Training on good practices for start-up, use and maintenance of processing equipment in a cereal processing unit in the Mouhoun Province of Burkina Faso

ABSTRACT

The objective of this work is the ~~training of cereal processors in Good Practices for Start-up,~~ Use and Maintenance of cereal (maize, sorghum, millet, etc.) processing equipment ~~of a cereal processing unit~~ in the province of Mouhoun in Burkina Faso. The work is carried out through the establishment of a training booklet containing all the following information, namely: the technical and operational presentation of each piece of equipment in the unit, the products treated and the bio-parameters of use of each equipment, and finally the methods of repair or maintenance of the equipment after use. This fieldwork allowed us to transfer technologies from the processing equipment manufactured in the Mechanical Engineering workshop of the Mechanization Department of the Research Institute for Applied Sciences and Technologies. This work is therefore the result of the dissemination and popularization of the results of research work that are unknown to the general Burkinabe public.

Keywords: Agricultural unit, cereals, processing, agri-food, equipment, use, maintenance.

1. INTRODUCTION

Cereals make up the largest share of food for African populations. Sorghum, millet and maize cover 35%, 29% and 11% respectively of the cereal area, with rice covering only 1% [1-3]. However, it is noted some bottlenecks in their value chain, more specifically at the level of threshing, winnowing, crushing and milling. Indeed, threshing, winnowing, crushing and grinding operations are a little tedious and long, and are often done in a rudimentary / archaic way or with not adapted food equipment [4-7]. To compensate for this, a cereal processing gadget was built and installed in Dédougou in the province of Mouhoun in Burkina Faso within the agricultural scoop called Allah Komi. ~~In Burkina Faso.~~Agricultural processing units have several agricultural product processing facilities installed in the same production area around the province to make their activities profitable. In this case, the unit makes it possible to process cereals by husking, milling and transforming them into lumps, couscous or fine flour that will be utilized for the production of certain local dishes. Processed products are maize, millet, sorghum, and so on. At the end of the installation of the equipment, a directed training module of machine operators was initiatedas agood practicesfor starting, using and maintaining the equipment. A test run of the equipment was conducted successfullywithin the Mechanical Engineering Workshop of the Mechanization Department of the Research Institute for Applied Sciences and Technologiesin Burkina Faso province. ~~for the benefit of agricultural scoops.~~The cereal processingdevice was thus employed for the training of selected operators on the procedures for the start-up,manipulation, and maintenance for a more efficient production.

2. MATERIAL AND METHODS

The training method consisted of teaching and application through repetitive exercises, the elements of practical knowledge on the use and maintenance of the equipment installed within the processing unit. This is how each of the operators was able to do the equipment start-up exercise several times ~~until she arrived alone~~. The equipment concerned for this training are, the maize gin model ZEKEDE, the motorized basket weaver, the *Engelberg* cereal sheller, the hammer mill, the flour roller and the flour sieve. All these~~which make~~made up the Allah Komi agricultural products processing unit. The method consists of:

- a technical and operational presentation of each piece of equipment;
- a description of the functional organs and the bio-parameters of use of each equipment use according to the product treated;
- handling the necessary adjustments of each piece of equipment before and after use;
- maintenance of equipment after use.

3. RESULTS AND DISCUSSION

3.1 ZEKEDE maize sheller model

3.1.1 Technical and operational presentation of the equipment

The ZEKEDE maize sheller is a device of Beninese origin. It makes it possible to dissociate dry grains from their stems (case of maize), but also to shell cowpea pods, ears of sorghum and millet with a change of sieve. As shown in Fig. 1, the ZEKEDE maize sheller consists of the following functional organs:

- framework;
- hopper;
- ginning chamber;
- cob ejection chamber;
- spillway;
- thermal engine.

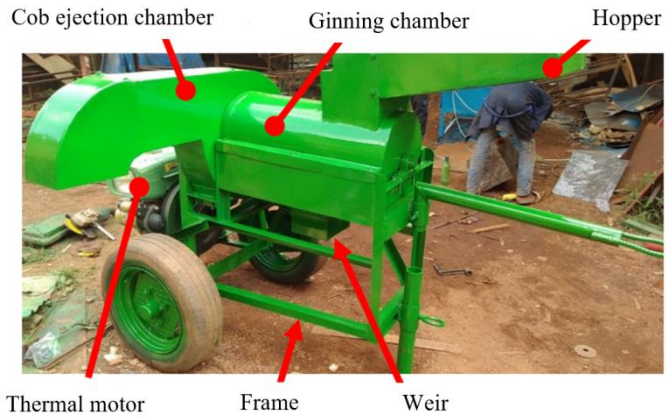

Fig. 1.ZEKEDE maize sheller

3.1.2 Sheller settings

The equipment is polyvalent, so it is equipped with two sieves, one for maize and cowpea, and the other for millet and sorghum. The sieve for millet and sorghum is of small mesh, while the sieve for maize and cowpeas is of large mesh.
Once the choice of product is made, it is necessary to proceed to the installation of the corresponding sieve. For this implementation it is necessary to:

- disassemble the cover of the ginning chamber by removing the bolts placed for this purpose by means of wrenches 19 (Fig. 2);
- remove the sieve (Fig. 2) in place by rotating it clockwise on the ginning rotor;
- place the corresponding sieve above the ginning rotor (Fig. 2);
- rotate the sieve counterclockwise until it is at the bottom of the ginning rotor.
- check the alignment of the holes in the sieve with that of the frame.
- reassemble the cover of the ginning chamber.

After this operation, the equipment engine can be idled to check for abnormal noise.

Fig. 2. Sheller adjusting devices

3.1.3 Operational start-up of the sheller

The operational start-up of the equipment is done by ~~using a~~ cranking~~to start~~ the engine. Starting is done by rapidly turning the crank (Fig. 3) positioned in the axis of the engine launcher, while decompressing the combustion chamber of the engine with the accelerator stretched almost to the maximum. After a few seconds of rotation of the crank, the operator releases the pressure relief lever and simultaneously removes the crank so that the engine can start. After starting, the operator sets the acceleration to idle speed. Then, he proceeds to an acceleration to be at the work regime.

The working regime is wedged by means of a clamping tab.

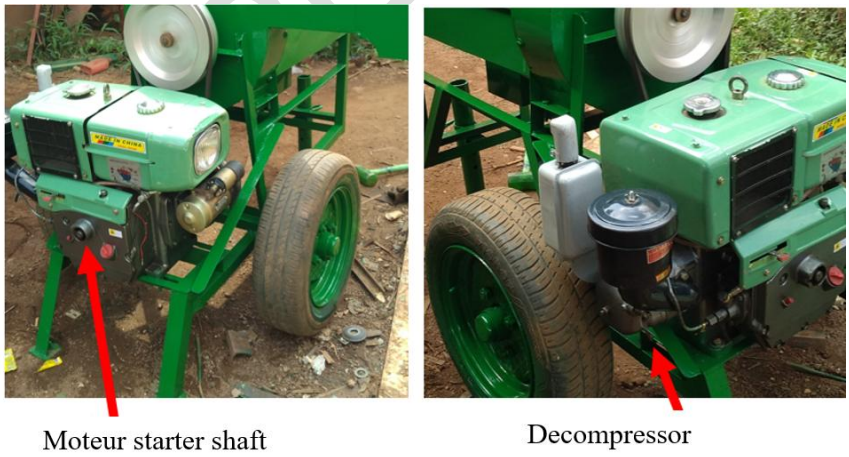

Fig. 3. Sheller motorization system

3.1.4 Technique for introducing the material into the gin

The raw material is loaded into the ginning chamber through the hopper. A regular supply of raw material in the ginning chamber ensures a regular expulsion of broken or topped stems or pods depending on the type of raw material and ginned seeds.

3.1.5 Verification and quality control at work

Quality control at work is carried out by observing:

- the state of the raw material at the exit of the ejection chamber, whether or not there are unginned grains on the stems;
- the condition of the ginned grains at the exit of the spillway, whether the grains are broken or not (rate of grain breakage).

3.1.6 Treated products and bio-parameters of use in equipment

The processed products are maize, cowpea, millet and sorghum.It is strongly recommended that the products should be dry and dispatched for corn, in order to achievebetter yield.

3.1.7 Maintenance of equipment after use of the gin

After use, it should beensured that, there are no elements left in the ginning chamber by leaving the engine running to evacuate all the raw material; a clean cloth should afterwards be used clean the engine. Depending on the ~~number of~~ hours of operation (100, 150, or 300 hours), an overhaul must be performed by lubricating the bearings and changing ofthe transmission belt, engine oil, oil filter, and fuel filter of the engine. The recommended motor oil is SAE 40.

3.2Powered winnower

3.2.1 Technical and operational presentation of the powered winnower

The motorized winnower is used in the post-harvest treatment of cereals to rid them of impurities. The functional organs of the equipment are:

- feed hopper;
- fan;
- spillways;
- output channel;
- thermal engine.

Fig. 4. Motorized winnower

3.2.2 Winnower settings

The main setting is the amount of air current passing through the product to be winnowed. It is carried out at the hopper closing valve (Fig. 5). Fixed on a guide, the valve can be opened to 25, 50, 75 and 100%. A 25% opening offers acceptable cleaning quality and productivity.

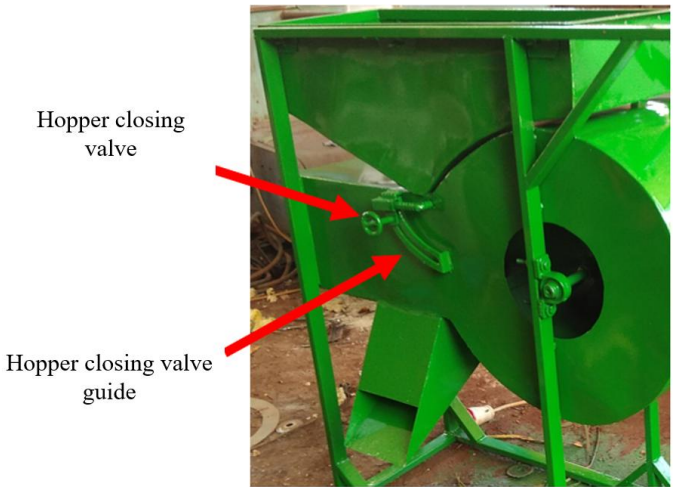

Fig. 5. Adjusting devices of the motorized winnower

3.2.3 Operational start-up of the winnower

The equipment is operationally started by cranking the engine (Fig. 6). Starting is done by quickly turning of the crank positioned in the axis of the engine launcher, while decompressing the combustion chamber of the engine. After a few seconds of continuous crank rotation, the operator releases the pressure relief lever and simultaneously removes the crank so that the engine can start. After starting, it is advisable to let the engine idle for a few seconds before accelerating to working speed.

Fig. 6. Winnower motorization system

3.2.4 Winnower feeding technic

Once the machine is running, the hopper is filled with the raw material to be winnowed. Then the operator opens the winnowing chamber supply valve through the closing tab. The airflow generated by the fan blows over the free-falling raw material and passes through it into the winnowing chamber, taking dust, dead leaves and other impurities with it. Clean grains are collected by the outlets arranged on the sides of the drainage channel.

3.2.5 Verification and quality control at work

Quality control at work is carried out by observing:

- the condition of the raw material at the exit of the spillway of the clean product (presence or absence of impurities). The raw material must be cleared of any debris;
- the outlet channel of impurities (the presence or absence of grains in the impurities). The outlet channel must evacuate the maximum of impurities without the presence of grains.

3.2.6 Treated products and bio-parameters of use of equipment

The processed products are cereals and all dry agricultural products. The humidity level must be as low as possible to ensure optimal cleaning.

3.2.7 Post-use maintenance of equipment

After use, it should be ensured that, there are no items left in the hopper and clean the equipment and engine with a clean cloth. No material should remain in the ventilation channel depending on the number of hours of operation (100, 150, 300 hours) performed, lubrication of the bearings and replacement of the transmission belt if it has significant cracks and breaks, change the engine oil, wash the oil filter and change the fuel filter of the engine. The recommended motor oil is SAE 40.

3.3. *Engelberg* cereal husker

3.3.1 Technical and operational presentation of the *Engelberg* husker

The *Engelberg* cereal husker (Fig. 7) is the motorizationof the husking system and the incorporationof asystemfor suctioning the brans and husks and / or bleaching of the products.The products treated by the husking are cereals (maize, rice, millet, sorghum). Itincludes:

- a frame on which the husking chamber and the feed hopper are seated;
- ahusking and laundryroom;
- awinnowing-suction mechanism for dust and other impurities;
- atransmissionmechanism with electric or thermal motor depending on the choice: in this case the choice is an electric motor;
- recovery outputs of husked grains;
- an exit through the silo of bran and flour, rice husks and other unwanted dirt;
- a frame on which is the engine.

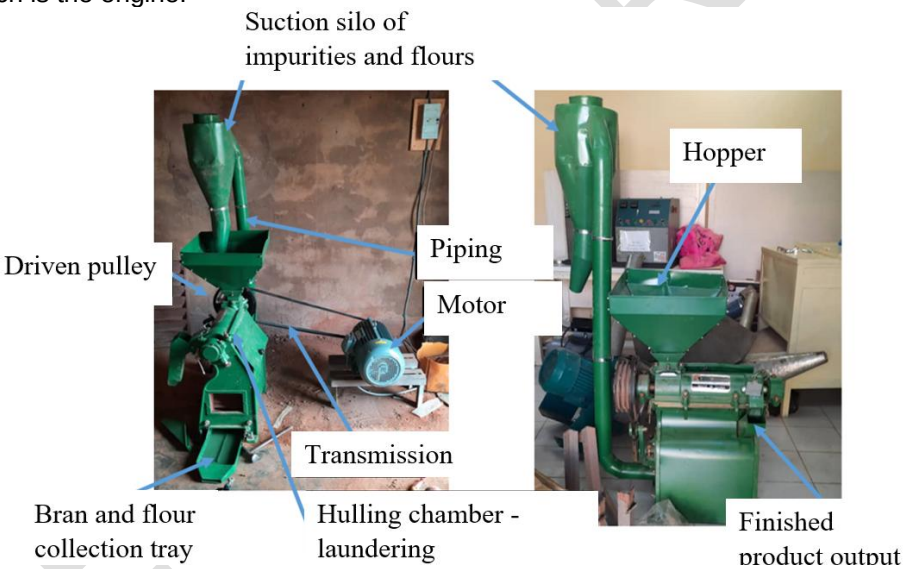

Fig. 7.Cereal husker

3.3.2 Husker settings

The adjustments to be made on the equipment before any work operation are: closing the feed hatch, checking the correct attachment and tightening of the vacuum cleaner, checking the sieve mounted by checking its tightness, tightening the two locking screws of the husking chamber cover.

3.3.3 Operational start-up of the husker

After checking the tightening of the various mounting bolts and the tension of the drive belt, the motor is started. Once the speed of rotation of the motor and the shelling drum in the husking chamber stabilized at that of the work; the operatorloads the product (slightly moistened) into the hopper, with the feed opening of the husking chamber closed. Subsequently, he places a container for the recovery of the finished product under the outlet of the finished product and then places a bag attached to the exit of the silo. It opens the closing valve of the husking chamber and closes the exit of the finished product. While the husking chamber receives the raw product, its outlet closed, the internal pressure of the chamber increases. When the machine operator notices that the engine appears to be choking or spinning, he opens the

exit of the finished product. While the husked product begins to come out, it adjusts the feeding of the cage in such a way as to maintain the almost constant pressure in the chamber.

3.3.4 Technic of introducing the material into the equipment

The product to be husked is loaded into the hopper when the feed hatch is closed. When the engine is started, the hatch is opened gradually and the product enters the husking chamber. The operator feeds the husking chamber manually through the orifice provided for this purpose.

3.3.5 Verification and quality control at work

The quality at work is given by the sound noise of the machine which must not squeak and the finished product obtained at the exit whose quality is observed by eyes. Also, the husked cereals and the bran must be well separated from each other.

3.3.6 Treated products and bio-parameters of use in equipment

The processed products are cereals (maize, rice, millet, sorghum). The products must be slightly moistened to ensure optimal husking.

3.3.7 Post-use maintenance of equipment

Maintenance of the husker after useconsistsof:

- cleanthe husking chamberand drum after the husking operation and removetheperforationsof therackscontaininglargerice grains andhusks or other cereals;
- greasethebearings;
- adjust the tension of the belt after alignment of the driving and driven pulleys.

3.4Hammer mill

3.4.1 Technical and operational presentation of the hammer mill

The hammer mill (Fig. 8) is powered by an electric motor and is composed of:

- a frame in mechanically welded structure consisting essentially of two U's and a heavy sheet. It carries the whole device;
- a feed hopper equipped with a hatch that allows the regulation and channeling of the product into the milling chamber;
- a grinding chamber consisting mainly of a rotor on which are mounted movable hammers and a sieve with interchangeable fine mesh;
- a cyclone that allows the channeling and suction of the finished product at the exit.

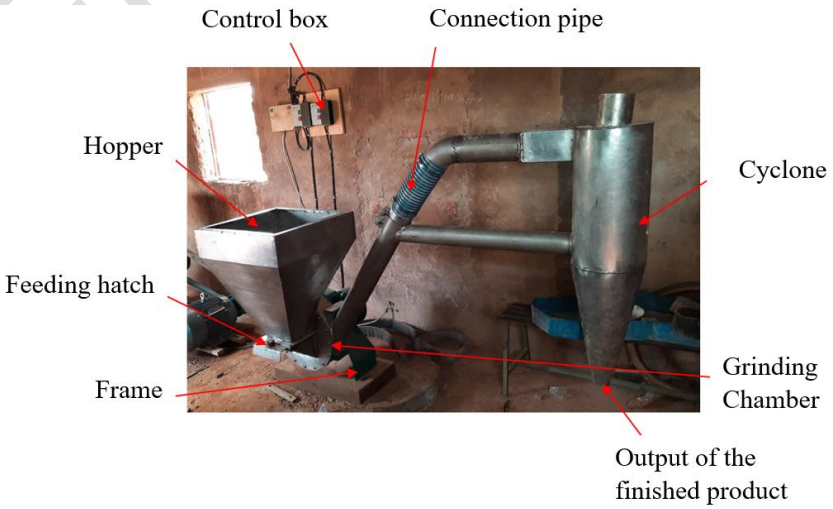

Fig. 8. Hammer mill

3.4.2 Hammer mill settings

The adjustments to be made on the equipment before any work operation are: closing the supply door (Fig. 8), adjusting the cyclone position (Fig. 8) (height of the outlet of the finished product from the ground) while checking the tightening and tightness of the connecting pipe.

3.4.3 Operational start-up of the hammer mill

The operator starts the equipment by pressing the green button on the control box that represents the start button. The product to be crushed is loaded into the hopper when the feed hatch is closed. The hatch is opened gradually and the product pours into the basin placed under the cyclone. The operator feeds the grinding chamber manually through the hole provided for this purpose. The product is decent by gravity and is crushed thanks to the movable hammers fixed on the axis of the drive rotor. Once crushed, the grinds pass through the fine-mesh sieves and are sucked by a cyclone thanks to the rotational inertia of the hammers. This operating principle shows that at the end of the flow, an almost negligible amount remains clogged on the walls of the milling / crushing chamber. The rate of clogging of the product on the walls of the grinding chamber depends on the moisture content of the cereal. The product must therefore be well dried beforehand. Note that this equipment does not have scrapers of the walls of the grinding chamber. The equipment is stopped by pressing the red button on the control box which represents the stop button of the equipment.

3.4.4 Technic for introducing the material into the hammer mill

The products processed by the mill are dry cereals. The product to be crushed is loaded into the hopper when the feed hatch is closed. When the engine is started, the hatch is opened gradually and the product pours into the bowl placed under the cyclone. The operator feeds the grinding chamber manually through the hole provided for this purpose.

3.4.5 Verification and quality control at work

The quality at work is given by the noise of the machine and the finished product obtained at the exit whose quality is observed by eyes and depends on the meshes of the sieve used.

3.4.6 Treated products and bio-parameters of use in equipment

The products processed by the mill are dry cereals.

3.4.7 Maintenance of the hammer mill after use

The maintenance of the hammer mill after useconsistsof:

- clean the grinding chamber;
- control the tightening of the cyclone.

3.5 Flour roller

3.5.1 Technical and operational presentation of the roller

The flour roller is an equipment used to produce cereal flour lumps. These lumps are then dried and valued in the preparation of porridges and dèguè. The equipment makes it possible to obtain four types of lump gauge namely, 2 mm, 3 mm, 4 mm and 6 mm particle size.The functional organs of the roller are (Fig. 9):

- a frame made of ordinary steel;
- a stainless steel drum;
- a stainless steel hopper;
- four recycling bins.

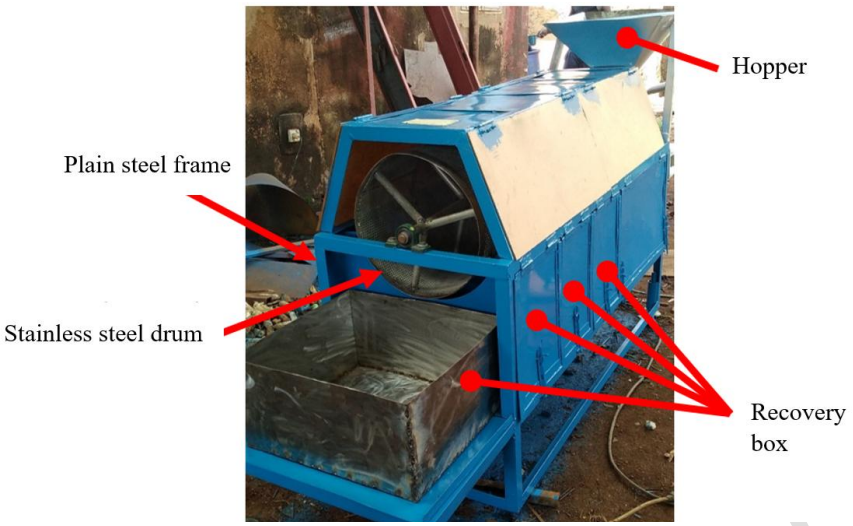

Fig. 9. Flour Roller

3.5.2 Wheel settings

The adjustment is made at the level of the inclination of the rolling drum of the equipment. Indeed, to ensure a good descent of the rolled product, it is necessary to create a slope of at least 15 ° degree by lifting on the side of the hopper. To do this, simply remove the support legs from the chassis by unscrewing them to the desired height.

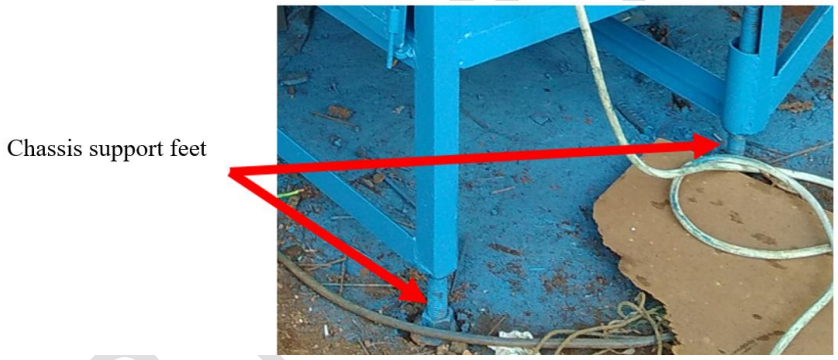

Fig. 10. Device for adjusting the angle of inclination of the roller taken at the end of manufacture

3.5.3 Operational start-up of the roller

The wheel roller is operationally started by pressing the power switch (Fig. 11).

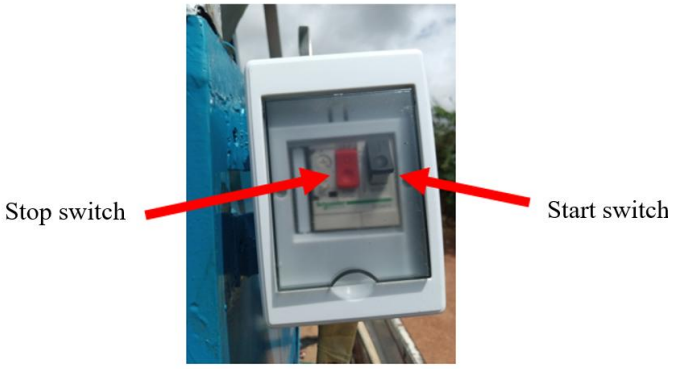

Fig. 11. Device for starting and stopping the roller

3.5.4 Roller supply

The processed product is mainly wet flour. The maximum recommended humidity level is 55% to avoid any risk of clogging. The raw material, which is flour moistened with 55% water or 0.55 liters of water per 1 kg of flour, is introduced into the drum through the hopper which is equipped with a sieve. For uniform particle size, it is advisable to use the sieve by crumbling the product through its mesh. This has the advantage of facilitating the forming of granules inside the drum.

3.5.5 Verification and quality control at work

Quality control at work is carried out by observing: the condition of the cereal flour granules at the outlet of the various weirs. The granules must be of regular shape and size and well compact.

3.5.6 Post-use maintenance of equipment

After use, the equipment is cleaned. There must be no residues or treated matter in either the hopper or the drum. Equipment is cleaned with a clean cloth or sponge. If there is a grinding noise, check the bearings and grease them.

3.6 Flour sieve

3.6.1 The technical and operational presentation of the sieve

The sieve (Fig. 12) is motorized. It is a removable mechanical-welded assembly composed of:

- a frame in mechanically welded structure consisting essentially of angles. It carries the entire device and rests on four (04) anti-vibration legs;
- a pulley-belt transmission system, towed by an electric motor, which transmits rotational movements;
- a closing cover with a window that allows the feeding of the sieving cage;
- a sieving system consisting of the sieving cage / hopper and the stainless steel sieve, it allows to sift the flour;
- a stair-shaped exit channel of the finished product with a narrowed outlet, made with stainless steel material, it channels the sifted product to the product recovery/storage output;
- an eccentric system consisting of bearing, eccentric cage and lever that transmits vibration movements to the sieving system through rotational movements;
- four (04) arms consisting of rods, bearings and bearings that support the sieving system and facilitate vibration movements;
- an electrical control part consists of an electrical box that contains the electrical elements such as the contactor, the motor circuit breaker, the lights and the push buttons that allow the control of the motor (turning on and off the motor).

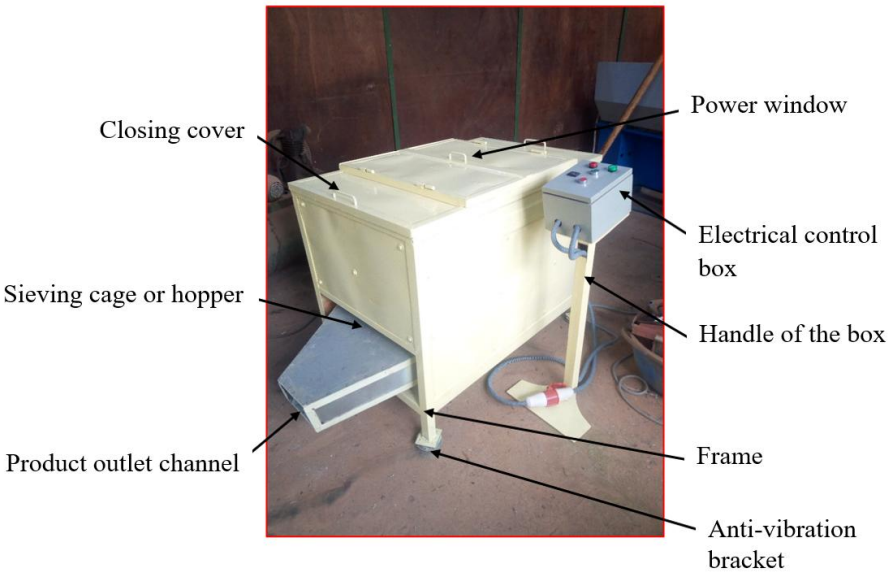

Fig. 12. The flour sieve

3.6.2 Sieve settings

The settings of the sieve consist of:

- arrange equipment on a flat surface or set the zero level using a water level;
- place the control device next to the operator to facilitate work and stop the equipment in case of malfunction (Fig. 12);
- check the tightening condition of the sieve;
- lock the sieve in the sieving cage by means of the hinges intended for this (Fig. 12);
- position the container tightly under the outlet channel of the sieved product (Fig. 12).

3.6.3 Operational start-up of the sieve

Turning on the equipment consists of:

- press the green button to start the engine, the green light on shows the engine powering up;
- correctly arrange the container to recover the product at the exit of the hopper;
- pressing the red push button allows the engine to stop.

3.6.4 Technique of introducing the material into the sieve machine

To introduce the flour it is necessary to open the window at the level of the upper cover, gradually introduce the flour at the level of the sieving box. It is necessary to prevent the product from overloading the machine. The residues are recovered using a squeegee on the sieve.

3.6.5 Verification and quality control at work

Verification and quality control of work consists of:

- checking the product obtained is homogeneous and well sifted;
- checking that the product comes out correctly at the sieving cage;
- checking that the residue has not clogged the mesh of the sieve.

3.6.6 Treated products and bio-parameters of use in equipment

The processed product is essentially well-dried flour. The humidity level must be almost zero to avoid any risk of clogging.

3.6.7 Post-use maintenance of equipment

Maintenance of equipment after use consists of:

- properly cleaning the sieve and hopper after use;
- checking the correct belt tension;
- greasing the turnover from time to time;
- closing the power window correctly.

4. CONCLUSION

The procedural approach for the start-up, utility and maintenance of the cereal processing equipment was explicitly elucidated in this work. As potential tools for training purposes, a case study of selected manipulators of cereal processors was carried out in Dédougou,Mouhoun province, Burkina Faso. The outcome has strengthened the technical capacities of the manipulating technical personnel towards the operational and technical management of the equipment in the cereal processing unit. certaincereal processing equipment found in the Allah Komi scoop were use as test-bed for the training. The work focused on the technical and operational presentation of the equipment, the treated products and the bio-parameters of use of the equipment, and their maintenance methods after use. At the end of the training the practical knowledge of the learners was assessed and the results obtained are very satisfactory. However, this document is made available to processors as a memory guide for better use and maintenance of the unit's equipment.

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