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Design and Fabrication of Multifunctional Agricultural Equipment

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Abstract - *All trades of village artisanship in black-smith carpentry, stone etc. contributed to the design of development of farm tools through artisan's ingenuity. Big size of earthenware was made by potters to store grains for month to be safe from insects and pest's cobblers used whole skins of animals to carry water to irrigate horticultural crops besides entering dust roads as an Engineer we extend our hand in helping farmer by fabricating multipurpose agricultural machine. A detailed study is made on need of agricultural machine for developing this multipurpose agricultural machine. The alteration in existing machine was made in significant figure. This project describes the practical implementation of forward thinking trivial solution to various agricultural prorogue seen in premature period. During this mature period the cost which engrossed the farmer has to be reduced complimented with various other adeptness. The indentation of this project is cost reduction with basic amenities like easy compressing mechanism, simple bundling technique without much spill attached with easy detaching system and motor less working model with gear and sprocket arrangement. This model is effective with almost all types of crops and other agricultural crop residues. The crop collection may be effectively utilized by the farmers. The compressing mechanism finds its application in crop residue bundling which is either fed to animals or effectively used for construction of roofs in hut. This project aims at 50% reduction in the production cost of existing model.*

Key Words: Agriculture, straw, harvesting, baling.

1. INTRODUCTION

The history of agriculture in India dates back to the Rig-Veda, written about 1100 BC. Farming has undergone a great evolution in last 50 years. Today India ranks second worldwide in farm output. The economic contribution of agriculture to India's GDP is steadily declining with the country's broad-based economic growth. Whereas the other spectrum, both Industrial and Service sector is receiving the steady increase. Still, agriculture is demographically the broadest economic sector and plays a significant role in overall socio-economic fabric of India. India's contribution on world's agriculture is substantial [1,2].

Crushing of crop residues is on the increase with the global quest for sourcing of renewable energy through pre-processing of bio-masses. Physical and mechanical properties of biomasses species and varieties are very important when considering the energy requirements for particle size reduction of agricultural residues. Of the various types of grinding equipment available, hammer mills are the best known equipment used for the shredding, in which the material fragment are subjected to complex forces and then the resulted particles are used in the following operations from the pellet obtaining technology.

1.1 Straw Collection

Straw are the left over branches of paddy and wheat after harvesting is done. Straw collector is a mechanical device used to collect the straw left on the agricultural fields (such as paddy, wheat fields) after harvesting. A baler is a piece of farm machinery used to compress cut and raked crop (such as wheat, paddy) into compact bales that are easy to handle, transport and store.

There are three main kinds of hay balers:

- small square
- large square
- round balers

Out of the above types, square bales are easier to handle and transport.

2. LITERATURE SURVEY

Hadidi et al. stated that the percentage of wheat and rice grain losses increasing as the machine forward speed increased. Increasing cutter bar speed leads to decrease the percentage of grain losses. Also, increasing forward speed leads to increase the number of uncut stalks [3].

Sahar, reported that, the use of a large scale machine is inappropriate for the following reasons:- it needs high technical experience for operation and maintenance, high capital requirements. Low field efficiency is in small holding and losses of straw are high on irregular furrowed soils. The use of small machines is appropriate for small holdings, low capital requirements and low technical operations and maintenance experience [4].

D. N. Sharma and S. Mukesh studied on the designing of handle and in that study approximate 100 cm height is sufficient for pushing of any machinery [5].

Gindy et al. studied the mechanical system of threshing and handling rice straw directly to the baler in order to rapidly clean the rice straw from the field during the threshing process. The burning of crop residues is one of national problems especially after harvesting or threshing operations to the different crops. A conveyor belt was

designed to transport the rice straw from threshing machine to the baler [6].

A.G.Khan et al. designed a commercial grass cutting cum collecting machine that facilitates both the cutting and collecting of the commercial grass usually more than 4 feet long through the formation of bunches, without any loss of grass arising due to scattering of grass on the account of strong cutting forces, which can be collected in a proper way [7].

Prof. P.B.Chavan et al. developed a manually operated reaper to harvest grains more efficiently, focusing on ease of harvesting operation to the small land holders for harvesting varieties of crop in less time and at low cost by considering different factors as power requirement, cost of equipment, ease of operation, field condition, time of operation and climatologically conditions [8].

Girish S.M et al. modified the bale cutting machine to improve the productivity and to reduce the time and stress on the workers. The system consisted of modified shear blade, suitable blade holder, hydraulic system according to new tonnage capacity and conveyor system [9].

M.V.Achutha et.al designed multipurpose farm equipment which can do the work of 4 labors a day which reduces the labor cost of the farmers and to reduce external charges like fuels, electricity etc. and this will be helpful for poor farmers [10].

3. SCOPE AND OBJECTIVES

The existing system runs by means of drawing power from the engine of the tractor. The machine is coupled by means of PTO shaft. The existing systems cannot be used separately without tractor. The cost of the existing system is high so these systems are not affordable by poor farmers. Moreover the maintenance cost is very high. The mechanism involved is highly complex and so it needs skilled person to operate. Present Methods of Cultivation are as follows:

3.1 Straw Collection

In manual methods of cultivation, there is no usage of machine all the cutting, compressing and bundling are done manually.

3.2 Manual cutting and Threshing machine for seed separation

In Manual cutting and Threshing machine for seed separation method, the crops are removed as mentioned in the traditional method and then crops are tied together to form a bundle. These bundles are garnered and taken to threshing machine. The threshing machine separates the seeds from the crops. These machines are available in most of the villages. The cost of such machine is estimated around 1.5-2Lakh rupees after subsidy. The farmers sweat blood to utilize this Manual cutting machine.

3.3 Combine Harvester

The combine harvester is a machine that harvests grains and crops. The name derives from it combining three separate operations comprising harvesting—reaping, threshing, and winnowing—into a single process. The waste straw left behind on the field is the remaining dried stems and leaves of the crop with limited nutrients which is either chopped and spread on the field or baled for feed and bedding for livestock. Combine harvesters are one of the most economically important labor saving inventions, enabling a small fraction of the population to be engaged in agriculture.

3.4 Innovation in Manual method of Cultivation

Although, the existing projects are in effectuation stage the main aspire is economization. Despite cost there are various setbacks in the existing model. The machine is excogitate for only use of grass roots. In proposed model, the cart is pushed with the effort of man and the compressing mechanism works with the same. The collecting hand collects the crops and straws. The compressing mechanism is hand driven which compresses the collected crops and straws. The bundling is done with a simple hook and thread arrangement. The collected and compressed crop is removed from the collector through the void space available. This model not only reduces the time but also the herculean efforts of farmers in bringing up the crops. The incontrovertible side of this method is all are human driven without the use of motor.

Our main objective is to collect and compress straws by means of simple mechanism and reducing the cost so that the system is affordable by all farmers. Moreover as this system is completely manual, it does not require engine power which is mandatory in the conventional machines. It's initial, operational and maintenance cost is very low. Moreover the existing systems can be operated only by skilled persons but this system can be operated easily by everyone.

4. PROPOSED DESIGN

The equipment is designed using the design software Creo Parametric 2.0 developed by PTC Ltd. The design is done using various modes in Creo such as Sketch, Part, and Assembly etc.

Fig.1 shows the CAD model of the equipment, which was designed using Creo Parametric 2.0. The wireframe model of the equipment with compressing ram and transmission chain sprocket assembly is shown in Fig.2.

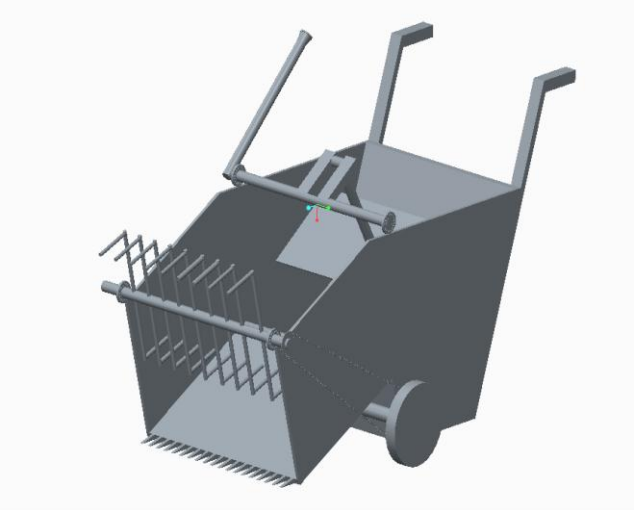

Fig.1 Proposed model

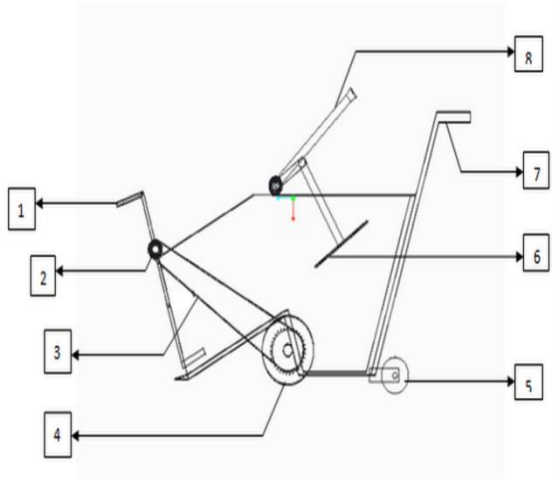

Fig.2 Side view of the model

(1) - Collecting fork, (2) - Sprocket, (3) - Chain drive,

(4) - Front wheel, (5) - Rear wheel, (6) - Compacting ram

(7) – Handle, (8) – Lever

Fig.3 shows the detailed top view with compacting mechanism and collecting fork.

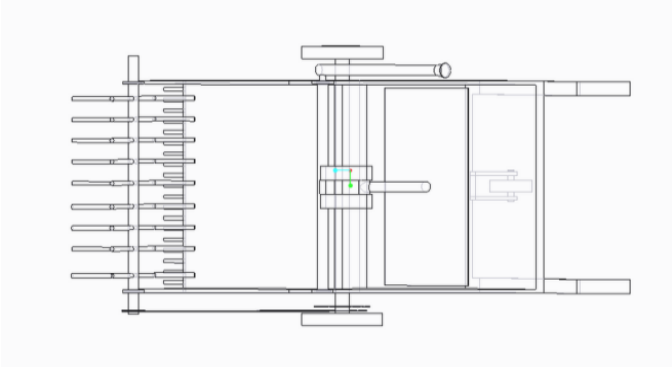

Fig.3 Top view of the model

5. COMPONENTS AND MATERIALS

The equipment consists of the following parts:

1. MS Sheet metal (SWG 19)
2. MS Flat (25x 5)
3. Shaft
4. 'L' Angle frame
5. Chain and Sprocket (40 and 18 driver and driven teeth count)
6. Bearings (SKF 6203 and SKF 6204)
7. Rubber wheels

6. DESIGN CALCULATION

6.1 Bending Stress in Compressing Arm

Assume a force of 2 kilogram is on the compressing lever which is at 775mm, and then the bending strength of the arm is calculated as follows:

From the bending moment equation,

$M/I = \sigma_b/y = E/R$

Where,

M is the moment in N-mm.

Z is the section modulus, Z=I/y

σ_b is the bending stress in N/mm^2.

E is the Young's modulus in N/mm^2.

R is the Radius of the arm in mm.

I is the moment of inertia in mm^4.

y is the deflection in mm.

Moment is calculated as,

M=force x perpendicular distance.

M= (2 x 10) x 775

M= 15205.5 N-mm.

Section Modulus Z is given by

$Z= (\pi/32) \times (d_2^4 - d_1^4)/d_2$

$Z= (\pi/32) \times (17^4 - 11^4)/17$

$Z= 397.78\ mm^3$.

$\sigma_b = M/Z = 15205.5/397.78 = 38.23\ N/mm^2$.

This is far less than the maximum stress value.

6.2 Transmission ratio

The number of teeth in driver (Z_2) is 40 and the number of teeth in driven (Z_1) is 18.

Then the transmission ratio is found by

$i = Z_2/Z_1 = 40/18 = 2.22$.

6.3 Force on chain

The frictional force acting on the chain and the sprocket is negligible than tangential force acting on the same. The tangential force acting on the chain and the sprocket is directly proportional to the applied force on the vehicle.

6.4 Shaft design

The twisting moment and the bending moment is designed and suitable value for the design is taken. As per the above statement only twisting force is dominant thus the design of shaft is made for the same.

The weight of the fork is measured as 100 grams and 1kg is taken as 10N in following calculations.

Twisting moment is calculated as
T = Force x Perpendicular distance
T = 0.8 x 10 x 380
T = 3040 N-mm.

Bending moment is calculated by
$M=WL^2/8$
$M=0.8 \times 10 \times 415^2/8$
M=172225 N-mm.

Equivalent twisting moment T_e is given by
$T_e= \sqrt{(M^2+T^2)}$
$T_e= \sqrt{(172225^2+3040^2)}$
T_e=172251.82 N-mm.
Also, $Te= (\pi/16) \times \tau_{.d2}^3 (1-k^4)$
Assume k = 0.8 and τ= 350 N/mm^2
$3091.39 = (\pi /16) \times 350 \times d_2^3 (1-0.84)$
d_2 = 16.6mm (approx.)
But the designed shaft diameter is far higher than the permissible values.

6.5 Selection of Bearings

Depending upon the nature of contact the antifriction bearing has been chosen.

SKF 6203 and SKF 6204 bearings are selected.

7. FABRICATION

The frame ('L' angle) is cut using the circular sawing machine for the required dimensions. The MS flat plates are also cut for the desired dimensions. First, the frame is welded according to the developed design. Then, the sheet metal sizes are determined using development of surfaces and are cut by shearing machine. The sheet metal is mounted onto the frame and welded. The wheels are mounted onto the frame. Holes are drilled in the flat plates for mounting the bearings in the assembly. The shafts are inserted into bearing housing and clamped. The handle is fixed at the top of the back end of the frame. The transmission sprocket is mounted in the wheels and roller chain is connected to it. The lever is connected the shaft which accomplishes baling action on the straw collected. Finally, the entire assembly is ground and snagging operation is performed on it. The equipment is painted with organic coating for protecting the surfaces from corrosive influences, for enhancing the appearance etc.

8. WORKING

Fig. 4 shows the picture of the fabricated model. It consists of a container which stores the straw. The box has an inclined plate through which the straw enters the container. It has a guide way for collection of straw.

Fig.4 Fabricated model

Crankshaft converts the rotational motion of wheels to reciprocating motion by means of chain and sprocket mechanism. The eccentric crank mechanism provided, performs the baling operation.

The whole setup is operated manually. When a person pushes this vehicle, the straw enters through the inclined plate due to forward motion. At the same time, due to rotation of wheels, the sprocket attached to it gets rotated; this rotation is transferred to the crankshaft by means of chain.

Due to pulling the lever, the compacting plate connected to the vertical rod compresses the straw which is entering the inclined plate. Finally the collected straws are made into bundle by using the ropes present in the setup.

9. MERITS

The merits of the proposed system are as follows:
- Cost of the model is greatly reduced.
- Machine can be operated by single man.
- Ramming and bundling can be done with simple mechanism.
- Crops can be collected with less human effort.
- There is easy detaching mechanism.
- The power consumption is less.
- Easy in operation.
- Economical and ergonomically design.
- Simple construction.
- Adaptable design.

• Performance is comparatively higher than the existing model.
• Easy to setup.
• Light weight.
• Easy maintenance plays a major role in vehicle.

10. DEMERITS

The demerits of the fabricated equipment are as follows:
• The set-backs of this model is only basic functions are aimed which could have been aimed at early stage of this project.
• It is applicable for slow speed operation.

11. FUTURE SCOPE

The work has been a real challenge to execute as there were many practical design and fabrication problems along with cost constraints. The machine has a great future scope in any industry and for farmers due to its ease of use, moderate cost and simple design. Savings resulting from the use of this device will make it pay for itself within the short period of time. The machine can be made lighter by doing detailed analysis of the design and removing excess material wherever it is not necessary. With minimal modifications this machine can be used for harvesting of different crops. A better and large storage unit has to be provided. The flow of the unwanted crop waste is to be made more efficient.

12. CONCLUSION

The harvester developed is just proof of concept. This has to still undergo a detailed analysis of components used. The new design of the other amenities is to be designed and tested and changed as per the requirements. The machine can be operated by single labor. The machine will eliminate the labor problem and struggles of labor in cutting the crop. This machine will serve greatly for small scale. This machine greatly reduces the cost of labor. This machine also reduces the fuel and the electricity charges. However the weight of the equipment is higher than the estimated the effectiveness of the material remains to be the same.

REFERENCES

[1] Ministry of Statistics and Programme Implementation accessed on 28 March 2017.
[2] Statistics Times http://statisticstimes.com accessed on 28 March 2017.
[3] Hadidi, Y. M., "A study on mechanical mowing", M.Sc. Thesis, Agriculture Engineering Dept., Faculty of Agric., Mansoura Univ. Egypt, 1984.
[4] Sahar, E. A., "Design of a harvester appropriate for Egyptian Agriculture", M. Sc. Thesis, Agric. Eng. Dept., Faculty of Agric., Ain Shams Univ. Egypt ,1988.
[5] Sharma DN, Mukesh S, "Farm Machinery Design, Principles and Problems", Jain Brothers Publications, pp 149, 2008.
[6] El-Gindy, A. M., Baiomy, M. A, Abdelhamed, "Design And Fabrication Of A Simplified Mechanical Handling System Of Rice Straw Baling Operation To Reduce Environment Pollution", Farm Machinery And Power, Misr J. Ag. Eng., 26(1): 667- 685, 2009.
[7] Girish Kumar S.M, V.Venkata Ramana, "Design And Modification of Bale Cutting Machine to Improve its Productivity", IJRET-International Journal of Research in Engineering and Technology, Vol.4, Issue 08, 2015.
[8] Aaqib Gulzar Khan, Adeel-ul-Haq Qurishi, "Commercial Grass Cutting cum Collecting Machine", IOSR Journal of Mechanical and Civil Engineering, Vol.10, Issue 1, pp 35-38, 2013.
[9] Prof. P.B.Chavan, Prof. D .K. Patil, Prof. D .S. Dhondge, " Design And Development Of Manually Operated Reaper", Iosr Journal Of Mechanical And Civil Engineering (Iosr-Jmce), Volume 12, Issue 3 Ver. I, Pp 15-22, 2015.
[10] M.V.Achutha, Chandra. N, Nataraj.G.K, "Concept Design and Analysis of Multipurpose Farm Equipment", International Journal of Innovative Research in Advanced Engineering (IJIRAE), Issue 02, Vol.3, 2016.
[11] Design of Machine Elements, V.B.Bhandari, Tata Mcgraw hill companies, 2012.
[12] P.S.G. Design data book, P.S.G. College of Technology, Kalaikathir Achagam.