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DESIGN AND FABRICATION OF REAPER MACHINE WITH ATTACHMENT MECHANISM

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Abstract

The article discusses the design and construction of a reaper machine. The aim is to create a system for crop harvesting that facilitates efficient collection in the shortest possible duration. This configuration is employed for the harvesting of crops, thereby assisting farmers. This configuration harnesses engine power through various mechanisms, including belts, pulleys, rubber wheels, and spur gears, facilitating the conversion of rotary motion into the reciprocating motion of the cutter, which efficiently severs crops without causing damage. The cutting depth for harvesting crops can be modified, and the ground level can be altered according to the farmer's preferences. The attachment mechanism facilitates the disassembly of the blade assembly, allowing for the assembly of blades tailored to specific crop types, such as wheat, rice, grass, and sugar cane.

1.Introduction

Mechanized agriculture refers to the utilization of agricultural machinery to enhance the productivity of workers or farmers in fields or farms. Currently, numerous tasks once performed by physical labor or with the assistance of animals such as horses, mules, and oxen have been supplanted by powered machinery. Agriculture features numerous instances where the plough serves as a fundamental implement. At ground level, reapers are mostly utilized for harvesting crops. The categorization of reapers is based on the movement of harvests from one location to another. This results in reduced fuel consumption and diminished labor requirements. With the daily expansion in our country's population, there is a must to augment the production of food and vegetables. The demand for agricultural machinery is also rising. Powered agricultural machinery performs numerous operations in a brief period; however, their costs are prohibitively high for the average individual, rendering such equipment inaccessible. Consequently, hand-operated and automated agricultural tools remain essential [1]. Conversely, reaper harvesters are seen as an alternative to cutting equipment that yields dry stalks of grain or cereal plants. Straw is an agricultural by-product utilized as feed for various animals and regarded as an economically valuable by-product for industrial purposes. Considering the aforementioned concerns, a review has been conducted indicating that the utilization of agricultural machinery has resulted in a reduction of cutting in the paddy crop. The hand-driven and motorized reaper holds greater significance for this purpose. A solitary individual can efficiently run this type of reaper; nevertheless, pulling efforts are essential in less economical contexts. A typical farmer can readily purchase this type of reaper for crop cultivation. Wheat is the most favored cereal crop globally. To augment global food grain production, coordinated efforts are necessary to examine the factors impeding food demand, thereby mitigating potential disruptions to peace and preventing food scarcity worldwide [2]. In Pakistan, wheat is the primary staple meal, consumed everyday by the populace due to its substantial energy content. Wheat occupies a crucial role in agricultural practices. In 2011-12, a substantial wheat harvest was cultivated, including an area of 8,666 thousand hectares. A decline of 2.6% occurred in 2011-12. In the previous year, an area of 8,901 thousand hectares was devoted to wheat cultivation [3]. Pakistan is emerging as a developed nation in South Asia, with 22 million hectares of cultivated land. The agricultural sector significantly contributes to the economic advancement of Pakistan. 24% of agricultural Gross Domestic Product (GDP) is generated by utilizing 48% of the labor force. Approximately 67% of Pakistan's population resides in villages, which are directly or indirectly linked to agricultural regions for their livelihoods. In Pakistan, an agricultural region not only fulfills the food and fiber requirements of the populace but also contributes 75% to foreign revenues [4]. During the peak harvest season, the shortage of personnel is a significant challenge for farmers, necessitating substantial financial expenditure for crop harvesting. The labor-intensive tasks must be structured to minimize labor movement, while engaging agricultural machinery. Typically, wheat and rice are harvested using a front-mounted tractor reaper, whereas brassica is collected manually in certain areas of Pakistan. Harvesting equipment, including combines, reapers, and threshers, is designed not just to address labor shortages and optimize timing but also to facilitate multi-cropping systems in Pakistan. Small landholders (5 to 10 hectares) in Pakistan significantly hinder the use of sophisticated harvesting equipment and mowers [5].

2.Literature Review

Historically, reapers were limited to cutting the crop and unbounding it, while contemporary machinery incorporates harvester, combiners, and binders, which also perform other harvesting tasks They were limited to cutting the crop and unfolding it unbound, whereas contemporary machinery incorporates harvester, combiners and binders, which also carry out other harvesting tasks. The patent for a reaper was granted in the United Kingdom to Joseph Boyce in 1800. The patent for a reaper was granted in the United Kingdom to Joseph Boyce in 1800. In 1830, Jeremiah Bailey of the United States obtained a patent for a mower -reaper, while Obed Hussey and Cyrus McCormick developed reapers equipped with guards and reciprocating (back-and-forth-moving) cutters in 1830, Jeremiah Bailey of the United States obtained a patent for a mower-reaper, while Obed Hussey and Cyrus McCormick developed reapers equipped with guards and reciprocating (back-and-forth-moving) cutters. Hussey was the first to acquire a patent in 1833; however, McCormick 's reaper featured the advantages of a divider to distinguish between cut and continuous wheat, and a revolving reel to propel the cut wheat towards the rear of the machinery, thus allowing its subsequent spreading. CW and WW Marsh filed a patent for the first harvester successfully in and WW Marsh filed a patent for the first harvester successfully in 1858. The team processed the sawn grain through a canvas conveyor that transporteda canvas conveyor that transported the material to a container for bonding [6]. Hussey, originally from Ohio, registered the patent for a reaper in 1833, called the Hussey Reaper. Originally from Baltimore, Maryland, Hussey 's design represented a significant advance in terms of optimizing efficiency the new reaper The new Reaper required only required only two horses operating in a non- exhaustive manner, one individual for the operation of the machine, and a second individual for driving two horses operating in a non- exhaustive manner, one individual for the operation of the machine, and a second individual for the driving. Additionally, the Hussey Reaper resulted in a uniform and clean surface after application [7]. Cyrus McCormick claimed that the invention of his reaper took place in 1834, giving him the genuine right to the general design of the McCormick argued that the invention of his reaper took place in 1834, giving him the genuine right to the general design of the machinery. In In the coming decades, competition is anticipated, competition between the Hussey and McCormick reapers among the reapers in the market, despite their remarkable similarity. Hussey and McCormick are on the market, despite their remarkable similarity [8]. A significant competitor in the sector was Manny Reaper, an initiative of John Henry Manny, along with the companies that have subsequently emerged. Although despite the fact that McCormick has frequently been simplistically attributed to McCormick the sole " inventor " of the reaper machinery , a more accurate statement holds that he reconfigured components of it, created an initial essential integration of enough components to has been an effective assembly , and benefited from the influence of more than two decades of work done by his father , as well as the assistance of Jo Anderson , a slave held by his family .Often simplistically attributed to me as the sole "inventor" of the reaper machinery , a more accurate statement maintains that I have reconfigured components of it , created an initial essential integration of enough components to constitute an effective whole , and benefited from the influence of more than two decades work done by his father, as well as the assistance of Jo Anderson, a slave guarded by his family [9].In 1980 Arnaout carried out an estimate of the capacity and efficiency in wheat harvesting using a combine harvester , discoveringwheat that using combine harvesters , discovering that effective training was increased by accelerating combine harvesting and expanding the agricultural area .effective trainingThey were increased by accelerating combine harvesting and expanding the agricultural area . He also found that field efficiency was significantly affected by the loss in both aspects : turning time in relation to forward speed and the duration of travel from one field to another .it was seensignificantly affected by the loss in both aspects: the turning time relationship with the speed of advance and the duration of the displacement from one field to another [10]. In 1985, Devnani, and Pandey developed and designed a vertical conveyor belt windrower intended for wheat crop harvesting. conveyorbelt windrower intended for harvesting wheat. It It concluded that the field capacity achieved with a 1.6 m wide unit was 0.269 ha / h, while with a 2.09 m wide unit it was 0.337 ha /h. was concluded that the field capacity achieved with a 1.6 m wide unit was 0.269 ha / h, while with a 2.09 m wide unit it was 0.337 ha / h. The costs associated with operating with tractors and power tiller models were lower compared to the manual method, varying between 20 and 30 %.The operation with tractors and power tiller models proved to be inferior compared to the manual method, varying between 20 and 30 %. Total whole losses from harvesting ranged between 4 and 6 % of the wheat yield, when the moisture content in the wheat ranged between 7 and 11 %. of the resulting lossesHarvesting yields ranged between 4 and 6 % of the wheat yield, when the moisture content in the wheat ranged between 7 and 11 %. job requirements are minimized to 40-42 man -h/ha, with one- are minimized of the labor allocated to the manual harvesting method .at 40-42 man-h/ha, with one- third of the work assigned to the manual harvesting method [11]. In 1988, Singh, He conducted a study on the collection of wheat using the power reaping technique through the power reaping technique. determined that the average field capacity was field capabilitybe 0.4 ha / h, with a wheat loss rate of 4 %. the average was 0.4 ha /h, with a wheat loss rate of 4 %. The labor required in the operation technical reaping of consisted of approximately 5 man -h/ha, in contrast to 84 man - h/ha in the manual harvesting operation. The reaping technique consisted of approximately 5 man-h/ha, in contrast to 84 man -h/ha in the manual harvesting operation. [12]. In 1992, El-Sahrigi et al. devised a front-mounted reaper, the design incorporates a flat belt mechanism for lateral crop conveyance, an enhanced cutter bar star wheel assembly to reduce clogging, a bevel gear drive for power transmission, a sturdy frame, a header design that prevents soil penetration, and the capability to convert the flat belt conveyor drives to chain without requiring frame alterations [13]. In 1995, Mahrous assessed and analyzed a horizontal flat conveyor belt to enhance the efficiency of a rear-mounted mower. The mower was utilized on wheat crops at forward speeds of 3, 4, 5, and 6 km/h. The developed rear-mounted mower exhibited an average field capacity of 1.18 fed/h, field efficiency of 70%, cutting efficiency of 97%, and cost needs of 6.947 L.E./fed [14]. In 1995, Helmy noted that the effective field capacity augmented with a reduction in straw moisture content. Moreover, a rise in forward speed generally results in heightened overall grain losses, amounting to 10.11% with the Dutz-Fahr combine and 10.43% with the Isaki combination. They discovered that elevating the forward speed of the combine harvester from 0.85 to 2.27 km/h generally reduces harvesting costs from 82.46 to 59.93 L. E/ton for the Giza-171 rice variety and from 57.69 to 37.61 L. E/ton for the Giza-175 rice variety [15]. Kamel asserted in 1999 that all types of losses for the two examined combines escalated with the rise in harvesting speed and cutting height for the three chosen rice varieties. He stated that the minimum total losses recorded at a harvesting front speed of 0.3 m/s with a cutting height of 7 cm were 3.25%, 2.4%, and 2.4% for the rice varieties Giza 178, Sakha 101, and Sakha 102, respectively, for the combine harvester CA-385 (hold-in) system, in contrast to 3.9%, 3.15%, and 3.0% for the combine harvester CA-760 (through-in) system for the same rice varieties, cutting height, and forward speed. He also noted that the maximum total grain losses for both combine types did not surpass 5.80%, in contrast to 25% with the traditional harvesting approach [16]. In 2003, El-Nakib employed a Kubota combine as a mechanical harvester for the Sakha 102 rice crop. It was observed that losses during header operation, threshing, separation, and shoe processes escalated with a rise in forward speed and a reduction in grain moisture content. The ideal operating parameters for rice crop harvesting were a combine forward speed of 4.5 km/h and a grain moisture percentage of 16.5%. [17]. In 2005, El-Khateeb evaluated the multi-purpose combine harvester (Yanmar model CA-760) and determined that the maximum actual field capacity was 2.90 fed/fed at a forward speed of 3.0 km/h and a grain moisture content of 18%. He also discovered that the maximum fuel consumption rate was 7.20 l/fed at a forward speed of 1.5 km/h and a grain moisture level of 25%. He suggested that the optimal working conditions for mechanically harvesting rice include a grain moisture content of 22.0%, a forward speed of 1.5 km/h, a cylinder speed of 24.0 m/s, and a baffle plate angle of 90 degrees (1.57 radians). The utilization of a combine harvester was the most efficient and cost-effective method (89.70 L. E/fed) in comparison to human harvesting and gathering, succeeded by threshing and winnowing (181.60 L. E/fed) [18]. In 2010, Koori built a crop cutter powered by an operational engine. The apparatus is equipped with a horizontal blade affixed to a vertical shaft. The machine was evaluated, yielding an efficiency of 88.4% and an average effective field capacity of 0.127 ha/hr [19]. In 2017, Tesfaye built a reaper machine to address agricultural challenges in Ethiopia at a modest cost, hence enhancing farmers' income [20]. In 2019, Khin Ohnmar Myo et al. devised and manufactured an agricultural reaper machine that executes cutting and bending concurrently. Additionally, the designs of the reaping gearbox and carrier chain systems were delineated [21]. In 2021, Manjunath M. Ullagaddi designed a reaper for corn harvesting. The harvesting of maize is a labor-intensive procedure that entails considerable toil. The created standard encompassed critical criteria such as ground clearance, wheel diameter, engine power, cutter blade diameter, wheel spacing, reaper weight, and cutting speed [22]. In 2025, Udaya Sri Kakarla focused on the design and production of the grim, reaper, and binder components of a semi-automated electric vehicle agriculture machine. The design of this machine was developed using Fusion 360 software. The proposed electric vehicle machine design addresses the cost, labor, and tiredness challenges encountered by small-scale farmers [23].

The literature reviewed suggests that identifying the issues with the reaper is crucial for its acceptance among farmers. Previous investigations focused solely on the enhancement, advancement, and configuration of the machine. The primary functional issues of the reaper remained undiscovered, resulting in a minimal number of operational reapers on the farmers' fields. The current study aimed to identify the primary functional issues of the reaper and promote its use among farmers.

3.Design Calculations

The power required to drive the compact harvesting machine must be such that: The harvesting machine must carry variable load during the harvesting to avoid clogging. Reciprocating speed of harvesting machine blades should be 0.8 to 1.2 m/s. Crop stem strength i.e. grass, wheat so, keeping these objectives in mind, the power required to drive the load is according to the requirement of machine. It must be 4HP to 6.5HP. So, being on the safer side engine producing power of 6.5HP was selected.

3.1 Design of Drive

For wheels

To calculate the required rpm at shaft pulley

$$N_1D_1 = N_2D_2$$

Where;

N_1=speed of engine in rpm
D_1=diameter of engine pulley in mm
N_2=speed of larger pulley in rpm
D_2=diameter of larger pulley in mm

Putting values in eq (1)

$$2800\times50 = N_2\times150$$

$$N_2 = 933.33 \text{ rpm}$$

933.33 are the required rpm transmitted at shaft pulley to drive the wheels.

For cutting blades

Firstly, calculate rpm transmitted at idler pulley.

$$N_1D_1 = N_2D_2$$

Putting values in eq (1)

$$2800\times50 = N_2\times90$$

$$N_2 = 1555.55 \text{ rpm}$$

1555.55 are the required rpm transmitted at idler pulley.

Now calculate rpm transmitted from idler pulley to blades pulley.

$$N_2D_2 = N_3D_3$$

Where;

N_3 =speed of blade pulley
D_3 =diameter of blade pulley

Putting values in above equation;

$$1555.55\times90 = N_3\times150$$

$$N_3 = 933.33 \text{ rpm}$$

Therefore, final rpm transmitted from idler to blade pulley are 933. 33rpm.Now that rotary motion of pulley will be converted to reciprocating motion of the blades by using slider crank mechanism.

3.2 Design of Main Shaft

Diameter of driving pulley = DA =50 mm
Diameter of driven pulley = DB =150 mm
Radius of driving pulley = RA $=\frac{50}{2} = 25$ mm
Radius of driven pulley = RB$=\frac{150}{2} = 75$ mm
Angle of lap $= \varphi = 180° = 3.1416$ rad
Coefficient of friction between belt and pulley $\mu = 0.3$
$N_3 = 933.33$ rpm

Objective is to increase the torque at blades by reducing rpm. First calculate the initial torque at the engine flywheel pulley by using the relation:

$P=\frac{2\pi NT}{60}$
$4.84\times 10^3=\frac{2\pi\times 933.33\times T}{60}$
T=29.77 Nm
As torque transmitted through the shaft is same so, now calculate tension forces in belts by using the relation:
$\frac{T_1}{T_2} = \frac{T_3}{T_4} = e^{\mu\varphi}=e^{0.3\times 3.1416}=2.56$
Where;
T=Initial torque value at engine
Now,
$T= (T_1-T_2)\times RA$
Where;
T= Torque value initially at the engine flywheel pulley
T_1 = Tension on the tight side of the shaft pulley
T_2 = Tension on the loose side of the shaft pulley
$T= T_2(\frac{T_1}{T_2} - 1) \times RA$
$29.77=T_2(2.56-1)\times \frac{0.05}{2}$
$T_2=763.33$ N
Putting value of T_2 we get;
As $\frac{T_1}{T_2} = 2.56$
$\frac{T_1}{763.33} = 2.56$
$T_1=1954.12$ N
As $T_1 > T_2$ so it shows that tension on the tight side of the pulley is greater than the loose side of the shaft pulley that is measured in newtons.
Also,
$T= (T_3-T_4)\times RB$
Where;
T_3 = Tension on the tight side of the blades pulley
T_4 = Tension on the loose side of the blades pulley

T= $T_4(\frac{T_3}{T_4} - 1)\times RB$

29.77=T_4 (2.56-1)× $\frac{0.15}{2}$

T_4 = 254.44 N

As from eq (1)

$\frac{T_3}{T_4} = 2.56$ Putting value of T_4

$$\frac{T_3}{254.44} = 2.56$$

T_3 = 651.37 N

As $T_3 > T_4$ so it shows that tension on the tight side of the pulley is greater than the loose side of the blades pulley that is measured in newtons.

3.3 Calculations of Torque

Torque (Nm) = 9.5488 x Power (W) / Speed (rpm)

As power

P = 4.847×10^3 W

N_4= 933.33 rpm

So, torque transmitted at the blades is

T = $\frac{9.5488\times 4.847\times 10^3}{933.33}$ T = 50 Nm

So initial torque value of 29.77 Nm at engine flywheel is increased up to 50 Nm by using combination of pulleys of various diameters to reduce rpm at the blades.

3.4 Length of Belts

3.4.1 Length between Engine and Main Shaft Pulley

L_B=2C+1.57(D+d) + $\frac{(D-d)^2}{4C}$

Where;

L_B= Length of belt

C= Central distance between engine flywheel pulley and main shaft pulley

D= Diameter of driven pulley

d= Diameter of driving pulley

L_B=2× 254+1.57(152+51) + $\frac{(152-51)^2}{4\times 254}$

L_B= 837 mm

3.4.2 Length between Engine and Blade Pulley

L_B=2C+1.57 (D+d) + $\frac{(D-d)^2}{4C}$

L_B=2× 610+1.57(152+51) + $\frac{(152-51)^2}{4\times 610}$

L_B= 1543 mm

3.5 Torque Required at Wheels

- Gross Vehicle Weight (GVW) = 66 kg
- Weight on each drive wheel (WW) = 33 kg
- Desired top speed (V_{max}) = 1.40 m/sec
- Desired acceleration time (ta) = 4 sec

- Radius of wheel/tire (R_w) =127mm=$\frac{127}{1000} = 0.127$m
- Maximum inclined angle (α) = 4 degree
- Working surface = Grass (firm)

To select the engine which has ability to produce maximum torque to pull the reaper or harvester, it is required to calculate the **total tractive effort (TTE)** which is the demand for the reaper or harvester.

TTE = RR + GR + FA

Where;
TTE = Total Tractive Effort [N]
RR = Rolling Resistance force [N]
GR = Grading Resistance force [N]
FA = Force of acceleration [N]

The factors or elements of the above-mentioned equation has to be calculated in the following steps.

3.5.1 Determine Rolling Resistance

The force which is required to pull a harvester or reaper on a specific level. This force is known as Rolling Resistance. The reaper or harvester has come across the minimum possible level type must be put into the following equation.

RR = GVW x C_{rr}
Where;
GVW = Gross vehicle weight
C_{rr} = Surface friction
Putting values in above equation;
RR = 66 x 0.055 = 3.63 N

3.5.2 Determine Grade Resistance

The force required to move up a vehicle on the climb or steepness. This force is known as Grade Resistance. This procedure or operation has to be made by using the supreme angle or grade the reaper or harvester would be due to rise in typical method.

For the conversion of inclined angle to the grade resistance, we have
GR = GVW x sin (α)
α = maximum inclined angle [degrees]
Putting values in above equation;
GR = 66 x sin (4°) = 4.60 N

3.5.3 Determine Acceleration Force

The force required to move the machine from the stationary position to the supreme or extreme speed in required time. This force is known as Acceleration Force (FA).

FA = GVW x V_{max} / (9.81 x Ta)
Where;
Ta = time required to achieve maximum speed [s]
V_{max} = maximum speed [m/s]
So, putting values in above equation;
FA = $\frac{66 \times 1.4}{9.81 \times 4}$ = 2.35 N

3.5.4 Determine Total Tractive Effort

The addition of the rolling resistance, grade resistance and acceleration force are known as Total Tractive

Effort (TTE). (On higher velocities reapers or harvesters' resistance in the operated sections may be justified the extension of 10 %-15 % to the total tractive effort to confirm the standard reaper or harvester result).
Now as eq (1) is
TTE = RR + GR + FA
So, putting values we get the value of TTE;
TTE = 3.63 + 4.60 + 2.35 = 10.58 N

3.6 Determine Wheel Motor Torque

For the verification of the reaper or harvester, it will be improvised as formulated. To verify the vehicle will perform as designed in consideration of the total tractive effort and acceleration, wheel torque is essentially required to determine (T_w) based on the total tractive effort.
T_w = TTE x R_w x RF
Where;
T_w = wheel torque [Nm]
TTE = Total Tractive Effort [N]
R_w = Radius of the wheel/tire [m]
RF = Resistance factor

The resistance or drag elements has caused the frictional losses between the caster wheels and their axles and the resistance on the bearings of the motor. The standard values of the RF ranges in between 1.1 and 1.15 (or 10% to 15%).
So, putting values to calculate the value of wheel torque.
T_w = 10.58 x 0.127 x 1.15 = 1.5452 Nm

4. Components of Reaper machine

- Frame and Engine
- Bearing
- Pulley and Belt
- Ground Wheel
- Cutter Bar
- Clutch

4.1 Material of the components

The components which are used in the manually operated reaper machine are given below in the table 4.1.

Table 1: Reaper machine components and their material

Sr No	Components	Material Used
1	Frame	Cast Iron
2	Ground Wheel	Tubeless tire
3	Shafts	Cast Iron
4	Cutter Bar	Stainless Steel
5	Handle	Steel Bend Pipe
6	Belt	Rubber
7	Shaft Pulley	Cast Iron
8	Gear	Cast Iron

4.2 Specifications of Machine Parts

4.2.1 Dimensions of Machine

The frame is used for supporting the part member used in this project. Frame specifications is given below in the table 4.2.

Table No. 2 Dimensions of Machine

Sr No	Dimension	Length
1	Length	1120 mm
2	Width	710 mm
3	Height	660 mm

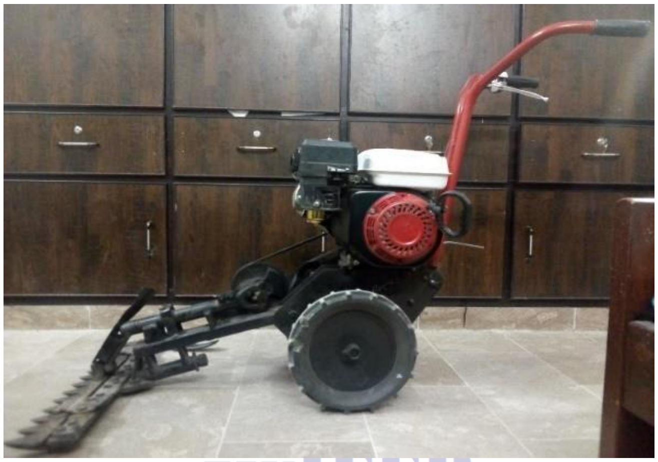

Fig. 1 Reaper Machine

4.2.2 Engine

Engine is a device which converts one form of energy into any other form of energy.

Table No. 3 Engine Specifications

Sr No	Engine Parameter	Value
1	Engine horsepower	6.5 hp
2	Engine RPM	2800

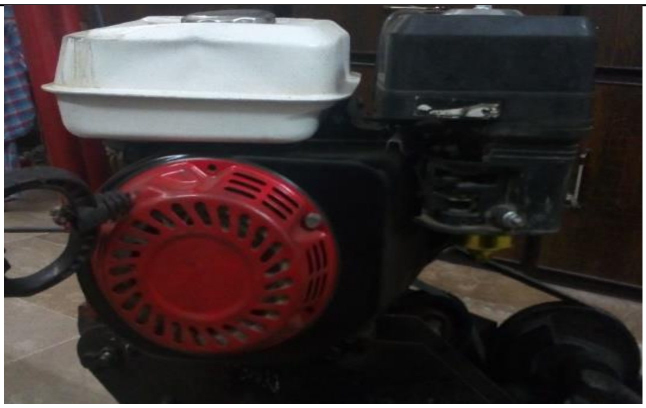

Fig. 2 Engine

4.2.3 Pulley

A pulley is a wheel on a shaft that is designed to support movement and change the direction of belt or to transfer power between the two parts.

Table No. 4. Diameters of Pulleys

Sr No	Pulley Name	Diameter
1	Main Shaft Pulley	152 mm
2	Blades Pulley	152 mm
3	Idler Pulley	89 mm
4	Flywheel	51 mm
5	Belt Tightener Pulley	51 mm

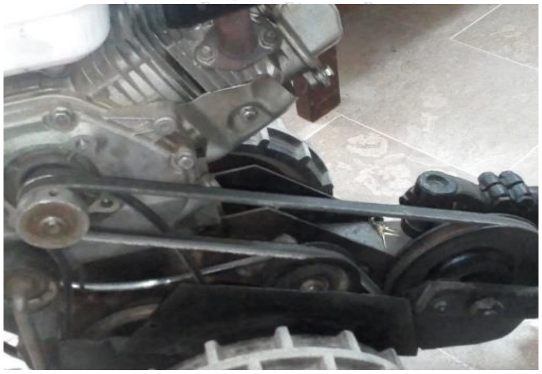

Fig. 3 Pulley

4.2.4 Belt

Belt is a strip of flexible material like rubber to mechanically link two or more rotating shafts that may not be axially aligned. Due to belt drive, there is smooth power transmission between shafts at variable distance.

Table No. 5 Dimensions of Belt

Sr No	Belt position	Diameter
1	Belt diameter between flywheel and pulley	864 mm
2	Belt diameter between blades pulley	1220 mm

4.2.5 Ground Wheels

Ground wheels are used for the travelling like one field to another field.

Table No. 6 Dimensions of Ground Wheel

Sr No	Details	Size
1	Diameter	305 mm
2	Thickness	51 mm
3	Diameter of Wheel Shaft	70 mm
4	Length of Wheel Shaft	178 mm
5	Distance Between two wheels	230 mm

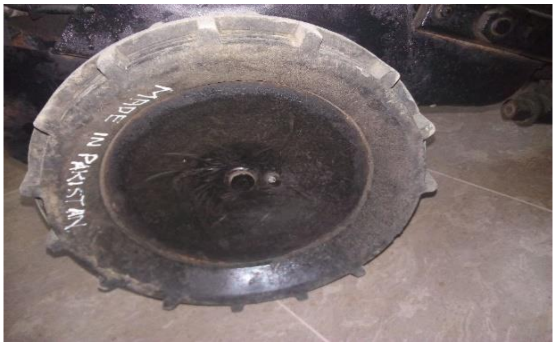

Fig. 4 Ground Wheels

4.2.6 Handle

Handle is used to control the reaper machine.

Table No. 7 Dimensions of Handle

Sr No	Parameter	Size/ Shape
1	Shape	Circular
2	Diameter of Pipe	51 mm
3	Length	864 mm

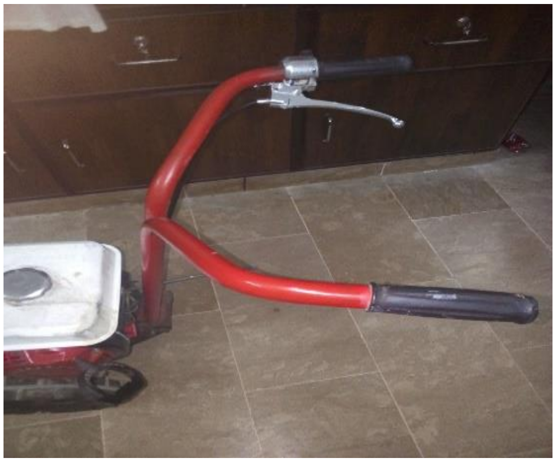

Fig. 5 Handle

4.2.7 Cutter Bar

Cutter bar is made up of the knife sections and hold down clips. The cutter bar is positioned along the front part of the reaper. It will cut the crop be shearing action. Reaper machine contain seven guides which mean there are fourteen blades while blades are of stainless steel.

Table No. 8 Dimensions of Cutter Bar

Sr No	Parameter	Size
1	Cutter Bar Width	712 mm
2	Blades Central Distance	51 mm
3	Blades Length	76 mm
4	Blades Width	51 mm
5	No. of Blades	14
6	No. of Guiding Blades	7

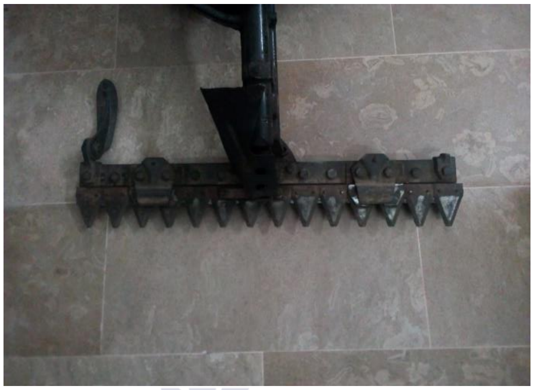

Fig. 6 Cutter Bar

4.2.8 Clutch

A clutch is a mechanical device which engages and disengages power transmission especially from driving shaft to drive shaft so that the driven shaft may be started or stopped at will, without stopping the driving shaft. In belt timing clutch there is a belt tighter which act as a power transmission source which clutch is engaged it tightens the belt between flywheel and main shaft pulley due to which power is transmitted from engine to wheel shaft and then machine starts moving forward. When clutch is dis-engaged then belt between flywheel and pulley is loosened and engine is unloaded so machine is stopped.

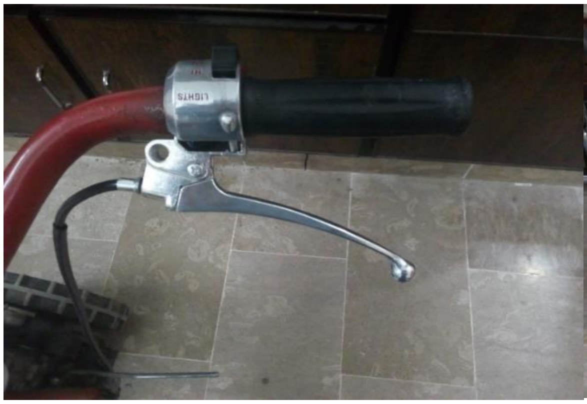

Fig. 7 Clutch

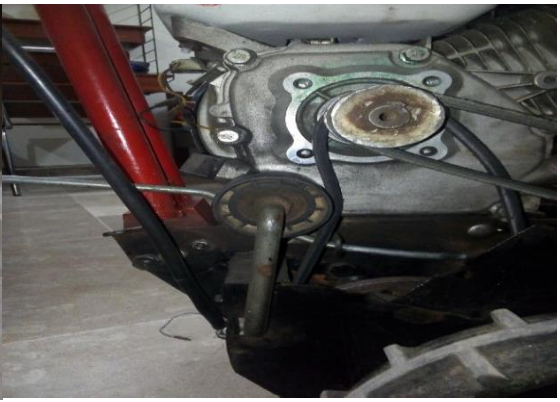

Fig. 8 Roller Contact Pulley

5.Conculsion

The machine underwent field testing to evaluate its cutting proficiency and efficiency. The test results were positive, as the equipment operated without error. The machine is rather compact and manageable. This machine can operate in the field effortlessly, hence diminishing the labor required from farmers. The expense of harvesting with this machine is significantly lower than that of human harvesting. The harvesters available in the market are designed for vast farms, making them the optimal machinery for farmers with limited acreage. The economic slump and manpower shortage in Pakistan would underscore the necessity of utilizing self-propelled reapers for the harvesting of various crops. The alterations to the current reaper were implemented utilizing nuts and bolts to provide easy assembly and disassembly for various crops. The manufacturing cost of the self-propelled reaper was minimal due to its lightweight, compact design, and adherence to engineering specifications during fabrication. The results indicate that the performance of the self-propelled reaper is satisfactory. The shatter losses, percentage slippage, and field efficiency were affected by the chosen levels of ground speed and machinery. Overall, the lowest ground speed yielded the minimal proportion of slippage, reduced shatter losses, and maximized field efficiency. The increased ground speed led to greater shatter losses and diminished the operational efficiency of the self-propelled reaper.

6.Future Recommendations

- In the future, the reaper's frontal head may integrate a conveyor chain and star wheel engineered to transfer harvested crops to one side.
- In the future, diverse cutting blade mechanisms may be affixed to the primary assembly to harvest various crops as required.
- In the future, a seat may be incorporated for the operator's convenience.

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