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Self-Cutting Spiral Chipper for Fully Mechanized Landscape Conservation Measures

For fully mechanized bush and shrub removal in valuable open landscapes, a prototype bush chopper was developed for the preliminary tests, which can cut, chip and load plant material in one operation. Experiences from the first field tests show that upright chopping helices are not suitable for application in bushy vegetation.

Removal of bushy and woody vegetation from open grassland is a key issue in landscape conservation and biotope protection [5, 6]. The development of appropriate machinery for this purpose is a key question for the section of Agricultural Engineering of the Georg-August-University in the joint venture project "Fully mechanized landscape conservation in nature reserves and FFH-areas [7]. First experiences with a specially developed prototype, based on a self-cutting spiral chipper are presented in the following.

Concept of the Chipper

The self cutting chipper consists of a combination of a tractor propelled wood chopper for short rotation plantations [4] and a machine for cutting and mulching vegetation in tropical secondary forests [2], both being prototypes, developed in the section of Agricultural Engineering.

The combination of these separate machine concepts lead to a prototype, constituting a first approach to mechanizing landscape conservation measures.

The machine (*Fig. 1*) is mounted to a three-point hitch of a conventional tractor and is actuated by the power take-off (p.t.o.).

The working width of the machine covers the whole width of the tractor and it works independently of planting rows. The cutting and chopping of the vegetation is done by two rotors, standing in upright position, equipped with a saw blade at the base and a conical chipping spiral on each rotor. Ejection paddles are placed between the saw blade and the spiral [1, 3].

The cut plant material is transported to a reducing opening between the rotor and the side panel of the chassis, driven by the rotation of the rotors and the saw blades. The material is fed tangentially to that position and clamped for subsequent chipping. The sharp-edged chipping spiral, welded to the conical rotor drum, cuts into the stems and detaches wood chips. The pitch of the spiral accomplishes the upright subsequent feeding of the plant material and its complete chipping. The wood chips are transported by the ejection paddles to an accelerator, supporting the loading of the chips by a spout.

To assure the maximum manoeuvrability of the tractor even in inclined and with vegetation abundantly covered areas, the wood chips are bunkered in the container of the tractor's front loader.

Fig. 1: First prototype of the Göttingen bush chopper „Tritucap" with a spout

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Keywords

Landscape conservation, open landscape, self-cutting chopper, spiral chipper

Fig. 2: Tilted sprouts of a dog rose at the feeder

Experiences

In 2005, first field tests on neglected grassland covered with heavy bushy vegetation of different types near Göttingen were carried out. The predominant plant species were blackthorn, whitethorn, cornel and dog rose, but to a lesser extent also tree species such as ash and birch. Partially, the population of woody and bushy species was dominating the grassland and was over thirty years old. The stem base diameter reached from below 1 cm up to 20 cm. Heights of the bushes ranged from 1 m up to 5 m. As a rule, woody and bushy species of all ages were found.

Overview and manoeuvrability
With the relatively small and compact design of the prototype, the normal manoeuvrability of the tractor could be maintained. Merely the position of the front loader-container and its dimensions interfered during turns and manoeuvres on narrow terrain. Lifting of the container could help to increase manoeuvrability in some cases. Visibility to the working area was good at all time.

Cutting
Cutting of the vegetation was trouble-free up to the existent diameter of 20 cm. Even though the saw blades work only few centimetres above the soil's surface and having even contact with the soil, there was no significant wearing detectable.

Feeding of material and chipping
The feeding of the plant material to the chipping unit plays a key role using the spiral chipper principle. To achieve an accurate and clean chipping process, the axis of the plant stems has to be parallel to the rotor drum's axis. The material is then, in the ideal case, retracted in this position to be chipped with low power demand. This prerequisite could be fulfilled when working in tree-like material up to a diameter of 12 to 15 cm. Due to the habit of the bushy vegetation, the requirement of parallelism of plant axis and rotor drum axis could not be fulfilled. The bushes consist of several branches, while the growth of the branches is usually somewhat tilted. The sturdy branches give the bush a voluminous shape. Therefore, the branches shore up to the machine's chassis when approaching, so that the shoots of the bush are directly after cutting pressed out of the machine. This results in major difficulties to feed the material to the chipping area of the machine. The lateral branches or those, inclined in working direction, due to their high centre of gravity tilt over and out of the machine before being clamped between the rotor and the chassis. Hence, the prerequisite of parallelism of rotor and plant axis is not fulfilled. The material is collected by the ejector paddles and with high power demand coarsely shattered to big sized wood chips of up to 50 cm length. This leads in some cases to an obstruction of the machine. Furthermore, the tangential feeding of the stems allows only the chipping of one stem. Especially in bushy vegetation with a multitude of branches and smaller stems, separation to single stems is impossible with this design of the machine. Therefore, the surpluses of stems tend to tilt and topple down, so that the cutting spiral cannot process this material properly (*Fig. 2*). Hence, an ideal, upright feeding to the chipping spiral is almost impossible due to the structure of the vegetation. Tests with an active feeding unit also did not assure a proper feeding of the material.

Loading
The loading capacity with regard to throwing range and throwing precision to the container in the front loader is good. The chipped material could be collected completely. Only the coarsely chipped wood particles, caused by tilted material, which was chopped by the ejection paddles, lead to obstruction of the accelerator of the spout and, thus, to a stop of the machine.

Conclusion and Outlook

Processing a bushy vegetation as described above is not suggestive, because the main prerequisites for a defined chopping process, such as parallelism of the rotor axis and the stems, cannot be fulfilled. A redesign of the machine concept is not offhand possible. Therefore the concept of the machine is being worked over and a completely new prototype is in preparation, aggregating the knowledge from the first field tests. It will be tested this year.

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