Review Article

HYDRAULIC BUSH CUTTER- BUSH CUTTING DEVICE: A REVIEW

ABSTRACT

Farmers are facing with a major problem of a trimming of boundary bush or cutting the fence of agriculture. In addition to this unwanted growing bush also obstructs roads and electricity poles. The existing method of bush cutting is manual pruning by a labor. But day by day the labor’s are becoming costlyand the manual method is a time consuming process. In addition, there isdanger of being hurt by an axe or saw.To overcome this problem, it require’s a good tools/machine and safe operation.Transmission of power by hydraulic media is considered to be more economic as compared to mechanical power.Conventional mechanical power have several drawbacks such as non-continuous, limited speeds due to use mechanical gearbox, loss of power in transmission and also the risks of human injury are more as compare to hydraulic power.An alternative of mechanical power for above crucial problem ishydraulic power. A hydraulic motor operated bush cutter will be helpful to minimizecost of operation,labours, drudgery and time of operation and alsothe chances of injury to operater.

Keywords:*Hydraulic, Transmission, Blade, Cutting, Bush.*

1. INTRODUCTION

In general the bush is observed everywhere specially just after rain, this hinders the movement of machinery, bullocks and also even human beings. It is observed that farmers are adopting very simple hand tool for cutting of bush. Very less efforts have been made to develop indigenous mechanized systems for cutting of bush. Also, pruning of branches is essential for better growth of trees and many horticultural crops. Pruning is generally done manually by using knives or special tools, which is very risky, tiresome and time consuming process. The manual method is not useful for large trees as pruning using a stand or ladder for top finishing and side finishing is risky. The hydraulic motor operated bush cutter machine provides a solution for bush cutting and tree pruning.

2. BUSH CUTTER

The principle involved in bush cutter is utilizing high impact cutting force or shear action to cut branch of tree/vegetation by blade or cutter bar rotating at high speed. Bush-cutting equipment has diverse applications in farm such as cutting/pruning of bushes and maintenance for farm roads, highways, pipelines and other utility lines.

2.1Cutting Speed

Chardin (1957) did some experiments about cutting speed effects in sawing. The author observed better chip evacuation at higher speeds and thus, less heating of the saw blade. From a turning experiment and evaluated the force variation in the cutting direction when cutting speed was increased from 15 m/s to 150 m/s.

Ohta and Kawasaki (1995) studied several types of fractures in wood cutting. A transversal cutting process has been conducted with velocities ranging between from 5 m/s to 70 m/s. For the lowest velocities, the test piece was deflected and no chip was removed. From 10 m/s, the “breakage type” often occurred (a split from rebate to the test-piece embedding). Above 60 m/s, the cutting process produced good chips with no deep splits.

Karunya*et al.* (2016) evaluated the performance of chaff cutter. Test was conductedat three different cutting speeds 0.1 m/s to 0.14 m/s by changing the driving pulleys of the motor. They found that, the efficiency of chaff cutter increased with increase in cutting speed.

2.2Cutting Blade

Baneh*et al.* (2012) designed and developed a cutting head for a portable brush cutter for harvesting four Iranian rice varieties. A circular saw blade with 24 cm diameter and 2 mm thickness and blade having 136 teeth with 0° rake angle, 30° clearance angle and 6 mm pitch. Made from aluminum sheet. Results also showed that losses in portable reaper were lower than manual harvesting. Field capacity of machine was 4.20 times greater than manual harvesting.

Alandkar (2017) studied different types of cutter blades for wood cutting. Hefound that high carbon steel shearing type circular shape blades were provided having serrated edge. Diameter of each cutting blade was 300 mm and thickness 4 mm. The revaluation per minute of cutting blade was 376 rpm.

2.3Mechanical bush cutter

Lambert (1974) studied vertical-shaft and horizontal shaft brush cutters. Models provide more mulching action, require more energy to attain the same cutting capacity and are more sensitive to wear.

Sutherland (1985) studied bush harvester cutting principles and horizontal-vertical shafts cutting process for harvesting brush. The Crabe Combine brush harvester used sickle knives with a counter-shear to cut large-diameter material, and other designs have used twin saws to cut the stems.

Martinez and Martin (1985) studied on different chains used on some brush cutters, although seldom in Canada. A study comparing verticalshaft cutters with knives or chains found that chains required 30% more power and 16 to 30% more fuel per hectare. Uneven chain wear can also result in vibration problems. Nevertheless, chains are less sensitive to impacts with rocks and may prove beneficial in some applications.

Ryans (1986) designed fixed cutting devices usually comprising of circular saws and discs with fixed teeth. These have the advantage of being more efficient at cutting than pivoting blades, thus lowering the energy requirements and/or improving the cutting capacity for similar power input. Devices with saw teeth require frequent sharpening to maintain their performance and can dull quickly from contact with rocks or the soil. A number of circular-saw heads have been used on prototypes and on an operational basis in Quebec.

Ryans (1988) developed horizontal shaft bush cutter and test in silvicultural operations. Chain flail delimbers have been used in pre-commercial thinning and slash-reduction operations. Chain flails consist of lengths of chain attached to a single horizontal shaft. Cutting tips, multiple lengths of chain bolted together, and bars fixed between the chains have sometimes been added to increase the effective cutting surface compared with standard chains. Chain is effective at cutting at or near the ground surface, whereas hammers or knives dull quickly if used this way.

Cormier (1991) studied horizontal shaft bush cutter and observed that in contrast, horizontal-shaft brush cutters produce finer mulch, thus making the site plan table with no follow-up treatment if mineral-soil exposure is not required. However, the productivity of horizontal-shaft equipment is much lower, which can result in higher overall costs than a combined brush-cutting/raking treatment using vertical-shaft equipment.

McKenzie and Makel (1991) designed free-swinging cutters consisting of pivoted knives mounted on a central disc or bar. The knives swing back under an impact, returning to their working position through centrifugal force. The free-swinging action reduces the risk of damage to the knives or main shaft when the blades strike an immovable obstacle. Proper geometry between the blade, pivot point and center of rotation are essential for the swing timing, which affects the force of impacts and vibration of the head. Most of the vertical-shaft brush cutters used in forestry have free swinging cutters.

Ryans (1995) studied a modified chain flail used to create planting corridors through logging debris and to destroy unwanted hardwood and softwood competition at the same time. Although the heavy concentrations of debris were not greatly reduced, access on the site was improved and the finer slash was mulched enough to provide plant able microsites.

Langton and Paterson (2004)in a study on self-operated bush cutter observed that an adapted brushcutter with a specially designed blade could significantly increase the cutting rate compared to a manual system. This would decrease the pressure on the available cutting force. This system was able to operate on steep slopes and under a variety of conditions. However, more work was required to test new blades and implement the brushcutter into an effective working system.

Savaliya and Jhala (2015) developed tractor operated bush cutter.A set of two cutting blades of bush cutter was powered by tractor PTO power. Experimental results revealed that the average height of cut of bush cutter was found as 275 cm, while width of cut was observed as 90 cm. On an average the diameter of the branch that can be easily cut ranged up to 42 mm. The cutting capacity of bush cutter was found as 2.41 km in one hour with fuel consumption of 3.39 l/h. The cost of operation of the tractor operated bush cutter was found as 0.24Rs/m length as compared to 2.17Rs/m in case of manual cutting. The ratio of cost of operation for tractor operated bush cutter and manual bush cutting (1:9) indicates that the tractor operated bush cutter is highly beneficial in terms of cost and time both.

2.4Hydraulic Motor

Coates (1986) developed an improved braking system using a rotary hydraulic actuator in a closed loop circuit in combination with a caliper disc brake. Heobserved that the control of reel peripheral velocity during installation of drip irrigation laterals is a major problem. Therefore they used hydraulic motor operated drip line installer. Laboratory evaluation indicated improved performance for implement speeds of 3 km/h to 16 km/h.

Nadre and Kadam (1992) designed and developed low horse power tractor with hydrostatic transmission system. The prototype tractor was tested and demonstrated for performance. The performance was found to be satisfactory. Hydraulic pump with 41 cm^3/rev displacement,3600 rpm maximum rated input speed,200 bar maximum continuous pressure and hydraulic motor with 254 cm^3/rev displacement, 45-67 N m torque rating,200 bar continuous pressure has been used.

Pawar(2004) designed and developed hydro rotavator. He used hydrostatic power transmission system over the mechanical power transmission in the rotavator and compared the performance. Suitable hydrostatic power transmission system was designed comprising of hydraulic piston pump, hydraulic motor, hydraulic hoses, control valves, reservoir and filter etc. In field trials if was observed that, Field performance index, pulverization index and fuel consumption rate for hydro-rotavator are 94.25%, 1.75 cm and 4.66 lit/h respectively and that of mechanical rotavatorwas 90%, 1.89 cm and 5.25 lit/h respectively. The operation of hydro-rotavator was smooth with less noise and vibrations as compared to mechanical rotavator. Initial cost of the hydro-rotavator has been reduced by 10,000/- in comparison with mechanical rotavator.

Awad*et al.* (2012) used a hydraulic transmission system instead of the mechanical transmission system in a converting of rotary plow. They observed that, decreasing in power requirements and the fuel consumption up to 18.4 % as compare to mechanical transmission.

Singh (2012) developed a tractor operated tree pruner,meantfor pruning the trees and topdressing as well. The developed machine was mounted tractor and gets drive on from hydraulic system. A hydraulic motor was used having a powerof 15 kW and speed of 1000 rpm.Rotational speed at intermediate shaft, at central shaft and at the blade was 2000 rpm,3000 rpm and 4200 rpmrespectivly.It can be attached to any tractor of size 40 hp and above.The machine can prune trees of height 20 ft (top-down) while keeping blades verticaland can top dress the plants of height 12-15 ft.The machine can cover a circle of 10 ft diameter while tractor is static. It can prune 2000ft long rows of trees at a spacing of 18-20 ft on both the sides of a road. He found that, in orchards machine can cover about 200 plants in one hour, spaced at 18-20 ftdistance.

Mollapour*et al.* (2018) designed and developed a motorized hydraulic hole-digger. Aim of researcher was to handle the problems and to optimize the working quality of hole-diggers via developed digger. They used an orbital hydro-motor, (BMR-80) with the maximum torque of 220 N m and an external gear pump (REXPORT-2APF8) with displacement volume of 8 cm^3 and flow rate of 12 L min^{-1}. Also usedIC engine about 6.5

hphaving a speed of 3600 rpmand hydraulic oil tank with total volume of 24 liters made from a sheet metal having thickness of 3 mm. The helical auger having a diameter of 200 mm and pitch of 180 mm. Working condition at 30 cm depth, 20 cm diameter and 100-160 rpm rotational speedof auger and high soil moisture (25.95%) in the silty-clay soil. They found that, the maximum force 214.07 kgf (2100 N), minimum specific fuel consumption was 0.0014 liter pit^{-1}. Also, the maximum device's power (2.548 kW) occurred in deep soil (30 cm) and low soil moisture in silty-clay texture.

Fouda*et al.* (2019) developed hydraulic operated reciprocating mowers. Due to the ease and excellence of the hydraulic transmission, researcher are concerned to transmit power from tractor to a reciprocating mower using a hydraulic cycle. They determine the cutting force, efficiency of cutting height and power consumption and obtained results that, the efficiency of cutting height increased by 9.7%, but the actual cutting force decreased by 24%, for developed mower than the conventional mower. In the other hand, by increasing the knife speed the power consumption decreased. To achieve the highest efficiency of cutting height, which is 90.2%, it is recommended to operate the cutting knife at a speed of 2.9 m/s with a forward speed of 0.89 m/s for developed mower. Finally conclude that, drive mower with hydraulic motor achieved balance and stability during the mower is working.

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