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Design, development and performance evaluation of a hand operated maize sheller

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ABSTRACT : The research was conducted on design, development and evaluation of hand operated maize sheller in College of Agricultural Engineering during the year 2012-2013. Maize (*Zea mays* L.) is one of the most important cereal crop in the world agricultural economy. It is called as queen of cereals and king of fodder due to its great importance in human and animal diet. The traditional shelling methods are rubbing the maize cobs against each another, rubbing on bricks or stone and by using iron cylinder consisting of wire mesh inside. These methods are time consuming involves drudgery. In view of this, the study was undertaken to design, development and evaluation of hand operated maize sheller. The maize sheller consisted of a cylinder and a concave. The cylinder made up of high carbon steel of size diameter 21 cm. The cylinder length 86 cm, having beaters which rotates along the cylinder and separates grains from the cobs. While the concave was fabricated using 5 mm size mild steel rods. The length of concave was 91 cm with slotted opening size of 30.3cm×2.5cm. It was observed that for hand operated maize sheller at a moisture content of 12% w.b., and at a feed rate of 130kg/h, the shelling efficiency, unshelled percentage and visible damage was found to be 99.56%, 0.44% and 1.07%, respectively.

KEY WORDS : Maize sheller, Shelling, Cylinder, Concave

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Maize (*Zea mays* L.) is one of the most important cereal crop in the world agricultural economy. It is said to have originated from Mexico several thousand years back, even before Columbous landed in south America. It is also known as corn, is the world's third most important cereal crop after wheat and rice. It has very high yield potential and is commonly known as "queen of cereals".

Maize contains about 10% proteins, 4% oil, 70% carbohydrates, 2.3% crude fibre, 10.4% albuminoides and 1.4% ash. Maize has significant quantities of vitamin A, nicotinic acid, riboflavin and vitamin E. (Naveenkumar and Rajshekarappa, 2012). World produces about 856 million tons of maize, whereas India produces about 21.76 million tons (2011-12), (*www.indiastat.com*). It is grown over an area of 8.33 lakh hectares in Andhra Pradesh with total production of 36.58 lakh tones (*www.indiastat.com*).

Shelling is one of the important post harvest technology operation where the kernels are to be separated from the cobs to use as seed, fodder, oil extraction and to prepare the value added products and also to maintain the quality of end product (Singh and Singh, 2010). The traditional method of separating the kernels from cobs is by pressing with fingers or with sickle are time consuming and tedious. The maize shellers which are manually or power operated, are used to remove the corn pearls from the cobs. There are hand-held devices of various designs and outputs *i.e.*, small rotary hand sheller, free standing hand shellers, small/large hand operated shellers with cleaning and grading facilities. Various types of manually and power operated maize shellers have thus been developed and evaluated (Ali *et al.*, 1986). Hand operated rotary maize shellers have been found suitable for small and marginal farmers for shelling maize, especially for seed purposes, as damage grains are lower in comparison to power operated maize shellers. The large power operated shellers are provided with loading, cleaning, grading and bagging facilities, but they are not affordable by small and medium farmers. In view of this, it is highly essential to develop a continuous hand maize sheller for enhanced capacity with low grain broken percentage hand operated maize sheller for the benefit of small and marginal farmers, especially for seed purposes.

The present study was undertaken with objectives, to design, development and performance evaluation of hand operated maize sheller.

METHODOLOGY

Constructional features:

Details of different parts of the maize sheller (Plate 1, 2 and 3):

Frame:

The frame was made up of mild steel. The overall dimensions of frame were 92.5 cm length, 85 cm width and 136.5 cm height. The sheller unit was fixed to this framework. The frame has a bottom set, stand, flywheel.

Cylinder:

It is made up of high carbon steel of 21 cm diameter. The length of cylinder was 86 cm having adjustable metal pegs/ spikes which are placed at a spacing of 9 cm in equally spaced in four rows which rotate along the cylinder and separate grains from the cobs.

Hopper:

The hopper was fabricated in trapezoidal shape, using mild steel of 18 gauge thickness and dimensions of 28 cm length, 18 cm width and 39 cm height. It is placed on the outer casing for feeding the maize cobs.

Concave:

The concave was fabricated using 5 mm mild steel rods. The length of the concave was 91 cm with slotted opening size 30.3 x 2.5 cm. It was fabricated using two half round rings on which 5 mm mild steel rods were welded at spacing of 2.5 cm. The clearance between concave and cylinder was adjustable but normally it is around 2 to 3 cm.

Outer cover:

It was made up of 16 gauge mild steel sheet and was bent to semicircular shape of diameter 43.3 cm and was rigidly fixed to give protection to the cylinder and to avoid grains spilling out. It has a provision for attaching to hopper. A flange was attached to it along the length to facilitate cleaning of inner cylinder.

Rotor shaft:

It was the main key component of the machine on which flats of cylinder, bearing and fly wheel were mounted. A 10 cm bearing attached to the shaft was connected to the rotating pulley of 30 cm diameter using a 'V' belt. The power was transmitted from pulley to bearing through 'V' belt which will facilitate in rotation of fly wheel.

Outlet:

The outlet is made up of metal sheet which is placed at the bottom of the shelling cylinder to collect the grains without shattering outside.

Working of the sheller:

The developed sheller was tested as per the standard procedures (Indian Standard test code for power maize sheller IS: 7052.1973) for combination of various moisture contents *i.e.*, 10, 12, 14, 16, 18 and 20 % w.b. and different feed rates *i.e.*, 120, 130 and 140 kg/h. These three feed rates corresponded to 300, 330 and 350 rpm of the cylinder, respectively. Before starting the actual testing, direction of rotation of pulleys was checked. The clearance between cylinder and concave was determined using vernier calipers. The cylinder speed was also recorded using a tachometer. The specifications of hand operated maize sheller are given in Table A.

Table A : Details of the construction features of hand operated maize sheller

Particulars	Hand operated maize sheller
Frame	92.5×85×136.5 cm
Hopper	28×18×39 cm
Outer cover	27.4 cm
Cylinder	21×86 cm (Diameter×Length)
Concave	Concave with 91 cm length and 2.5 cm slot opening
Cylinder concave clearance	Adjustable (2 to 5 cm)
Transmission system	Belt and pulley
Fly wheel	16 inch diameter flywheel

Front view Side view

Plate A : Hand operated maize sheller

The maize cobs from each treatment combination samples were fed continuously through the hopper. The rotating beaters produced two kinds of forces namely impact and shearing which caused to remove grains from maize cobs and kernels were collected at the bottom end of the outlet. Two persons were engaged for these operations, one for feeding maize cobs at hopper and the other for rotating the pulley.

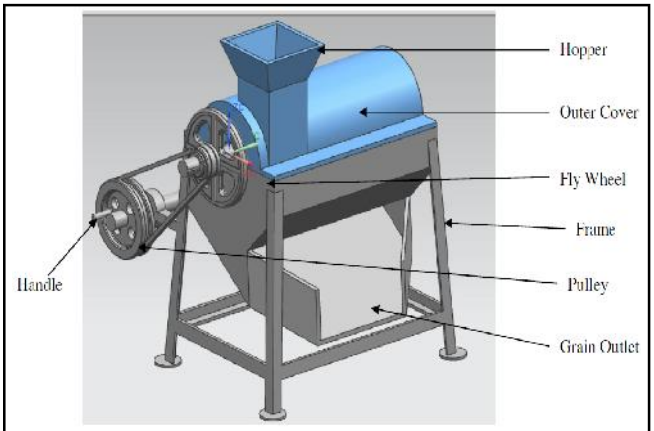

Plate B : Overall view of hand operated maize sheller

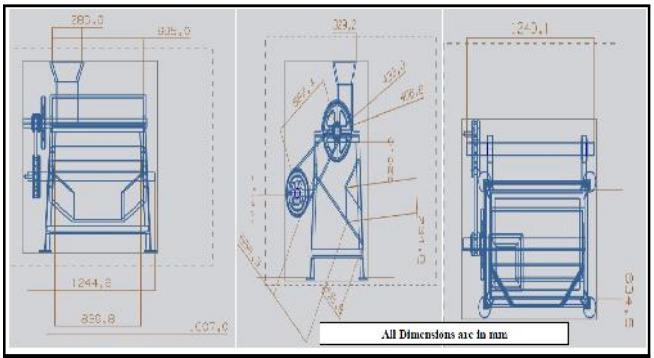

Plate C : Schematic diagram of hand operated maize sheller

The shelled grains were collected at the bottom of the outlet.

Weight of whole grains, broken grains and unshelled cobs from all outlets were recorded and time of operation to calculate feeding capacity, shelling efficiency and visible damage percentage, were also recorded.

Performance evaluation of hand operated maize sheller:

Shelling efficiency:

Percentage by weight of shelled grains from all outlets of the sheller with respect to total grain input and it was calculated by the following formulae (IS: 7052.1973).

Shelling efficiency(%)=100–percentage of unshelled grains (1)

Determination of total losses:

Grain content:

Ten samples (each sample not less than 1 kg) of the cobs were taken at random. The grain was separated manually and the ratio of weight of grain and shelled cob was taken as grain content. The average of the ten samples was taken as grain and shelled cob ratio (IS: 7052-1973).

Total grain input:

Total grain input = Feed rate x Grain content, kg (2)

Unshelled cobs:

Unshelled grain from all outlets with respect to total grain input, expressed as percentage by weight (IS: 7052.1973).

$$\text{Unshelled gain (\%)} = \frac{\text{100 (quantity of unshelled gain obtained from all outlets in kg)}}{\text{Total grain input in kg}} \quad (3)$$

Visible damage:

Visible damage grains from the specified grain outlet with respect to total grain received at outlet expressed as percentage by weight (IS:7052.1973).

$$\text{Visible damage (\%)} = \frac{\text{100} \times \text{(Broken grains from specified outlets in kg)}}{\text{Total grain input in kg}}$$

RESULTS AND DISCUSSION

The results were analysed with respect to effect of different moisture content and different feeding rate on shelling efficiency, unshelled grain (%) and visible damage (%).

Shelling efficiency at different combinations:

The shelling efficiency of maize cobs was found higher (99.56%) at moisture content 12% w.b. with feeding rate of 130 kg/h as compared to other combination treatments. The shelling efficiency decreased with increase in moisture content at each feeding rate. Decrease in shelling efficiency is mainly due to the difficulties in separation of grains and as result, the percentage of unshelled grains increased (Alonge and Adegbulugbe, 2000). It was also observed that at each moisture content, the shelling efficiency at 130 kg/h feed rate was higher, followed by 140 kg/h and 120 kg/h feed rates (Fig.1.)

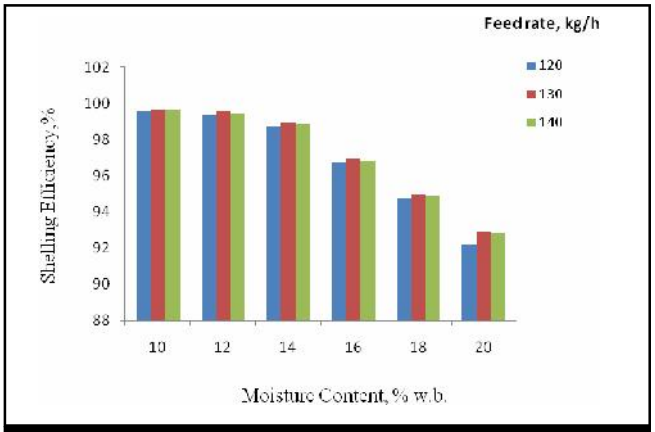

Fig. 1 : Shelling efficiency under different combinations

Percentage of unshelled cobs:

The unshelled grains of maize (0.44%) was found lower when maize at moisture content of 12% w.b. and feed rate of 130 kg/h as compared to other combination treatments. The unshelled grains increased with increase in moisture content at each feeding rate. The increasing of unshelled grain losses at high moisture content is due to the elastic conditions of high moisture content, this may be due to decrease of grain cohesion force with decreasing grain moisture content. It was also observed that at each moisture content, the unshelled efficiency at 130 kg/h feed rate was lower than followed by 140 kg/h and 120 kg/h feed rates, respectively (Fig. 2).

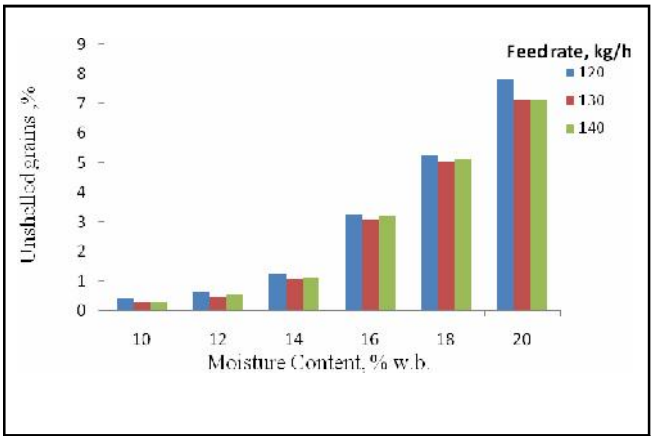

Fig. 2 : Unshelled grains under different feed combinations

Visible damage percentage:

The visible damage percentage of maize (1.07%) was found lower when maize at moisture content of 12% w.b. and feed rate of 130 kg/h as compared to other combination treatments. The visible damage percentage increased with increase in moisture content at each feeding rate. This result may be attributed to the fact that the grain is soft at the higher grain moisture content level and becomes more brittle at low moisture content level, so that it could damage easily by the shelling process. It was also observed that at each moisture content, visible damage percentage at 130 kg/h feed rate was lower than followed by 140 kg/h and 120 kg/h feed rates, respectively (Fig.3.)

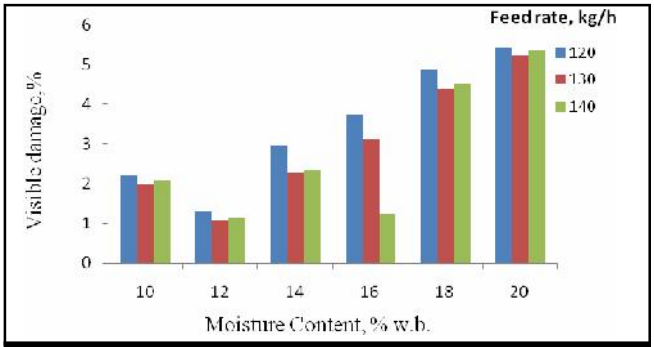

Fig. 3 : Visible damage efficiency under different feed combinations

Conclusion:

It was observed that for hand operated maize sheller at a moisture content of 12% w.b., and at a feed rate of 130kg/h the shelling efficiency, unshelled percentage and visible damage is found to be 99.56%, 0.44% and 1.07%, respectively.

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REFERENCES

Ali, Y., Singh, J., Soni, A. and Maheshwari, A.K. (1986). Economic and technical feasibility of maize deshuking and shelling. *J. Agric. Engg.*, **23**(1): 71-81.

Alonge, A.F. and Adegbulugbe, T.A. (2000). Performance evaluation of a locally developed grain thresher-II. *Agric. Mechanization Asia, Africa & Latin America,* **31**(2) : 51-54.

Indian standard test code for power maize shellers (1974). IS:7052.1973**.** New India Printing Press, New Delhi, INDIA.

Naveenkumar, D.B. and Rajshekarappa, K.S. (2012). Performance evaluation of a power operated maize sheller. *Internat. J. Agric. Engg.*, **5**(2):172-177.

Singh, S.P and Singh, P. 2010. Hand operated maize dehusker-sheller for farm women. *Agric. Engg. Today,* **34**(1): 25-29.

WEBLIOGRAPHY:

Production of maize in India [online], Available to: *http://www.indiastat.com*, [Accessed 23, April, 2013].