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SRC Harvesting Machinery – a Status Report

Mechanising the harvest of short rotation coppices (SRC) on farmed land is a prerequisite for providing this source of bioenergy efficiently and economically. Three process lines can be distinguished: trunk wood, bundle, and chopping lines, whereby the latter are the cheapest. In the past, more than 20 different harvesting machines and assemblies were developed for this alone, but they have rarely progressed beyond the prototype stage. In addition to special cutter tools already available for forage harvesters, lower cost mounted assemblies for tractors also have a good chance on the market. However, these still require considerable development and optimising inputs.

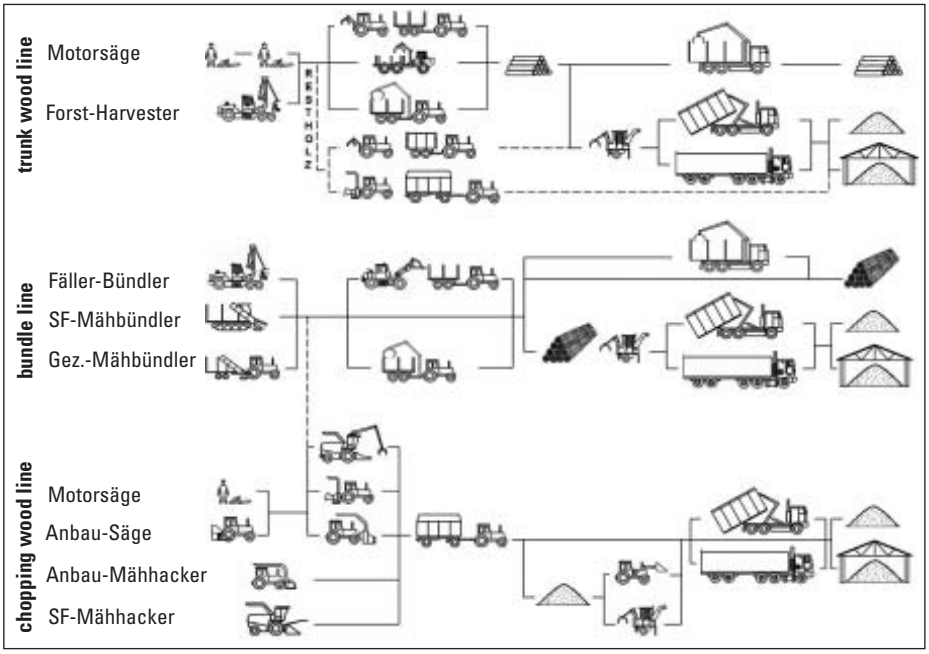

Fig. 1: Systematisation of harvest and post-harvest technologies for short rotation coppice

Mechanisation is an essential prerequisite for introducing the production of short rotation coppices into agricultural practice. Harvesting is a key area here, and depending on the procedure adopted accounts for 15 to 60 % of total costs. Harvesting procedures can basically be divided into trunk wood, bundle and chopping lines, resulting in the products trunk sections, loose or tied bundles, and wood chips. The trunk wood process lines are applied almost exclusively for material use of the timber, while the bundle and chopping lines are used chiefly for energy purposes (*Fig. 1*).

Trunk wood lines

Conventional forestry machinery is used to obtain trunk wood, which requires rotation times, i.e. harvest intervals, of at least 10 years. This comprises manual power saws or forest harvesters with a processor head, which fell, delimb and prepare trunk sections of the desired lengths. Large crown timber and branches are carted away and/or chopped with a mobile chipper as needed. Results of and experience in the use of trunk wood harvesting machines in poplar stands are available at the Bayerische Landesanstalt für Wald und Forstwirtschaft (Bavarian Forest Institute) Freising (LWF) [1] and at the Sachsenforst Graupa state estate [2].

Bundle lines

Bundle lines, also known as collecting or twig lines, are process lines in which trees or shoots are felled and gathered in a single operation and are thus available as bundles, which are loose or tied up with wire or yarn. Forestry machinery such as e.g. the forest harvester with a felling-bundling head [3] can be used for intermittent operations. However, in view of the low field capacity this method is chiefly suitable for stands with long rotation periods, but only up to a cutting / root neck diameter of 200 to 300 mm. The loose bundles deposited in the intermediate rows, in other words untied bundles, are subsequently chopped and/or carted away, i.e. at the latest by May.

Felling bundlers, which fell the trees (shoots) continuously and at the same time bundle (gather) them on the loading platform exploit the advantages of row stands. The bundles (the entire cargo) are generally dumped at the edge of the field. They can be left in storage there for an unlimited period

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Literature

Literature references can be called up under LT 07415 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

and are chopped and/or carted away as required. In principle a distinction must be made between self-propelled and tractor-trailed machines. Literature shows 14 felling-bundler developments, especially from Sweden, but these have hardly progressed beyond the experimental stage [4, 5].

Chopping lines

The chopping lines generally cause the lowest harvesting and transport costs and are therefore preferred as energy sources. As the investigations conducted at ATB Potsdam-Bornim show, however, the storage life of chip material is limited. Finely chopped chips are highly susceptible to mould development, when stored without ventilation and lose up to 30 % dry matter per year. These undesirable effects are much less pronounced in trunk wood and bundling lines [6, 7, 8].

In the chopping lines a distinction must be made between single phase and dual phase harvesting.

Dual phase harvesting

In the dual phase harvest, felling and chopping including loading are carried out in two separate operations. In the first operation the trees are felled manually with power equipment or using a "mounted saw", i.e. a (chain) saw mounted at the side of a tractor that works like the customary mounted mower used in farming and largely lays the trees down in a single direction [9]. However, development of this unit has been discontinued. In the second operation the trees lying in a row (windrow) are chopped intermittently by a mobile chipper with grab arm, or are picked up using a continuously operating front-mounted or rear-mounted chipper with pick-up drum such as is used, for instance, for shredding uprooted fruit trees lying in rows [5]. The disadvantage of the dual phase harvest is that with the customary row spacing only one row can be felled at a time and then it is necessary to chop in the opposite direction before the next row can be tackled.

Single phase harvest

The single phase harvest uses self-propelled machines and mounted equipment that fell and chop the trees in a single operation. This very efficient working principle has been implemented technically worldwide in altogether more than 20 developments, but has seldom been carried through to practical market maturity [5]. The modified sugar cane harvesting machine of Messrs. Austoft/Case (Australia) and the two special forage harvester units from CLAAS Harsewinkel and HTM Soltau-Mittelstendorf, as well as the cutting chipper for mounting on tractors and based on an invention by our colleagues Wieneke and Döhrer [10, 11], appear to be promising. With the exception of the Claas cutter unit, these are essentially prototypes, which have so far only demonstrated their suitability for practice to a limited extent [12, 13, 14, 15] (*Tab. 1*).

The two field chopper cutter units achieve high field capacities, but as a consequence of the intake rollers in horizontal bearings they are essentially only suitable for willow and very young poplar coppices (up to ~ 2 years) and the cutting diameter is limited to ~70 mm. As measurements by ATB Potsdam and LWF Freising show, the mounted cutting chipper equipped with a vertical chopping auger is suitable up to a cutting diameter of ~ 120 mm, but as a result of its single-row operation achieves lower field capacities than the two-row chipper cutter units. That is why the University of Göttingen is developing a multi-row or row-independent version of this mounted cutting chipper.

There are also differences in the quality of the chipped material. The chopping drums of the forage harvester produce uniform but short chips with a length below 40 mm that are unsuitable for storing, while the chopping auger of the cutting chipper produces long but uneven chips with a length above 50 mm that can be stored, but may involve difficulties in further processing.

Table 1: Promising cut-chipper developments

		Mod. Sugar cane harvester	Forage harvester special cutter units		Tractor-mounted unit
Type	-	Austoft 7700	Salix-Header HS-2	Woodcut 750	Single-row cutting chipper
Manufacturer/developer	-	Austoft Indust. (AUS)	Claas KG mbH Harsewinkel	HTM GmbH Soltau	Preuss GmbH, ATB Potsdam
Development status	-	Prototype	Small series	Prototype	Prototype
Deadweight	kg	12500	1300	~ 2000	1200
Basic machine	-	Self-propelled	Claas-Chopper Jaguar[1)]	Krone-Chopper BIG X[1)]	Farm Tractor[2)]
Power requirement	kW	216	≥ 245	≥ 360	≥ 80
Weight of basic machine	kg	s.o.	≥ 10800	≥ 13500	≥ 4000
No. of rows/cutting width	-/mm	2 / 1000	2 / 1000	2 / 1300	1 / 560
Row spacing[3)]	m	0.75 + ≥1.4	0.75 + ≥1.5	0.75 + ≥1.5	≥ 0.9
Cutting diameter	mm	< 70	< 70	< 70	< 120
Mean chopping length (x_{50})	mm	> 80	5 ... 40	5 ... 30	50 ... 100
Mass throughput[4)] (PPT)	t_{atro}/h	≤ 20	≤ 30	≤ 30	≤ 15
Working rate[4)] (PPT)	ha/h	0.2 ... 0.6	0.5 ... 1.3	0.5 ... 1.2	0.2 ... 0.5
Working rate[4)] (ET)	ha/h	0.1 ... 0.4	0.3 ... 1.0	0.3 ... 1.0	0.1... 0.4

1) Standard field chopper with forest tyres and special header, partly with reinforced drum, header hydraulics and underbody protection
2) Standard tractor with front pto shaft and 3-point front suspension
3) The second summand states the distance between adjacent double rows. The mounted cutting chipper can where applicable also be used to harvest double rows, however where row spacing is < 1.0 m only with appropriate tyres.
4) Valid for primary processing time (PPT) or execution time (ET)

Summary and prospects

As production of short rotation coppices is a relatively young area of cultivation for farmers, there are only few validated results and experience inputs regarding machinery, despite an amazingly large number of development approaches. This experience has been and is being gained above all on farms in Scandinavia, as well as in agricultural machinery and forestry research facilities in Sweden and in the German states of Bavaria, Lower Saxony and Brandenburg.

Conventional forest machinery is available for harvesting poplars in very slow growing coppices. The development started in Scandinavia of using felling-bundlers that gather up rods or whole trees and deposit them at the edge of the field is evidently not being pursued further at present.

Felling-chippers, in other words harvesting machines, which fell and chop at the same time, have so far asserted themselves most on the market. In Germany two powerful special cutter units for forage harvesters are available, but these are essentially only suitable for willows and young poplars with a cutting diameter of up to 70 mm and require large areas to be cost-effective. Mounted units for tractors are being developed and optimised at the University of Göttingen and at ATB Potsdam-Bornim. These can produce good quality and storable rough chips, and can also be used in poplar coppices with rotation periods of 3 to 5 years.