Design and Development of Portable Corn Huller

[1]Rakshith M B,[2]Rohan Hajeri,[3]Sanket Lahoti, [4]Sarfrajahamad and [5]Avinash S
[1]Studentand [2]Assistant professor
[1,2,3,4,5]School of Mechanical Engineering,
REVA University, Bengaluru,India

Abstract:In India, corn is one of the major crops being consumed for industrial usage besides its use as food for human and feed for animals. It can also be used to produce a large variety of food and non-food products. After harvesting these crops and finally shelling of cob is to be done by hand to remove its outer shell in traditionally way that is by beating the de-husked cobs with sticks or with requires more man power in terms of energy and time. So there is need for design and developing a "Self Reliable Cost Effective Portable Corn Huller". This project is being planned and executed based on the present situations for shelling of corn seeds from the cob. This prototype consists of feeding cup with spring suspension, the hulling disk driven by the flywheel and the collecting bucket with mesh which separates the hulled corn and cobs.

Keywords-Portable corn huller, cost effective and de-husking.

1. INTRODUCTION

Maize (*Zea mays* L.) said to have originated in tropical zones of America is the third most important cereal crop in the world, next to wheat and rice. World maize production is estimated 856 million tons in 2011/2012 (Ashwin and Shaik, 2014). Maize contains starch (60%-80%), protein (8%-12%), fat (3%-5%) and minerals (1%-5%) Sexena et al. [1]. It is the cheapest source of starch,proteinnutrientsforhumanbeingandanimalsandserving asabasicrawmaterialfortheproductionofstarch,oilandprotein, alcoholic beverages, food sweeteners and, more recently, fuel. In Ethiopia, maize grows from moisture stress to high rainfall areas andfromlowlandstothehighlands.Itisoneofthemostimportant cereal crops grown in the country and is the main staple food in rural areas. It accounts over 14 % and 18% in terms of land area coverage and productivity respectively with higher annual growthrate.Ethiopiaisthelargestmaizeproducerin Easternand SouthernAfrica.Over8smallholderfarmersareengagedinmaize productionandthisaccounts28%thetotalcerealproduction.The total maize production in 2010/2011 was estimated 4.98 million tonsDemekeetal.[2].Theoverallproductivityofmaizeisaffected by many factors including lack of post-harvest technologies, such asshelling.Maizekernelsshouldberemovedfromcobtobeused as seeds, prepare value addition, improve handling and storage as well as maintain its quality. Shelling which refers removal of kernel from cob is an important post-harvest operation in maize production.Shellingcanbecarriedoutinthefieldoronthefarm. Maize shelling is difficult at moisture content above 25%, with this moisture content, grain stripping efficiency is very poor with high operational energy and causing mechanical damage to the seed.Amoreefficientshellingisachievedwhenthegrainhas beensuitablydryto13to14%moisturecontentDaniloetal.[3]. Maize shelling in Ethiopia is mainly carried out using traditional methods.Themostcommonlyemployedmethodsincludemanual rubbing maize cobs against one another,, using human finger, bitingthecobwithwoodenplank,treadingwithanimal.Likewise the grain can be detached from the cob with the use of pestle and mortal. All these traditional maize shelling methods are highly tedious, inefficient; do not support large-scale shelling of maize requiringalotoflaborandtimewithlowproductivityasaworker can only shell a few kilograms per hour[4].

Kernel damages in the form of bruiser, crack or breakage are inevitable during these shelling methods. Such kernel damage facilitates the infestation of field pests during storage. Attempts were in the past to develop and introduce engine driven and tractor driven high capacity Sheller's. The technology though perfect is not within the reach of marginal farmers. Existing motorized Sheller are too expensive to be purchased by resource poor smallholder farmers. The cost of hiring to get the service is evenhighformostfarmers.BahirDarAgriculturalMechanization and Food Science Research Center has adapted cylindrical hand operated and motorized maize Shellers and preliminary demonstration reveals that farmers have shown interest to use them.

Thus, there is a need to introduce this implement thatreduces post-harvest loss, increase labor efficiency in time and avoid the drudgery and harms to the hand of men and women farmers. Thus, there was a need to demonstrate both of the machines and collectfeedbackfromfarmersthatareusefulforfuturepromotion and modification activities. This was supported by the national strategy that states further strengthening the introductionof suitable post-harvest tools. Therefore, this research activity is conducted; (1) to create awareness in hand-held maize Sheller, and(2)tocollectfarmers'opinionontheftuturedisseminationand use of the technologies and hence contribute to the improvement of the productivity and drudgery of smallholder maize producing farmers.

2. LITERATURE SURVEY

[1] Earl Milton Ladd

The paper focuses on the primary function of the pickup conveyer which is to remove the whole and partial ears of corn from the ground and place them on the combine header. Through field testing, it was found that to adapt to different operating condition, the pickup conveyor should be versatile.

[2] Anant J. Ghadi

This paper focuses on the existing methods of corn de-husking in agriculture industry consist of using large machinery for deseeding breaking the grains by the hand or both which are not affective and are time consuming. Hence there is need for innovative idea or product that is feasible, safe, cost effective and productive for the farmers. Hence it is necessary to design and develop a low cost corn deseeding machine.

[3] Praveen KiranMalil

This literature report is review on human powered machine, the survey proved to system which shows cost effective and functional viable. There are many maize threshing techniques which are used in our life the main problem with these machines are that they are not affordable to farmers who are having acreage farms. So, these farmers resort hand operated tools which gives low output, more damages of kernel threshed from cob, which is monotonous work. These machines are automatic operated; fuel operated which provides simple mechanical design.

[4] Y.V. Mahatale and V.P. Pathak "Physiological Evaluation of Different Manually Operated Corn Shelling Methods" Corn is the Third largest cereal produced in the world with a trend of rising production in India. The normal area for Corn in India was 77.27 lakh hectares with production about 150.91 lakh tones in the year 2007. Rajasthan has the largest area 10.62 lakh hectares under cultivation among all states with total production of 21 lakh tones. Four method of Corn shelling namely shelling cob grain by hand, octagonal Corn Sheller, hand operated Corn Sheller and beating by stick method were carried for removing Corn kernel from the cob. For ergonomically evaluation ten male agricultural subjects of 25-35 yr. age group were randomly selected for study. Present traditional method of shelling Corn has proved to be inefficient, laborious, time consuming and low output. The energy expenditure rate was highest for beating by stick method (3.84 kcal/min) and lowest for octagonal Corn Sheller (1.52 kcal/min). Traditionally Corn is threshed by shelling cob grain by hand and beating the cob by stick. At present Corn shelling has been improved by the use of tubular Corn Sheller and hand operated Sheller. The energy expenditure rate was highest for beating by stick method (3.84 kcal/min) and lowest for octagonal Corn Sheller (1.52 kcal/min). Energy expenditure rate for shelling cob grain by hand and octagonal Corn shelling operation could be scaled in "Very light" category of work load. Whereas the hand operated Corn Sheller and beating by stick method could be scaled as in "Light" category of work load. For Corn shelling operations octagonal Corn Sheller and hand operated Corn shelling are superior than shelling cob grain by hand and beating by stick Method

[5] Ilori T. A., Raji A. O and O. Kilanko "Modeling Some Ergonomic Parameters with Machine Parameter using Hand Powered Corn Sheller"

In this paper the author studied about the economic situation in most developing countries have left farmers and processors operating at the small scale, hence the use of automated and electric power-driven equipment is limited to the few largescale industries. The effect of the ergonomic parameters namely; weight, age, height and arm length in relation to the resulting efficiencies; shelling efficiency, cleaning efficiency, mechanical damage and percentage loss of a hand powered Corn Sheller were studied It was observed by the author that age is more correlated with weight than arm length. From the results obtained in this study, the following conclusions were drawn; the shelling efficiency increase with increases in weight of the operator and significantly with age and arm length. The weight of the operator has a great influence when driving the machine. The mechanical damage observed from the performance evaluation has very low correlation with the ergonomic parameters.

[6] Ashwin Kumar and ShaikHaneefa Begum "Design, Development and Performance Evaluation of a Hand Operated Maize Sheller"

The author conducted a research on design, development and evaluation of hand operated Corn Sheller in College of Agricultural Engineering during the year 2012-2013.The traditional shelling methods are rubbing the Corn 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 Corn Sheller. The Corn 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 by the author that for hand operated Corn 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.

[7] PratimaPandey, JwalaBajrachrya and S Pokharel" Influence of Corn Seed Processing with a Locally Produced Sheller on Seed Quality and Their Damage"

The author says that corn is one of the most important staple crops in the world. It is also the second important food crop in Nepal, that more than 45% of the population in mid-hill and high-hills considers maize meal to be their survival food. Community Based Seed Production (CBSP) is a sustainable agricultural phenomenon implied in hill and high-hills of Nepal under the Hill Maize Research Program in collaboration with Nepal Agricultural Research Council (NARC); CIMMYT, Nepal; Directorate of Crop Development (CDD), with the objective to produce quality seeds of maize at local level and to increase the use of improved quality seeds and eventually increase the crop production. Maize kernels are in general shelled from the cob manually using hands. Manual shelling of maize is labour intensive and typically takes weeks and months for shelling the manual harvest. The mechanized alternatives to shelling maize by hand are available but they are often unaffordable for subsistence farmers. Wooden corn sheller is a simple but traditional device made locally for shelling the maize kernels and distributed to CBSP farmers group. All data observed and analysed in the present study reveals the corn sheller is equally efficient and saved the time, labours and other resources. The corn sheller could be used for maize processing and conditioning.

[8] Oriaku E.C, Agulanna C.N, Nwannewuihe H.U, Onwukwe M.C and Adiele, I.D "Design and Performance Evaluation of a Corn DeCobbing and Separating Machine"

Here the author told that, Agricultural products like maize, soya bean, millet and rice, when processed into quality forms not only prolongs the useful life of these products, but increases the net profit farmers make from mechanization technologies of such products. One of the most important processing operations done to bring out the quality of maize is de-cobbing or threshing of

maize. Consequently, a de-cobbing and separation machine was designed, fabricated and its performance evaluated. Corn at moisture content of 15.14% db sourced locally was used in the experiment and the data collected were analyzed. Results showed that for a total 20kg of sample tested, the average feed and threshing time were 2.37 and 2.95 minutes respectively. The average feed and threshing rates were 2.06 and 1.65 kg/min with an average threshing efficiency of 78.93 %. The average separation efficiency was 56.06 %. These results indicate that threshing and separation can be performed out satisfactorily with the designed machine and it can be used to process about 1 tonne of maize per nine-hour shift.

3. METHODOLOGY

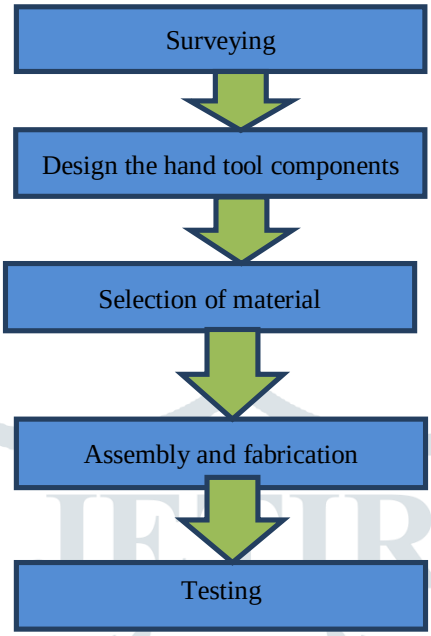

Fig 1-Flow Diagram of Methodology

4. Scope of Present Work

This modified sheller is to be manually operated equipment. Its working also depends upon the operator(s) also on the machine. The operator is to perform the maize shelling operation by rotating a fly wheel and therefore, proper fly wheel height and fly wheel would be necessary for efficient operation of the machine. Improper fly wheel height and shaft length will result in discomfort to the operator and difficulties in the smooth operation of the equipment, thus resulting in lower work efficiency.

In view of the above this paper focuses on energy considerations which arise from among other factors, the physiological and psychophysical responses of the rural farmer during operation of the maize sheller at different shaft handle heights and shaft lengths and to carry out design modification in work system so as to have higher man-machine system efficiency.

5. Objectives

The main aim of this project is to overcome the traditional method.

- To design and fabricate the hand tool.
- To shell the maize of different sizeseffectively.
- It should be manually operated, thus avoiding the need of additional powersource.
- It should not damage the corn grains whileshelling.
- To reduced time to shell the CORN

6. Problem Statement and Problem Analysis

6.1 Problem Statement

For a long time now, shelling maize to remove the grain from the cob has been a time consuming, tedious and a mind cracking process especially to the many small scale farmers in the country who basically practice subsistence maize farming. However, traditional shelling methods do not support large-scale shelling of maize, especially for commercial purposes. Hand shelling takes a lot of time, even with any hand operated simple tools. The most mechanized shellers designed for maize threshing or shelling are tractor PTO shaft operated and cause great damage to the maize seeds likewise breaking the cob to pieces. Such shellers are equipped with rotating threshing drum with beaters or teeth, which cause damages to the seed. Besides, the cost of purchasing such shellers are high for the rural farmer and therefore call for the need of a relatively low cost maize shelling mechanism that will be affordable to such farmers not only to meet their shelling requirement but also to improve the threshing efficiency and reduce damage to the seed.

6.2 Problem Analysis

Many small scale maize farmers opt to shell their maize produce by use of hand, something that is time consuming and tiresome. Shelling the annual maize harvest by hand typically takes weeks with children sometimes kept out of school to help with the work of shelling the maize to meet their daily food requirements. This is because processing food for survival takes priority over education in subsistence farming households since the staple food in the country is maize meal. In addition, the hardened, dry maize can also be painful to shell and lead to hand injuries. For this reason, other such farmers choose to use simple hand held tools which are strenuous as well as slow.

For the large scale maize farmers, those who tend over 10 acres of maize crop for commercial purposes, shelling their produce has not really been a big problem majorly because they have sufficient capital to hire combined harvesters from well established companies and organizations including amongst others KSC and ADC. Alternatively, quite a number of such extensive maize farmers own tractors or they have the capacity to hire tractors which operate sheller machines.

It is in this regard that the design of modified hand operated maize sheller which is typically a thresher for the small scale farmers who tend to maize farms less than two acres. For these farmers, the produce is approximately twenty sacks of maize in cobs or less per acre of cultivated farm.

7. Introduction to components

7.1 Feeding cup

The main part of the easy portable corn huller is the feeding cup. The feeding cup is used to feed the corn to be hulled from above. In order to select the cup standard size of corn cobs was studied and analyzed.

Table 1 - Characteristics ForEar Length Without Husk And Ear Diameter Without Husk (In Middle).

SL.NO	Characteristics	States	Note(3 to 7)
1(*)	Ear: length without husk	Short(<10cm)	3
		Medium(10-15)	5
		Long(>15cm)	7
2	Ear: diameter without husk (in middle)	Small (<4cm)	3
		Medium (4-5cm)	5
		Large (>5cm)	7

Then the size of the cup was selected. The feeding cup has two halves, the first is stationary and contains the hulling disk, the second half is supported by a spring which gives proper tension to the corn cobs while hulling. The secondary half of the feeding cup be opened in order to ease cleaning purposes.

Fig 2 - Feeding Cup When Second Half ofthe Cup Is Open

7.2 HULLING DISK, FLYWHEEL AND SHAFT

The most essential part of the easy portable corn huller is the hulling disk. Hulling disk plays a major part in de-husking the corn kernels from the cobs. The hulling disk contained small protrusions or spokes which is welded on the rotating disk using small cross section. This hulling rotating disk is attached to a shaft supported by bearings to flywheel which is manually rotated by the handing user.This helps the user to manually control the hulling speed according to the feed of cobs and the type of corn cobs being used.

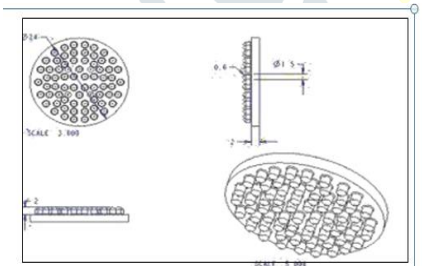

Fig 3 – Hulling Disk Design

Fig 4 - Hulling Disk

7.3 Supporting frame

The supporting frame is the main structure which houses the main mechanism on it. It helps to hold the mechanism intact and under it the collecting unit I placed in order to collect the hulled corn kernels from the corn cobs.

Fig 5 -supporting frame of Tool

8 D-Diagrams in CATIA Software

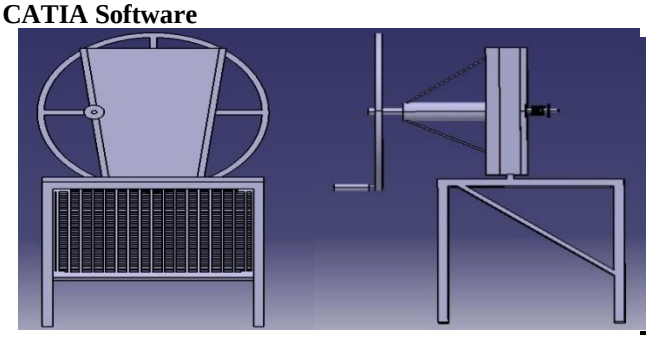

Fig 6 - Front View ofTool

Fig 7 - Side View of Tool

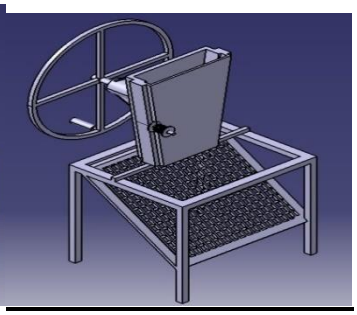

Fig 8 - Iso View of Tool

9 Selection of Materials

For cost evaluation purposes, the following table presents a BEME for the cost list of material of this project modification and possible construction or fabrication of this design's hand operated maize threshing machine.

Table 2 - Raw Materials Required

Sl. NO.	MATERIAL	DIMENSION (mm)	QUANTITY
1.	MILD STEEL (C-SHAPE COLUMN)	25*2*100	3
2.	MILD STEEL(ROD)	10*10*100	1
3.	MILD STEEL (MESH)	50*50*2	1
4.	MILD STEEL (C SHAPE FLANK)	270*30*300	1
5.	BEARING	INNER DIA-20 OUTER DIA-45	2
6.	HAND CUTTER BLADES	DIAMATER-85	4
7.	MILD STEEL(SHEET)	100*100*2	1

10. TESTING

Testing of the product is carried out to find the advantage over the hand shelling. The shelling of corn is done for a period of 10mins and the mass of grain is weighed and noted down in the table.

Table 4 - Experimental Output

	Hand Shelling		Crank Shelling		Difference
SL. N O	Time (seconds)	Weight (gms)	Time (seconds)	Weight (gms)	(gms)
1	600	450	600	2250	1800
2	600	480	600	2480	2000
3	600	500	600	2580	2080
				Mean	1960

As per the values obtained by the practical experiments it is found that the weight of the corn seeds obtained in the corn shelling for 10mins is more than that of the hand shelling as shown in the above table. Three readings are taken down & the mean difference is found to be 1960gms in comparison with the hand shelling.

11. CONCLUSIONS

Crank operated maize sheller is designed and fabricated to meet present objectives and constraints as specified.

1) Crank operated maize sheller does not require electricity to work as it is operated manually.
2) This machine is easy to operate and maintain without any faulty work.
3) It can accommodate different maize of varying in sizes.
4) Maize grains do not get damaged during shelling process.

12. FUTURE SCOPE

1) The process of maize shelling can be automated by using motors to turn the crank and providing timer circuits for reducing human interaction with the process.
2) The crank operated maize sheller produces noise during operation.

To avoid this, improvements can be made in the design. To increase the productivity, the design can be modified in such a way that more than one cob can be inserted at a time.

13. REFERENCES

1) Sexena HK, Ajitha KR, Singh KR, "Assessment of post-harvest storage losses in wheat: case study in East Uttar Pradesh", Indian Journalof Agricultural Marketing, 2000, pp-16-54.
2) DemekeM, "Analysis of incentives and disincentives for maize in Ethiopia", Technical notes series, MAFAP, FAO, Rome, Italy, 2012, pp-1-36.
3) Danilo Mejia, "Maize Post Harvest operation", FAO technical report,Ethiopia, 2003.
4) FAO Country Information Brief Ethiopia. Rome, Italy,1995.
5) Earl Milton Ladd, Jr., B.S., "A Mechanical Design For Recovery Of Corn From Field Residue", A Thesis In Agricultural Engineering Submitted to the Graduate Faculty of Texas Technological College May, 1969,805.
6) Anant J. Ghadi and Arunkumar, "Design, Development and Fabrication of a Low-Cost Corn Deseeding Machine", Volume: 03, Aug-2014.
7) Praveen Kiran Mali, Dr. C. N. Sakhale, S. D. Shelare, "A Literature Review On Design And Development Of Maize Thresher", Volume 3.
8) Y.V. Mahatale and V.P. Pathak, " Physiological evaluation of different manually operated Corn shelling methods"
9) Ilori T. A., Raji A. O and O. Kilanko, "Modelling some ergonomic parameters with machine parameter using hand powered Corn Sheller"
10) B. ASHWIN KUMAR AND SHAIK HANEEFA BEGUM, "Design, development and performance evaluation of a hand operated Maize Sheller"
11) Abdulkadir, B.H., Mattew, S.A., Olufemi, A.O., and Ikechukwu, C.U. "The Design and construction of maize threshing Machine". Assumption University Journal of Technology, 2009, pp-12(3).