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Using the bush chopper for secondary utilisation of forest in tropical fallow systems

First trial results

The application of slash and burn as preparation for crop production areas in tropical agricultural systems has considerable influence on the long term yield potential of the areas. It appears that the sustainability of the system can only be secured by replacing slash and burn with mulch cultivation. A step-up to mulch cultivation is made possible by the bush chopper developed in Göttingen. First tests were carried out in autumn 1997.

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Keywords

Bush-chopper, fallow vegetation, tropical agricultural systems, slash-burning

Even nowadays, a leading role in the small-scale farming use of forests in tropical agricultural systems is played by forest fallow[2]. To avoid the negative effects of the slash and burn system (nutrient loss, reduction in plant variety, loss of organic matter) it is essential that a change be made to a fire-free soil preparation system.

Basic concept of the bush chopper

The prototype which was developed in the Institute for Agricultural Engineering was tested in the estuary region of the Amazon area in Autumn 1997. The implement is mounted on the front hydraulic linkage of a tractor of around 70 kW power. The maximum power requirement for the implement was determined in Göttingen as around 60 kW. The implement is activated via quadruple belt drive, a system with a theoretical power transfer of 76 kW per rotor. The tractor transmission is protected through a rpm-dependent overload clutch. Each of the chopper's two saw blades has a diameter of 1000 mm and is finished in chrome-vanadium steel. On one side, the saw teeth are set 3 mm upwards. This one-side setting is to allow a vegetation cut which is as clean as possible (without fibre built-up). On the upper side of the chopper a guide bar is fitted and designed to propel out of the cutting area any sawn material that remains on the blades.

First trial results

The autumn 1997 trials allowed opportunities for further improvement of the prototype as well as supplying first performance data. The differences between vegetation were reflected in the performance figures. Because of the higher dry matter of the material where growth was in the main woody, the performance in such areas was less compared with that in smaller, bushy vegetation. On average, around 10t of fresh matter was sawn and processed per hour. An overview of selected area performances is supplied in *table 1*. The quality of the chop was first of all determined by the volume of chop material. More than 50% of the chop material was smaller than 4 cm^3. The larger chips of chop material are so damaged that they also offer good access areas for attack by degrading micro-organisms. Covering the soil surface with the chopped material protected the ground from erosion and drying-out and depressed growth of non-agricultural plants. Spreading was consistent and the degree of cover was around 90%. This doesn't include dead organic material that was present on the ground before the chopping. When this is taken into account the surface is, as a rule, completely covered.

Table 1: Elapsed working time dependent on the biomass

Biomass (t/ha)	Time (h/ha)
44,7	8,02
31,6	2,62
23,3	2,15
12,5	0,87

Technical problems with the prototype

Through the extreme outside temperatures and the shock-type stresses through working in uneven vegetation growth and wide variety of completely different plants, the driving pulley belts heated-up to such an extent that complete power transfer was no longer possible and the resultant belt slip in the pulleys led to the heat in the belts increasing up to destruction level. Great amounts of vegetation for chopping blocked the machine with resultant belt slip leading to the chopping rotors stopping. The saw blades were also susceptible to heavy corrosion through the dust development in front of the chopper and the aggressive plant saps. Because of this, the blades had relatively short working periods of around 1.5 ha chopped area.

The ejection of the chopped material in front of the tractor and the resultant dust pro-

Fig. 1: The Prototype working in a four-year-old fallow vegetation

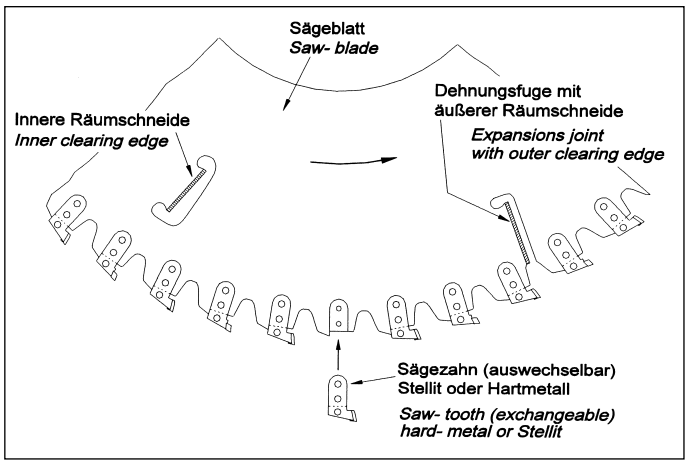

Fig. 2: Section of the newly developed saw-blade

duction very quickly blocked the tractor radiator sieve so that the sieve had to be cleaned practically every 10 minutes to avoid engine overheating. In the same way, the air intake filter was subject to great amounts of dust which brought with them very short service intervals.

The working area of the chopper is very hard to see because of the implement being front mounted. Ant hills or other obstructions were not seen in time by the operator. The momentary working of the sawblades in earth piles also shortened the working periods.

Tackling the problems

The pulley belt drive was replaced by a toothed belt drive to eliminate belt-slip. The new drive, however, demonstrated the inadequate power of the tractor engine where otherwise belt-slip had avoided the demands for too high torque. Furthermore, every rotor had to be fitted with an overload clutch because otherwise the torque demand of one rotor would be transferred to the others and thus could lead to an overloading of the drive. An increase in area performance can be expected with the new drive because blockages which occurred often with the belt pulley through belt-slip are now seldom. Even suddenly-appearing greater amounts of vegetation are dealt with competently. A further point is the poor matching of forward operating speed to the conditions. The hydraulic transmission with creeper gear allowed a stepless adjustment of speed in the area of from 0 to 1.5 km/h. Higher speeds, such as where the vegetation is sparser, which would have resulted in improved area performance, can only be carried out with a mechanical transmission tractor which, has only 2.8 km/h as lowest speed. The ideal answer here would be a stepless, adjustable transmission that worked in every required speed area. The working time between servicing for the saw blades has already been lengthened through the use of hard-chromed saw blades with teeth set-up on both sides by 3 mm. The implement is, however, not yet suitable for practical application. Because of this, new saw blades have been developed in cooperation with the company FELDE and fitted to the implement. These are illustrated in *figure 2* and have replaceable teeth. Here, two forms of teeth out of two different materials are utilised. Because of construction requirements a hard metal tooth is used as hollow tooth and a stellite tooth as flat tooth. Additionally, expansion grooves and space dividers are added to the blades. The expansion grooves allow for cooling of the blades and avoid the built-up of tension through friction heat. The space dividers keep the blade surfaces free from shavings and help expedite the cut material – as was shown by pre-trials in quick growing timber in Germany.

Unfortunately, all the desired alterations were not able to be carried out in the first prototype. For this reason preparations are already being made for the building of a second prototype into which should flow all the experience so far gathered.

This new version of the bush chopper will be rear-mounted which, in combination with a rear-driving system for the tractor, should considerable improve the operator visibility of the working area. Moreover, this application means that steering is via the rear axle and this greatly increases the manoeuvrability of the tractor-bush chopper unit. Rear mounting also means that the problem of high dust quantities in the air intake area of the tractor engine is solved. Moreover, the rear mounting improves the weight distribution of the tractor-chopper unit. Where, before, the greatest part of the weight lay on the front axle of the tractor, the weight is now distributed between both axles. Alongside the positive effect this has in avoidance of soil compaction, this also reduces the danger of damage to tyres – which were under substantial stress when the chopper was front-mounted.

Summary

The prototype of the bush chopper proved its functional capability under practical conditions. The problems which appeared during the first test phase could, to a great extent, be solved through additions and adjustments. On the basis of the data collected in the trials, a further prototype was developed which should almost be at the stage required for serial production.

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