

Improved Innovative Siddhant Windrower Automated Reaper (IISWAR)

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ABSTRACT

The paper reflects, machine designed and developed by authors that suit medium sized farmer and farm industrialist holding only few acres of land. It has been designed and developed by CMERI, Durgapur, India, in collaboration with NIF(National Innovation Foundation, Ahmedabad, India). A number of crops i.e., wheat, and pulse like soybean, gram have been successfully reaped(harvested), and, concurrently the m/c is ready to undergo reliability&feasibility trial/inspection/check, desired for an Agri Machinery. It will be indigenously get checked for Nation wide R&D standard. The system is designed by inculcating years of expertise in this stream. There is a keen observation by designer to simplify assembling/disassembly and maintenance/ operations/ of picker reel, cutter link & blade, roll & push type auger and simplest possible bevel PTO. This prototype is a foolproof machine, designed with consideration of global knowhow of scientific mechanisms of this stream. The basic research work has been done thoroughly by selecting adequate technology and scientific calculations in all the assemblies and critical parts e.g. pivots, mounting bearing are analyzed through readymade CAD software as very firmness and strength is desirable. Maximum spare parts have been preferred IS standard (ready stock found vigorously). Right from selecting end support bearing of reel-the foremost unit, Pitmanless tumble and knife link of cutter unit, dowel pin of cross auger(the screw to roll&push the cut crop), and bevel gear&pinion of PTO unit, Indian standards are followed thoroughly. At each and every point while design of various devices in this machine, care has been taken for economy, simplicity and life span into consideration (the value addition). As it is a vital need of the farmers and agriculturists (farm experts), one thing has been fully kept in mind that we should confirm to reliability by judging robustness/longevity of various units, its ease and simplicity while operation and maintenance. Finally, this device could be easily fabricated by a small enterprise, as scientific knowhow is available with the authors. It has been predicted to save final labour, being minimized in the field. Maximum spares parts(more than 70%) can be found as ready stock in the market for running a medium or small scale enterprise.

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Introduction

In today's scenario of Mechanical farming specifically in post harvesting, timeliness of harvest is of prime importance. During harvesting season, conditions prevailing like rains and storms often occurs causing considerable damage to standing crops. Rapid harvest facilitates extra days for land preparation and earlier planting of the next crop. The adaptation of scientific equipments, mechanical devices helps in harvesting at proper stage of crop maturity and reduce drudgery and operation time.

Considering these, now improved harvesting tools with mechanized devices are being accepted by the farmers. The very common is a combine, which, being gigantic, technically- needs more turning radius as well as fuel in continuous run so there is a certain demand for medium sized harvester reaper which suits the farmers having limited land(in India mostly are small fields); hence a windrower reaper technology came into picture. This feature includes cutting as well as carefully leaving crop, in line, in the field. This can be further utilized by the farmers to feed to thresher, as huge combine leaves randomly, the hay, in the field hence, saving remains as well.

The Windrower reaper consists of 1.hexagonal reel, 2.single knife, 3.cross auger, 4.pulley-belt drive and 5.PTO (power take off) units. The units are similar to many units already in use with the devices in fields. In this mechanism the following points are worth noting-

1. Integrated drive based on manual calculation.
2. The power from PTO goes to Driving shaft then to Cross Auger and further to cutter and then to reel.
3. Ease of assembling the 5 units namely Reel, cutter, auger, Belt & Pulley and, PTO drive.
4. Fully enclosed from sides and back (mostly running parts) from safety point of view.

Technical Features

Improved Tractor Mounted Front Reaper Windrower has improvements on crop dividers, cutter, knife guard fixtures, conveying, hitching, lifting and transmission assemblies fully safe easy to assemble with PTO of the 15-35hp tractors; and in some cases power tiller also. Extensive mechanism design and spares selection as per IS standard and simplicity of operation were accomplished in this system. The residual straw is totally useful and grain loss is less, compared to manual harvesting.

The reaper has a capacity of 0.5 ha per hour and saves an amount of Rs. 950 per ha and 135 man-hrs per ha compared to conventional harvesting. In general this attachment may cost around Rs. 20,000/- (after govt. subsidy).

It has following salient features-

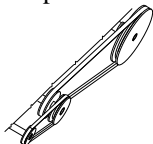
- (1) Small size as seen in a conventional huge combine.
- (2) Simplified transmission system.
- (3) Power required is comparatively less.
- (4) Recently, innovator of this mechanism has devised a gear box to connect this at front of traditional tractor having rear PTO.
- (5) The operation and maintenance cost in Indian purchase condition for this item is highly appreciable.
- (6) Value addition by IS standardization in all units and parts has been an important work. Right from pick up reel to cutter (hardened knife with IS std section), a pitmanless unit, drive to V-belt and pulley selection by calculation, every spare is as per IS (Bureau of Indian standards) specification.
- (7) Useful straw, as residual can be handled appropriately.

The major units are described as under

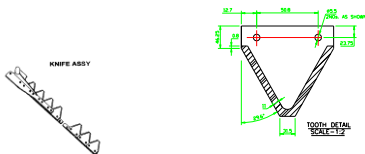
Various parts of reaper are as follows:

- 1. PTO with stepped shaft and gear pair and
- 2. Belts with Pulleys.
- 3. Cutter with knife&Tumble.
- 4. Cross Auger with Chassis.
- 5. Reel (Hexagonal)with spikes.
- 6. No. off woodruff keys Collar pins, End Pins, Split pins, External Circlips, Screw&nuts.

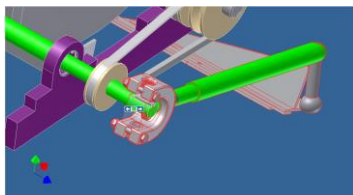
1. The Belt & Pulley Drive Unit is very much simplified as here is only V belts(2nos.) & Pulleys(3nos.). These are used in 2 steps i.e.- no.1 from PTO shaft to Auger(1:2) and no.2 from Auger to Reel(1:3) that means total step of 1:6.



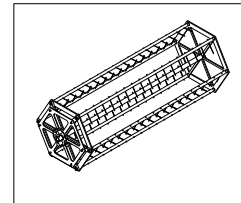
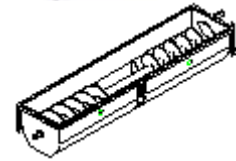
2. The knife unit comprises of cutter blade having cross section as per IS: 6025-82.



The drive translates the motion from Main PTO shaft to cutter (is) through Pitmanless(a twin block and a taper pin inside) which converts rotary motion into reciprocating motion (as shown below).



- 3. Auger unit has a very common use for screwing. Here it rolls the cut crop by pushing, and bringing at middle it drops the crop through opening at bottom (windrowing). The unit can be fabricated by welding worm one by one over the pipe. Two similar sets are fabricated so as to assemble in mirror position.
- 4. In common harvester a crop holding unit at front called Reel is to hold and feed the crop to cutter is mounted on end pivot pins. Based on bulk /capacity to work it is of different lengths.



5. The PTO Drive unit Consists of input from PTO of driving prime mover and this is transmitted through a set of bevel gears to driven shaft (PTO).

Calculation for drive(si units)

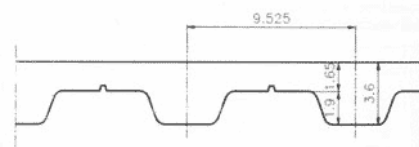
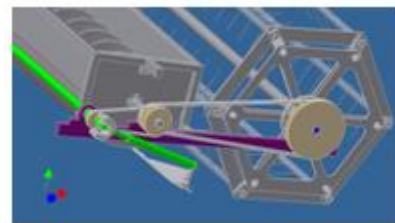
The drive from PTO is stepped down in 1:2 ratio. This drives the V pulley& belt-I and further output goes to cross auger; the unit which collects and rolls the crop converging it to the middle opening from two opposite side worms. This transmission ratio is in 1:2. The drive from Cross auger is then stepped down by V pulley&belt-II, in transmission ratio 1:3, which drives reel; the foremost unit to hold and pick the crop. Hence, the RPM from standard engine drive is reduced to 1:12.

Since auger needs to take drive from both sides, second side is just mirroring of one set, which is as under (refer figure below)-

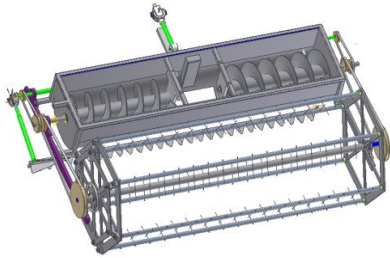
(1)Pulley-1-2&Belt-1

The Prime mover drive from PTO driven shaft through V Pulley-1 to V Pulley-2 , is forwarded via V belt. The pulley-2 is duplicated (no.off 2).

(1)Pulley-2-3&Belt-2:- Pulley-copy-2 transmits power to pulley-3 via timer belt-2 to drive the reel.



- The 3D-CAD model generated in design software reflects no interference in any unit. The few findings are as under-
- 1. The whole mechanism is fully integrated which means all the sub assemblies are proportionally powered and appropriately dimensioned.
 - 2. All the standard bought out items are as per IS-standards and assembled considering proper geometric dimensioning and tolerances.



3. The designed components match with standard parts as simulation and FE Analysis confirms this.

4. All the components selected are conventionally adopted although states of art components are chosen for drive unit. The heavy duty timer pulley and belt which are technically developed to meet high end medium sized harvesters and related machinery.

Table 1-Timer Belt Specification

#ID	Name of part	No of	Size	Material	Remarks
1.	Pulley-1(V)	01	Dia75	Steel	STD
2.	Pulley-2(V)	02	Dia115	Steel	STD
3.	Belt-1 (V)	01	C/C270	Rubber	STD
4.	Pulley-3(V)	01	Dia240	Steel	STD
5.	Belt-2(V)	01	C/C700	Rubber	STD

Initially we started with existing harvesting systems, and then further, we looked at the practical adoptability of units. Its technical specialties like-

- (i) Prime mover association e.g. tractor and power tiller.
- (ii) Power/Capacity- As per prime mover.
- (iii) Fuel Consumption-The minimum.
- (iv) Economy of development of units –very reasonable.
- (v) Field trial- no interference, Friction, Wear &Tear and noiseless running as these factors had already been considered while designing various units.

Conclusion

PTO connectivity through Tractor is possible like conventional models providing front arrangement with engine for PTO and hydraulic power pack for lifting and at the grass root level specially devised joints & hooks with bullock cart live is probably possible.

Further scope of work- The design can be more user friendly, if the PTO power pack which contains the connector through

front end of engine is sorted, which is common around the world.

A full single all in one solution to reap, thresh, store grain, and further make windrow of hay (combine) with the lesser hay loss is likely topic of special research.

Acknowledgment

We are grateful to the Director, CMERI (Retd.Dr.G.P.,Sinha) for providing us all kinds of support to avail of various facilities at CMERI, Shri S.K.Mandal, Sct 'C' for overall decision making in running the project with the past experience on same line with R.K.Bharilya.

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Authors

Sh.B.S.Dangi belongs to Village-Sojana, Vidisha (MP. India). His technology innovation skills turned practical in to machines, starting since 1990. He works in his 100 acres farmhouse cultivated by his own. The paper is prepared after his innovation of Sidhant windrow reaper. He invented few more attachments like efficient seed drill and portable thresher.

Sh.S.Sen Sharma,(Sct.E-II) Recently, few a many projects in his co-ordination has been taken from NIF, National Innovation Foundation, Ahmedabad, India. Few are stated as-Gravity sprayer, Seed drill, Semi-automatic Pulse thresher, Pedal pump.

RK Bharilya, (Sct,'C') has experience of 11 years in designing and development of Agri Machinery. Many Industrial m/c also successfully developed. Expertise in CAD Modeling and analysis. Recently undergoing design of oil squeezer. A no. of projects are continuously in hand for CAD/FE analysis.

A.K.Prasad, (Sct, 'E-I') has experience of 15 years in manufacturing, assembly, trial &testing of the various projects like agri machinery, textile, 4-axis servo control system, ADI crankshaft for ambassador, tractor and pump , intelligent robotic system and various NIF projects undertaken by institute. He is handling MTG process by flow chart, process planning.