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DESIGN AND FABRICATION OF CROP HARVESTING MACHINE

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Abstract— Crop harvesting machine is a mechanical machine used for the harvesting of crops such as barley, wheat, buckwheat and paddy. This project is carried out with the objectives to reduce cost, time and labor required to harvest crops efficiently.
This machine is simple and effective in which two mechanisms are used; straight bevel gear mechanism and crank and slotted link mechanism.
Keywords— crop harvesting machine, crank and slotted link mechanism, straight bevel gear mechanism.

I. INTRODUCTION

Agriculture is important in our country; it is the primary source of income for farmers. Most farmers are illiterate and lack access to agricultural facilities. Things must change over time to implement new approaches and equipment that will improve efficiency. Numerous agricultural machines are now available that are very large and could not be used effectively in small farm production. Furthermore, all farmers remove crops by hand, which is a more laborious and time-consuming process. Some farmers experience damage to their hands because of cutting or removing crops by hand, which results in a shortage of labor. To address this issue, a simple but more efficient machine is developed for farmers. This machine is aimed at small-scale farmers with less than 1 to 2 acres of land. This unit can cut wheat, millet, buckwheat, and paddy. So, this machine is mainly fabricated to save time, reduce human efforts and reduce the labor required for cutting the crops.
This machine has the advantage of being low-cost and simple to operate, even though it employs a variety of operations and mechanisms. The differential gear mechanism and crank and slotted link mechanism is used in the design to operate manually. This crop harvesting machine is made with readily available spare parts, making it simple to maintain. This crop harvesting machine might be the solution to the problems faced by farmers.

II. METHODOLOGY

2.1 Working Principle

The movement of the machine is achieved by the use of wheels. Cutting of crop is achieved by the scissoring motion of cutting blades (1 stationary and 1 movable). Two mechanisms are used in this machine: A straight Bevel Gear mechanism and, a Crank and Slotted mechanism. The Straight Bevel Gear mechanism transmits the power of the drive axle (driver gear) at an angle of 90 degrees to the driven gear

(crankpin). The crank and slotted link mechanism convert the rotary motion into reciprocating motion. The driven crank pin's rotary motion is transferred through the rocker arm to the cutting blades to obtain the reciprocating motion.

A bevel gear component (driving gear) is coupled to the drive axles. When the machine moves forward or backward the wheels rotate and drive the driver gear of the bevel gear component which in turn rotates the driven gear. To this driven gear, a sliding block is attached which will slide in the slot provided in the rocker arm. As the driven gear rotates, the sliding block will slide in the slot and rock the rocker arm due to which the rotary motion of the driven gear block is converted to reciprocating (side to side) motion of the movable cutting blades. The rotary motion of the driven gear is transferred to the reciprocating blades through the rocker arm. The rocker arm is pivoted in the middle to achieve side to side reciprocating motion of the movable blade instead of to and fro motion. The cutting speed of the blades is proportional to the speed of the wheels.

2.2 Design

The machine is designed in such a way, to fulfill the objectives of this project. An isometric view of this design is given below (Figure 1). The design of this machine eliminates the use of the fuel-consuming engine or electric motor. It can be manually operated and thereby making it economical. The power source for the machine is from the traction between the wheels and ground, which is transferred to the cutting blade by using the Bevel gear mechanism and Crank and Slotted link mechanism.

The machine is smaller in size and can be used in smaller field sizes. For this, the mainframe or the body frame of the machine is kept compact and is 0.90 m in length and 0.60 m in width. This body frame gives support and houses all the other components of the machine. The machine is moved forward and backward direction by the operator through the waist-high handle supports. The main wheels diameter of the machine is 0.25 m because the height of the blades from the ground has to be as low as possible. This height should be low enough to cut the crop from an appropriate height but high enough to make sure the driving gear does not touch the ground while operating the machine. Another swivel wheel is used to easily change the direction of the machine and is located at the middle of two handle supports. The component that transfers the crank pin's rotary motion to the movable blade to obtain the reciprocating motion is the rocker arm. One end of the rocker arm is attached to the movable blade and the other end of the rocker arm is above the driven gear. the distance between the two ends of the rocker arm is 0.68 m. The slot in the rocker arm is 0.18 m long which is slightly longer than the length of travel of the crankpin which will slide in the slot. For smooth sliding of the crankpin, the slot gap is made slightly bigger than the diameter of the crankpin by 0.015 m. In this machine design, two sets of cutting blades are used, one fixed and one movable. The fixed blade is fixed onto the frame of the machine and the movable blade is placed above it. This movable blade is also linked to the rocker arm and moves relative to the rocker arm as the rocker arm reciprocates. The width of the frame is 0.60 m and, the width of the cutting blades is 0.70 m, made slightly longer than the frame. The blade breadth is 0.18 m. From the blade breadth of 0.18 m, half of the breadth is used to make the teeth of the blades, and the remaining half is used to fix the blade to the frame. The gap between each tooth is 0.05 m so that there is enough space for the stem of the crops to get in between the teeth of the blades.

A straight bevel gear of gear ratio 1:3 is used, which means for every rotation of the driving gear the driven gear rotates three times. The driving gear of the bevel gear system is mounted on the shaft connecting the two wheels of the machine. As the wheel rotates, the driving gear shall also rotate at the same speed. To the driven gear of the bevel gear system, a crankpin is connected and rotates at the same driven gear speed. This is how the rotary motion of the crankpin is obtained. The crankpin will rotate in the slot which is provided in the rocker arm. The gear ratio used in this machine increases the number of blade motions per second. If a higher gear ratio is used the efficiency shall also increase since a greater

number of lateral reciprocations will be achieved for each rotation of the wheel. The handle of this machine is fixed onto the body frame and is used to push the machine forward. . The handle of the machine is kept 1m above the ground level so that it is convenient for the average human height to comfortably drive the machine. The design of this machine incorporates all of these components which work about each other to have a machine that serves the purpose of harvesting crops.

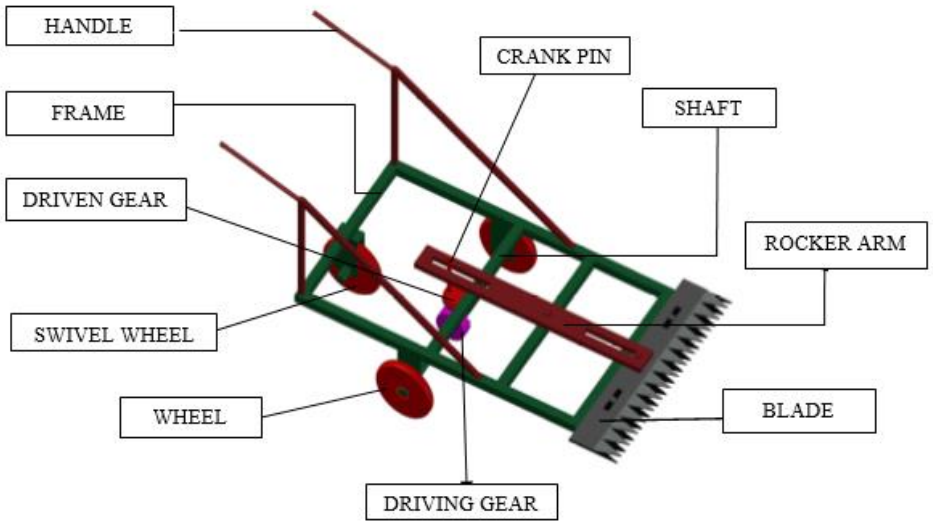

Figure 1: Three dimensional view of designed crop harvester

2.3 Characteristics of machine.

1. The assumed operating speed of the machine: 50m/min = 0.833 m/s
2. The number of revolutions made by wheel per minute: 63 rpm.
3. Gear ratio: 1:3
4. Lateral Reciprocating motion: 378 times/min = 6.3 times/second.
5. Area covered: 30 m^2/min = 0.5 m2/s
6. Machine cost: Nu. 16,500.00
7. Machine weight: 21.23 kg

III. RESULT AND CONCLUSION

This project fulfills the objectives of being cost-efficient, time-saving, labor efficient, and possibly replacing the primitive methods of harvesting crops. To come up with a machine that fulfills all the objectives, a machine is designed employing two mechanisms (crank and slotted link mechanism and bevel gear mechanism) and using materials that are cheap and strong enough for a crop harvesting machine. After designing and then fabricating the machine as planned, the designed machine was practically tested. The two mechanisms that were used proved to be workable and suitable for a crop harvesting machine. The

machine is simple and has limited parts making it easy to operate. We can conclude that the project`s aims and objectives are successfully achieved.

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REFERENCES

[1] N. R. Rai, A. S. Johare, C. M. Joshi and G. D. Malani, "Design and fabrication of small scale Sugar Cane harvesting and multi crop cutting machine," *International Journal of Advance Scientific Research and Engineering Trends,* vol. 4, no. 3, pp. 16-19, 1 May 2020.

[2] M. Prem, S. K. Dabhi and N. K. Verma, "A critical study on crop harvesting machine," *An International Referred, Peer Reviewed and Indexed Quarterly Journal in Science, Agriculture and Engineering,* vol. VII, no. XXIV, pp. 63-66, 31 08 2017.

[3] K. Dane, "Guide to Farm Machinery," Agricultural Goods, 3 July 2020. [Online]. Available: https://agriculturegoods,com/farm-machinery-importance-uses-and-types.

[4] P. Singh, Y. Singh and L. Sharma, "Crop cutting machine," Aryabhatta College of Engineering and Research Centre, Ajmer.

[5] S. T. Tirunch, "Modification and of cereal crop harvesting machine," *Internatuinal Journal of Mechanical Engineering and Application,* vol. 6, no. 3, pp. 55-58, 11 June 2018.