. • Battery is undercharged. • Starter motor is not operational. • Faulty wiring and connection problems in the ignition system	• Fill fuel tank with new supply of fuel. • Drain the old fuel and replace with clean and new fuel. • Fix the attachment of the hose; replace if already damaged. • Remove rust on plug wires using sandpaper; properly tighten bolts of plug wires. • Repair or replace damaged part • Have the battery fully charged. • Check, repair or replace non-functional parts Fill fuel tank with new supply of fuel.
Engine Stalls	• Air in fuel system. • Quality of fuel is bad or contam-inated with water. • Fuel supply hose is damaged or not properly attached.	• Prime the fuel system and “bleed” out any air by turning the ignition system to a “run” position for 30 seconds; repeat three times. • Clean the tank and pipe replace the old fuel with new and clean fuel. • Fix the attachment of the hose; replace if already damaged.

Engine power/ speed is low or not increasing	• Diesel oil filter and fuel pipe blocked; fuel delivery is not smooth. • Fuel delivery of pump is bad. • Faulty injector. • Fuel is old, dirty and contaminated. • Air filter clogged. • Low engine oil level.	• Check engine oil cock, clean oil filter and fuel pipe. • Repair or replace damaged part/s of pump. • Clean, grind and replace fuel jet; adjust injection pressure. • Drain the old fuel and replace with new and clean fuel. • Remove and clean filter. If damaged, replace filter. • Add engine oil.
Engine Overheating	• Overloading. • Water pump failure. • Clogged water lines. • Engine oil level is too low. • Low coolant level, coolant leak or poor coolant circulation. • Cooling fan failure. • Broken or cracked radiator hose. • Ruptured or broken radiator cup. • Poor airflow through the radiator. • Inefficient radiator.	• Lower or reduce the volume of inputs. • Repair or replace damaged parts. • Clean water lines. • Addition of engine oil. • Add coolant, seal for the leak and check/clean the coolant pipe/radiator. • Check/repair the fan connection. • Replace the radiator hose. • Replace new radiator cup. • Clean the radiator, check the cooling fan if it is working. • Repair or replace old radiator.
PRE-CLEANER		
Too much corn kernels flowing out as impurities.	• High input of corn kernels.	• Lessen the input rate by adjusting the feeding shutter knob of the pre-cleaner.
Unnecessary noise during operation.	• Presence of foreign materials in the aspirator. • Offset bearing not properly aligned.	• Remove foreign materials in the aspirator. • Check bolt of the offset bearing; adjust the offset bearing.

ELEVATOR ASSEMBLY		
Bucket elevator stopped running	• Too much corn input. • Slack in the pulley combination driving the pre-cleaner.	• Lessen the corn input by reducing the opening of the input hopper for corn. • Check pulley for loose bolts; check belt for cracks or signs of wear, replace if necessary.
DEGERMER AND ROTARY MILL ASSEMBLIES		
Degermer mechanism clogged	• Kernels with high impurities. • Kernels have high moisture content, greater than 14%. • Outlet opening of degermer assembly is too narrow. • Input hopper opening of degermer is too big.	• Subject kernels to pre-cleaning. • Subject corn kernels to drying. • Adjust the outlet opening to the recommended settings. • Adjust the input hopper opening to the recommended settings.
Unnecessary noise observed during operation	• Worn-out bearings and moving parts. • Presence of foreign materials on the hammer mill.	• Lubricate the bearings with good quality general purpose grease; if parts are bogged down, replace such parts. • Open the hammer mill through the side opening and remove foreign materials.
Dirty degermed corn	• Blower is not functioning well. • Sack for by-product collection is already full. • Hexagonal screen already damaged.	• Contact the technical staff or manufacturer for assistance. • Replace sack for bran collection; commence operation. • Replace hexagonal screen with new ones.
Presence of corn grits in the bran	• High pressure of air at the suction blower.	• Lower air valve duct at suction blower and grader.
Presence of bran in the collected corn grits	• Accumulation of bran in the suction for corn grits.	• Clean the suction for corn grits, including the hose that connects it to the suction blower.

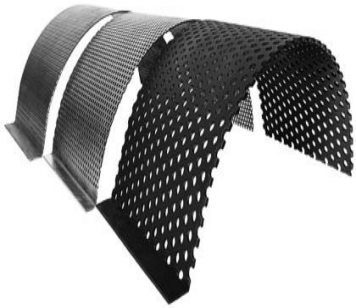
ROTARY SIFTER ASSEMBLY		
Presence of web-like matter on the products of milling	• Presence of spiders inside the rotary sifter assembly.	• Regularly clean the cylinder, screen and chutes of the rotary sifter.
Coarse products appear to be powdery upon collection.	• Accumulation of fine particles in the cylinders and screens of the rotary sifter.	• Regularly clean the cylinder, screen and chutes of the rotary sifter.

CONSUMABLE PARTS

V-Belt

Hexagonal
Screen

Pillow Block
Bearing



Hammer Mill
Screen

IMPORTANT NOTE: Spare parts to be used for the replacement of hammer mill and hexagonal screens shall be in accordance to the specifications used by the manufacturer. Usage of materials not prescribed by the manufacturer may be detrimental to the machine and operators.

RECORDS OF REPAIR

DATE OF SERVICE	SERVICING DEALER NAME	DESCRIPTION OF SERVICE/PARTS REPLACEMENT

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