Performance of a Newly Fabricated Finger Millet Processing Machine

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Abstract

Finger millet (*Elucene corocana*) grain is highly nutritious, being richer in protein, fat and minerals especially in calcium and iron compared to rice. It has an increasing demand in the health market because, most diabetic patients are eager to include finger millet in their diet. Considerable amount of finger millet are being lost during post harvest operations as there is no efficient method to thresh, de-husk and clean finger millet at present except manual application, which is laborious, difficult, time consuming and provides low quality output. The general objective of this research was to investigate an efficient method for threshing, de-husking and cleaning finger millet by mechanized process. Thus, finger millet threshing, de-husking and cleaning machine was developed. Main components of the machine were feeding unit, threshing unit, de-husking unit, separation unit, winnowing part, and the frame of the machine. A belt and pulley system was used to transmit the power from single phase 746 W, 1500 rpm electric motor to the machine. The machine was evaluated and received satisfactory results. It performed at a rated capacity of 32 kg/hr with total grain input of 29.92 kg/hr. The threshing efficiency was 94.3%, and the cleaning efficiency was 92.5%. The percentage of threshing recovery was 93.7. These results revealed that the developed machine is appropriate for finger millet threshing, de-husking and cleaning process via improving its efficiency.

Key words: Finger millet, Threshing, De-husking

Introduction

Finger millet is a cereal constitutes a major component of diet consumed in developing countries. In Sri Lanka, finger millet cultivation is popular among farmers who engage in dry zone chena cultivation. The finger millet is the richest source of calcium and iron among all the cereals. It is considered to be one of the least allergic and most digestible grains available. It is a popular food among diabetic patients in the country at present. Its slow digestion indicates low blood sugar levels after a finger millet diet thereby reacting as a safer food for diabetics.

A major problem confronting the finger millet industry in Sri Lanka is the complicated post harvest operations. There is high wastage, high damage percentage and high percentage of impurities due to currently practice manual threshing, de-husking and cleaning method. High labour force should be utilized for the processing and high labour wedges pose problem to farmers and also high production cost. Therefore it is important to mechanize this process at present. Appropriate machines and process line should be identified that can be affordable to small and medium scale producers for reduce cost and increase the quality, efficiency and capacity of production.

The general objective of this research was to design and development of appropriate finger millet threshing, de-husking, and cleaning machine to mechanize the finger millet processing line. The specific objectives were; to develop a suitable design, to fabricate and make a prototype and to test the prototype for performances, add some modification if necessary and to conduct the performance test of the final version of the machine and make required recommendations. Thus the machine will increase the quality of grains, feeding capacity and reduce the cost of production than manual method.

Methodology

After investigating the machine requirements, the main components of the machine were identified as feeding unit, threshing unit, de-husking unit, separation unit, winnowing part, and the frame of the machine.

The feeding hopper was designed to V-shape and it was welded to the feeding hole of housing of the threshing unit. The threshing unit was designed to separate the grains from their panicle. It was mainly consisted auger and auger housing. The threshing unit housing was mounted on the stand of the machine with the use of two "A" shaped frame (250 mm) which mounted on the stand using 10 mm nut and bolts. The stationary plate of the de-husking unit was fixed to cover the plate of the de-husking unit. Then the auger with rotatable plate was inserted to the housing cover of the threshing unit and fixed the housing of de-husking unit by nuts and bolts. Then two pulleys were fixed both end of the auger. The separation unit mounted on the top of the frame and below the de-husking unit. The separation and seed collecting hopper was designed as single vibrating unit. The vibration of the unit was generated by decentralized bush. Middle axel was fixed to the machine with the use of which was two 230 mm steel angle iron welded on the frame of the machine. Winnowing unit was consisted with mainly a fan. The fan was fixed to the frame at height 250 mm from the floor. Fan cover and belt cover were made as safety guards by steel net.

Single phase 746 W, 1500 rpm electric motor was used to drive the mechanism and was mounted and fixed to the stand. The external parts of the machine were painted to stop the corrosion. B section belt and pulley were used as the power transmission components. The pulleys were attached to the six different places in the machine such as motor, both ends of auger, fan unit, decentralized bush and separation unit. The frame of the machine was designed to tolerate the weight and vibrations of the machine and to convenience to the operator.

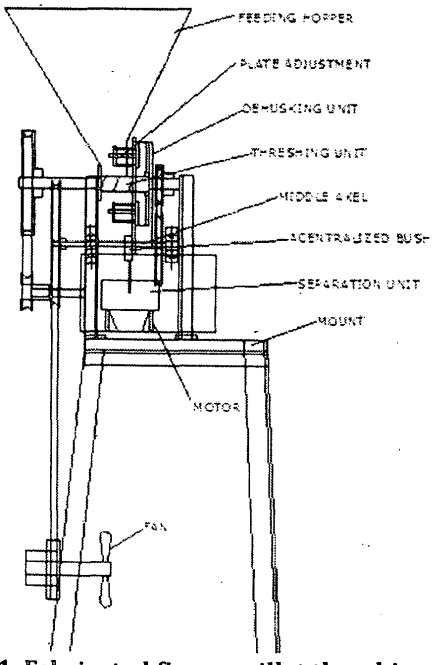

Figure 1. Fabricated finger millet threshing, de-husking and cleaning machine

The feeding, threshing, de-husking, separating, and winnowing units of the machine were assembled as figure 1. The designed machine was tested for its machine capacity, total grain input, damaged grain percentage at all outlets, blown grain percentage, grain losses percentage, un-threshed grain percentage, threshing efficiency, cleaning efficiency, and percentage of threshing recovery using standard formulae (RNAM 1995).

Results and Discussion

The length, width and height of the machine were 860 mm, 460 mm and 1035mm respectively, with a total weight of 45 kg. The machine was worked on following manner to thresh, de-husk and clean finger millet. Harvested and well-dried finger millet panicles were fed in to the feeding hopper. The feeding rate was controlled by the revolution speed of the motor. Finger millet panicles were threshed and then carry to the space between the de-husking plates by the auger. The rubbing action of stationary and rotatable mild steel plate was used to remove the grains from the panicles and to remove seeds from their seed husks. The separation unit below the threshing unit facilitates threshed grains to directly enter to the circular shaped sieving part. The cleaning of the seeds was done in two stages. In first stage the large size impurities were removed by the sieve part and seeds collected to the rectangular seed collecting hopper. In second stage the light impurities were separated by the winnowing unit. The dust and other impurities were blown out by blowing unit. The cleaned seeds were collected to the external bucket.

The power transmission pathway was motor to auger left, auger right, middle axel right, middle axel left, separation unit and then fan unit. As a result of the modification of the decentralized bush, the over vibration was stopped and splitting of grains was

stopped after elongation the outlet of the de-husking unit.

The average threshing capacity was 32.36kg/h. The average percentage of damaged grain at all outlets was 0.58. Manually 10-12% damaged grain percentage could be available in finger millet process. The seed damage was reduced due to rubber attached plates. The average percentage of blown grain was 0.83. When design of this machine was used 1 mm^2 sized a sieve to separate large particle from the seeds. Only dust, fine particles and seeds were collected to the seed-collecting hopper because of that their blowing was easy and minimize the seed blown out. The average percentage of grain losses was 1.41. Normally 15-18% of paddy yield is wasted during processing practices yearly. When compare with combine thresher grain losses are very low of this machine. The average threshing efficiency was 94.3%. The average cleaning efficiency was 92.4%. The cleaning efficiency is reduced when finger millet harvested with long stock or immature pods. Then the average cleaning efficiency was 92.5%. The percentage of threshing recovery was 93.6. The obtained results from the fabricated machine indicated that it can successfully use for finger millet threshing, de-husking and cleaning process than the current manual method.

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