Andreas Block, Göttingen

Mulching instead of Slash Burning

Non-burning Field Preparation with Mulching Machine and Woodchopper in North-eastern Amazonia

Substituting slash burning with mechanised mulching methods is the focal point of the effort towards sustainable agriculture in tropical regions. A special woodchopper, developed in Göttingen for this application, was compared to a commercially available forest mulcher in Brazil. Based on various operating principles, both machines have their specific application fields, depending on growth conditions. Therefore, both types of machines can be taken into consideration for future mechanisation concepts.

Fig. 1: The prototype (Tritucap) working in a four year old fallow vegetation

The land use system of peasants in tropical agricultural systems is still based on slash burning[1]. In Göttingen, a specialised bushchopper was developed to meet the demands of a non-burning mechanised land preparation system. The second prototype of this chopper, named „Tritucap" [4] was comparatively tested with a commercially available mulching machine in North-eastern Amazonia.

Measurement equipment and machines used

A „John Deere" tractor (type „7710" with about 122 kW), equipped with a reverse drive adaptation, was used to power the mulching machines. The commercial „FM 600" mulcher, manufactured by the Southern German company AHWI Maschinenbau, as well as the prototype from Göttingen had been tested under similar conditions. For the evaluation of working capacity and for data acquisition for the evaluation of gearbox components, fuel consumption, driving speed, driving direction, rpm and torque of the pto were measured continuously.

The working principle of the two machines is entirely different. The „Tritucap" chops the cut material with two rotor drums using cutting augers [1, 4], whereas the AHWI FM 600 has one horizontally built dented rotor. The „Tritucap" cuts and chops the vegetation with one operation, whereas the FM 600 needs two processes for the same result. For this reason, the „Tritucap" has, particularly in weaker vegetation, advantages compared to the FM 600 as far as operation costs and work quality are concerned.

Working principle of the „Tritucap" prototype

The machine is attached to the three-point hitch of the tractor (*Fig. 1*). Driving backwards, the vegetation is cut just above the ground and subsequently chopped with one operation. Experience with the first prototype showed that a tractor with above 100 kW power is necessary. The changing of the feeder design lead to significantly improved material acceptance of the chopping unit. The most incisive modification was the substitution of the tooth-belted drive by an axle drive of the rotors, since the formerly tested belt drives underwent extreme wear and tear under the given climatic conditions.

Working principle of the AHWI FM 600 mulcher

With the tractor going backwards, in a first step the AHWI FM 600 mulcher (*Fig. 2*) shreds the vegetation coarsely. In the second working step the tractor goes ahead, chopping up the pre-shredded material. Manually guiding the machine with the three-point-hitch above the surface, the driver must avoid any disturbance of the soil's structure. This would result in wearing of the rotor, because of the sandy tropical soils. Furthermore,

Dipl.Ing.agr. Andreas Block is scientist at the Institute of Agricultural Engineering of Göttingen University (director: Prof. Dr. Wolfgang Lücke), Gutenbergstr. 33, D-37075 Göttingen; e-mail: *ablock@gwdg.de*

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Fig. 2: Mulching machine (AHWI FM 600) working in an eight year old fallow vegetation

each even superficial disturbance of the soil structure results in yield losses [2]. An automatic guidance system for the machine by gliding units or guidance wheels is not applicable due to the soils' conditions and the high machine mass.

Choice and preparation of the experimental areas

The usual fallow period in the experimental region is two to five years. Afterwards the areas are slash-burned and taken into production again[1,4]. However, there are areas found which are fallow up to 15 years and, therefore, develop a vegetation of higher biomass. To gain a broad range of information concerning the working capacity of the machines, areas of different ages were chosen. For a reliable and roughly complete description of the working conditions, representative lots were marked within the areas. Each plant within these lots was measured, identified and weighed. From these data a rough description of the vegetational structure, which provides a rough pattern of the working conditions, can be rendered.

Data analysis

A conjecture to explain the different working performances is that with higher biomass the working performance diminishes. But reality showed a different picture: Biomass can be considered one important factor, but not the only one. First calculations did not show a clear dependency of biomass and working performance. A tendency can be found in the dependency of the number of individual plants per hectare and the working performance. The older the fallow vegetation, the smaller is the number of individual plants per area. Therefore, the number of plant individuals per hectare, together with the biomass, can be considered an indirect measure for the condition of the area.

Functioning of the machines

The tested second prototype of „Tritucap" has been improved in important parts. With the modified feeder geometry, the material acceptance of the mulcher has become more fluent. The experiments showed that the sharpness of the cutting augers has a great influence on the transportation process inside the machine. The sharper the augers, the more fluent and less obstructive is the flux of the plant material to be chopped.

By the measurement of torque data, important knowledge has been gained as far as the design of the power transmission is concerned. Measuring the torque of the pto showed considerable alternation of load, resulting from the interaction between the two chopping rotors. Usually the vegetation is inhomogeneous so that the two rotors do not work uniformly; where one does chop the other one runs free, transmitting its impetus via the power transmission to the chopping rotor. This supports the working rotor but leads to high impacts in the power transmission with alternation of loads. Measured torque peaks of 3000 Nm were not uncommon. Even those gearboxes used in agricultural technology for the transmission of highest torque did not resist the strain. A damping unit cutting these peaks can presumably augment the lifetime of the power transmission, but would perhaps affect the supporting effect of one rotor to the other.

The mulcher AHWI FM 600 was operated „as is". No modifications had been carried out before bringing it from Germany to Brazil. Problems with the power transmission unit had also been stated. While working under tropical climate conditions the central gearbox heated up to over 110°C. At these temperatures the lubrification properties of the oil are affected. Thus, an auxiliary oil cooler was installed, which, in experiments with similar machines, prevented the oil from overheating under tropical conditions. The oil temperature did not exceed 60°C afterwards. Measured surface temperatures of the rotor belt drive pulleys reached 113°C. Here, the installation of pulleys with improved ventilation lead to lower temperatures. Besides the heavy heat stress, a main attention is drawn to the power transmission. The friction disc clutch installed in the power transmission shaft did not resist the strain and failed after few hours of heavy work.

Conclusion

The prototype „Tritucap" as well as the AHWI FM 600 mulcher proved their operativeness under the given conditions. Weaknesses referring to the design of the power transmission, caused by extreme torque peaks, have become evident by the measurements and have to be considered in further developing work.

The tests under field conditions soon showed that the machines' comparability is limited. The work in formerly not mechanically prepared areas or areas of a fallow period exceeding five years, usually containing trees and stumps of bigger diameter, should be processed by the mulcher FM 600. These residues from slash burning and the larger, adult plants can be processed by this machine. The technical limitations given by the design of the Tritucap-prototype do not permit the preparation of areas older than five years. Showing excellent working results both in working quality and in terms of costs per hectare in Capoeira up to four years, the Tritucap is favourable. Its design only permits the chopping of stems no larger than 10 cm at the stembase. Therefore, a complete concept for non-burning preparation of fallow areas should implicitly consider both machines.

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