Review Article

DIFFERENT BUSH CUTTING DEVICE: A REVIEW

ABSTRACT

In a Saurashtra region, farmers are facing a major problem with the trimming of boundary bushes or cutting of the fence of agriculture. In addition to this, unwanted bush also obstructs farm operations, roads, and electricity poles. Currently, bush-cutting is done through manual trimming by agricultural workers, but it is a time-consuming and expensive operation. In addition, using an axe or saw may lead to injury. To overcome this problem, it requires good tools or machines for safe and easy operation. Many mechanical devices are available to perform boundary bush trimming or agricultural fence cutting, but conventional mechanical power has several drawbacks, including non-continuous operation, limited speeds due to the use of mechanical gearboxes, high power loss in transmission, and increased maintenance. As time has changed, an improvement in traditional tools and devices is required. Hydraulic power is a good alternative to mechanical power, and it reduces the risks of human injury as compared to mechanical power. Also, the power transmission is more economical as compared to the mechanical. To maintain the preceding point, a hydraulic power transmission system was chosen over a mechanical one. In this study, an existing method was compared in terms of time and cost with a developed machine.

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

UNDER PEER REVIEW

INTRODUCTION

In general, the bushes are observed everywhere, especially just after rain. This hinders the movement of machinery, bullocks, and even human beings. One of the most expensive and time-consuming operations involved in large scale wildlife management is the reclamation of brush choked land where open areas and herbaceous vegetations are required. And this problem is not faced by the wildlife alone, but as frequently by the farmer where dense undergrowth composed largely of "weed" species occupies the terrain. It is observed that the farmers are adopting very simple hand tools for bush cutting. Very few efforts have been made to develop indigenous mechanised systems for bush cutting. For horticultural aspects, pruning of branches is essential for the better growth of trees in many crops. The hydraulic motor operated bush cutter machine provides a solution for bush cutting and tree pruning.

MANUAL METHOD OF BUSH CUTTING

In the Saurashtra region, generally pruning is done by manual method. In bush cutting operations, tools are used like, sickle, knives or special tools, axe, etc. Use of these tools are very risky, tiresome and time-consuming process. The manual method is not feasible for the cutting of large trees. Some farmers are used a stand or ladder for top cutting and side cutting and it is very risky job.

Fig. 1 Different type of manually tree pruning tools

MACHENICAL BUSH CUTTING

There are many different kinds of bush cutters. According to power property, there are gasoline engine and electric types, and the latter can be divided into alternating and direct types; according to usage mode, there are handheld, side guide and knapsack types and so on. Bush cutter consists of blade/cutting tool and power transmission are major parts to decide the performance and quality of brush cutter. 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. The principle involved in mechanical bush cutter was high impact cutting force or shear action to cut branch of tree/vegetation by cutting tool. Following reviews are based on mechanical power source.

Herbert (1937) used mechanical brush-cutter in wildlife management. It consisted of the turned heart of a pine log about five feet long and some three feet in diameter, to which were bolted about a foot apart used veneer knives about six inches deep and running the full length of the log. The frame in which the axles turned was of wood, and the machine was pulled by a heavy team. This machine did very good work in cutting-in cover crops or demolishing low bushes, but could not stand up under long-continued heavy usage.

Fig. 2 Mechanical brush-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 vertical shaft 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.

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”.

UNDER PEER REVIEW

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.

Langton and Paterson (2004) in “a study on self-operated bush cutter observed that an adapted brush cutter 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 brush cutter into an effective working system”.

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”.

Fig. 3 Portable mechanical brush-cutter

Singh (2012) developed “a tractor operated tree pruner, meant for pruning the trees and top dressing as well. The developed machine was mounted tractor and gets drive on from hydraulic system”. A hydraulic motor was used having a power of 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 rpm respectivly. 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 vertical and 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 2000 ft 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 ft distance.

Du *et al.* (2014) studied "the existing brush cutter and the analysis of the known conditions. In this study mainly design mechanism, principle of brush cutter, and carried on calculation and calibration of spiral bevel gear cutting machine parts, so as to ensure that the design of brush cutter is safe, efficient, simple, comfortable and environmentally friendly. Product after research is of reliable performance, convenient operation, low noise and zero smoke and higher safety factor, making it get more extensive application in the industry".

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.

Fig. 4 Tractor (PTO) operated brush-cutter

Alandkar (2017) studied different types of cutter blades for wood cutting. Found that high carbon steel shearing type circular shape blades were provided having serrated edge.

UNDER PEER REVIEW

Diameter of each cutting blade was 300 mm and thickness 4 mm. The revaluation per minute of cutting blade was 376 rpm.

Bo Li and Shusen Li (2017) redesigned “knapsack brush cutter. It was a kind of portable forestry machinery which is widely used at home and abroad. Also used in forestry operation field such as landscaping, garden maintenance, forest cleaning, forest tending and harvesting crops. Chronic occupation injury and safety accidents caused by cutting irrigation operation ever are increasing in China. Worker’s wrong cutting irrigation posture is the main cause of workers’ occupational diseases and hazards. Based on ergonomics, the redesign of shape and structure of brush cutter can standard the postures of operators, thereby reducing the disease rate of the operators’ musculoskeletal disorders and it can reduce the occupational safety accidents”.

Fig. 5 Mechanical knapsack brush cutter

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”.

ELECTRIC OPRATED BUSH CUTTER

Chi (2012) developed “an electric operated bush cutter with blade rotation speed control and electronic circuit protection functions. The mechanical power source of tradition mechanical grass cutter is based on a two or four strokes petrol engine. Obtained some very attracting advantages such as low vibration and acoustic noise, free of air pollution and low using cost, a DC motor is used as the mechanical power source of new electric type brush cutter. In addition, a Li-ion battery and electronic control board designed for DC motor speed control and circuit protection purposes were included as well. The performances of the developed electric brush cutter were validated through extensive experiments and a laboratory scale implementation”.

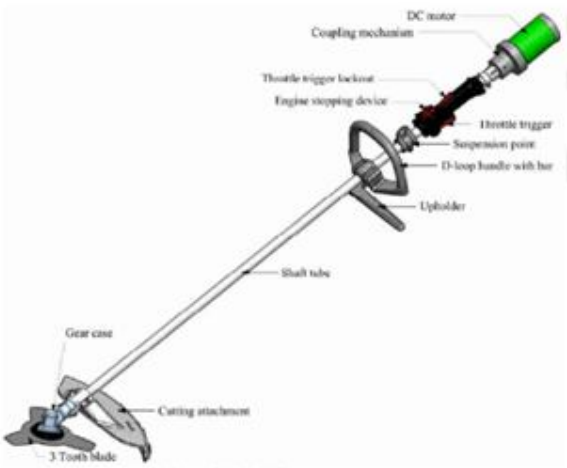

Fig. 6 Electric operated three tooth blade bush cutter

Ohkawa *et al.* (2014) developed “a robotic brush-cutter that operates a retail-purchased brush-cutter. The robotic vehicle is con structed with a centre articulated body, a manipulating mechanism for the brush cutter, sensors and controller. Two Laser Imaging Detection and Rangings (LIDAR) and a GPS campus are installed to achieve continuous positioning. The authors proposed a lateral guided method SSM for the articulated vehicle and then applied it. The map for self-localization is constructed with a 0.1m², 2-D grid that is measured by the equipped 2-D LIDARs. The experimental set up was developed and installed in the control program and then autonomous mowing was tested, leading to the results of running and mowing. The proposed system can effectively mow without leaving a strip of unmowed grass by setting the overlap to 20cm”.

Fig. 7 robotic brush-cutter

Bello *et al*. (2015) developed and fabricated "an electrically operated brush cutter was to eliminate inherent ergonomic designs and costs of imported brush cutters and also improve performance efficiency. The machine incorporated an electric power pack which provides 4 hours of continuous power for cutting, ergonomic design a ground wheel roller was introduced to reduce carpal disorder that could be associated with hand held brush cutters. Machine effective efficiency is rated at 46.67% and the blade cutting efficiency is 87.5%. The minimum height of cut is 1.3mm while the machine is capable of operating at variable conditions".

UNDER PEER REVIEW

Fig. 8 Electric operated bush cutter

Naskrent *et al.* (2020) developed "a brush cutter and it was used for tending young forests. When cutting unwanted vegetation, the operator is exposed to various harmful factors, such as: a forced body position, noise, vibrations and exhaust emissions. In this study, the impact of cutting attachment type on the noise level during tending of young pine stands was examined. The attachments used during the tests included: a wire head and cutting blades with 2, 3 and 24 cutting teeth. The research was carried out on 2–3 year old Scots pine plantations covered with three types of vegetation: herbaceous, mixed and woody. It was proven that the the wire head was the device that generated the highest level of noise. In the case of cutting blades, the number of cutting teeth was the important factor. The greater the number of teeth in the cutting blades, the lower the noise level the device produced. There was no significant influence of vegetation type on noise emission level. Based on the results, in order to minimize operators' exposure to noise, the use of wire cutting attachment should be limited".

SOLAR OPRATED BUSH CUTTER

Ashwin *et al.* (2021) developed a solar operated brush cutter for cutting unwanted plants in waste lands, borders of the field, road sides, public places. In a present the brush cutter is operated using diesel or electricity which is high cost per unit. To overcome this solar energy was effectively utilized instead of diesel or electricity. The solar energy observed by the panels is converted into electrical energy. The power is then transmitted to the battery and then from battery the power transmitted to a electric motor, on the shaft of the

UNDER PEER REVIEW

electric motor a nylon wire and aluminium cutter was connected. It is used to cut the grasses or bushes from the use of nylon wire the material was flexible on stones and safe of workers when compared with the blades. The main advantages of solar operated brush cutter is time saving, energy saving at less cost. Use of solar energy was found to be eco-friendly for environment and pollution free machine. This machinery is financially give more benefits for farmers. Use of wheels is the added advantage to the machinery, since mounting it on the labour's body will cause some health effects due to vibration that cause heart related problems and burden to the farmer.

CONCLUSION

Based on the modern concept, the development of modern system should consider manpower saving and avoid excessive energy consumption. Unfortunately, many systems such as traditional mechanical bush cutter consume more power and result in low efficiency. Develop electric brush cutter associated with high performances such as low noise and vibration, easy move and start, less malfunction and compact. The mechanical power of the internal combustion engine in conventional brush cutter is replaced by a DC brush motor (abbreviated as DC motor). A solar panel was used to charge battery in electric brush cutter and solar energy was found to be eco-friendly for environment and pollution free machine. But an electric brush cutter has low efficiency and required high maintenance. The use of hydraulic power in an agriculture sector now a day being an easy task. Therefore, the hydraulic motor operated bush cutter is an alternative of mechanical and electrical bush cutter. Through this study, a design of hydraulic motor operated bush cutter is a safer, simpler, more efficient, comfortable and environmentally friendly and gained more extensive application in the agriculture.

REFRENCES

Alandkar, N. 2017. Development and performance evaluation of sorghum stalk cutter. M.Tech. (FMPE) Thesis (Unpublished). Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

Aswin, R., Mano Bala, G., Dhananivetha, M. and Manickavalli, E. 2021. SOLAR OPERATED BRUSH CUTTER. *International Journal of Mechanical Engineering.* **6(3):** 1006-8.

UNDER PEER REVIEW

Awad, M. A.; Fouda, O. A. and Yusuf, R. Y. 2012. Modification of the rotary plow transmission from mechanical to hydraulic. 19th. Annual, Conference of the Misr Social of Agricultural Engineering. Tehran, Africa. Pp. 14-15.

Baneh, N. M.; Navid, H.; Alizadeh, M. R. and Zadeh, H. R. 2012. Design and development of a cutting head for portable reaper used in rice harvesting operations. *Journal of Applied Biological Sciences.* 6(3): 69-75.

Bello, R.S., Baruwa, A. and Orisamuko, F., 2015. Development and performance evaluation of a prototype electrically powered brush cutter. *International Letters of Chemistry, Physics and Astronomy*. **58:** Pp. 26-32.

Chardin, A. 1957. The study of ultra-fast photography sawing. *Bois and Forets Des Tropiques.* **51**: 40-51.

Chi, C.T., 2012. A new electric brush cutter. *WSEAS Trans System Control*, **3(7)**: 2224-2856.

Coates, W. E. 1986. A reel braking system for drip lateral handling equipment. *ASAE Applied Engineering in Agriculture*. **2(2):** 101-103.

Cormier, D. 1991. Stand conversion using the munger and denis-cimaf brush cutters. *Forest Engineering Research Institute of Canada*. **9(10):** 33-44.

Du, Q.L., Jiang, X.W. and Pan, L.A., 2014. Study and design of lawn brush cutter. *In Advanced Materials Research*. **971:** 736-739.

Fouda, O. A.; Awad, M. A. and Yusuf, Y. R. 2019. Utilization of the tractor hydraulic device to operate reciprocating mowers. *Journal of Soil Sciences and Agricultural Engineering*. **10(12):** 913-918.

Karunya, M.; Gowthami, E.; Reddy, K. R. and Pavani, I. 2016. Performance studies on power operated chaff cutter with Para grass (Brachiariamutica). *International Journal of Agricultural Science and Research.* **6(1):** 105-112.

Lambert, M. B. 1974. Evaluation of power requirement and blade design for slash cutting machinery. *American Society of Agricultural Engineers.* **3(8):** 26-29.

Langton, M. I. and Paterson, J. W. 2004. Alternative sugarcane harvesting methods. Final year design report, school of bio resources engineering and environmental hydrology. University of KwaZulu-Natal, Pietermaritzburg. p. 121.

UNDER PEER REVIEW

Li, B. and Li, S., 2017. Research on Security of Improved Design of Knapsack Brush Cutter. *International Journal of Simulation Systems, Science & Technology*. **36**:1473-8031.

Martinez, F. and Martin, C. 1985. Le debroussaillement au gyrobroyeur equipe de chaines ou de couteaux-etude comparative. In: *Annales de mecanisation forestiere*. ARMEF, Paris, France. Pp. 267-311.

McKenzie, D. W. and Makel, B. 1991. Field equipment for pre-commercial thinning and slash treatment. *Forest Service Technology and Development Center*. **5:** 21–29.

Mollapour, S., Kalantari, D. and Vandechali, R. M. 2018. Design development and evaluation of a new motorized hydraulic hole-digger for spot treatment. *Journal of Agricultural Machinery*. **8(2):** 235-248.

Nadre, R. G. and Kadam R. S. 1992. Low horse-power tractor with hydrostatic transmission system. *Indian Journal of Rural Technology.* **4:** 71-84.

Naskrent, B., Grzywiński, W., Łukowski, A. and Polowy, K., 2020. Influence of cutting attachment on noise level emitted by brush cutter during tending of young forests. *Croatian Journal of Forest Engineering: Journal for Theory and Application of Forestry Engineering*, **41(1):** 129-135.

Ohkawa, S., Takita, Y. and Date, H., 2014, June. Development of the autonomous brush-cutting robot using articulated steering vehicle. In ISR/Robotik 2014; *41st International Symposium on Robotics* (pp. 1-6). VDE.

Ohta, M. and Kawasaki, B. 1995. The effect of cutting speed on the surface quality in wood cutting – model experiments and simulations by the extended distinct element method. 12th International Wood Machining Seminar, London. Pp. 56-62.

Pawar, R. B. 2004. Design and development of hydro-rotavator. M. tech. (Agri. Engg.). Thesis (Unpublished). Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

Ryans, M. (1988). Mechanized pre-commercial thinning methods: experience to date. Forest Engineering Research Institute of Canada. Annual Report. p. 18.

Ryans, M. (1995). The Stora chain flail concept for slash reduction/stand tending treatments. Forest Engineering Research Institute of Canada. Annual Report. p. 2.

UNDER PEER REVIEW

Ryans, M. 1986. Development and evaluation of a FERIC concept machine for pre-commercial thinning and plantation weeding. Forest Engineering Research Institute of Canada. Annual Report. p. 33.

Savaliya, G. and Jhala, K. B. 2015. Design and development of tractor operated bush cutter. M. tech. (Agri. Engg.). Thesis (Unpublished). Junagadh Agricultural University, Junagadh, Gujarat, (India).

Singh, G. 2012. Tree pruner. National Innovation Foundation – India, Annual Report. Ganganagar, Rajasthan, (India). Pp. 12-24.

Stoddard, H.L., 1937. Use of mechanical brush-cutters in wildlife management. *The Journal of Wildlife Management.* **1**:42-44.

Sutherland, B. J. 1985. Brush harvester development and field test. *American Society of Agricultural and Biological Engineers.* **85**: 1628.

UNDER PEER REVIEW