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Poplar and willow production on farm land

With increasing commodity prices, the interest in fast growing tree species like poplars and willows on farmland for energy production is rising. In this paper, the most important agronomical aspects are considered, and the costs of the systems including the supply of wood chips are illustrated.

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Keywords

Fast-growing tree species, short rotation coppice, wood chips, cost calculation

Poplars and willows are particularly suitable as short rotation coppice. Like birch trees, alders, and robinias, they are fast growing tree species, which are characterized by quick growth and high wood yields.

From the agricultural point of view, the cultivation areas are permanent cultures, which can be used for at least 20 to 30 years based on current experiences. The trees are grown as short rotation coppice, which means that harvesting (rotation) intervals are short by the standards of forestry, ranging from 2 to 10 years up to a maximum of 20 years. After every harvest, the trees grow new shoots from the remaining trunk.

Fast growing tree species can be cultivated on set-aside areas and fields. (The set aside of land is currently suspended.) In the latter case, farmers must simultaneously apply for the energy plant premium if subsidy payments are intended to continue because otherwise no subsides are granted for permanent cultures. Coppice can be grown on grassland if the field is converted into arable land as long as ploughing is not forbidden by other regulations, such as those governing nature protection. Payment rights can then be activated like for arable land. This means that the energy plant premium must also be applied for at the same time.

For short rotation coppice (KN code ex 0602 90 41) and fast growing forestry wood, rotation time is limited to a maximum of 20 years. One rotation is considered the equivalent of one growth and harvesting period. The next rotation period begins with the sprouting of the trunks which remain in the soil.

The utilization period of the site is not limited. The period of utilization is the time between the planting of fast growing forest trees and their clearing or the reestablishment of the original condition of the area.

In the federal states, the state forestry laws sometimes provide different regulations. Therefore, binding legal information for farms can only be given by the local forestry administration offices.

Species suitable as short rotation coppice

Of the approximately 40 poplar (*Populus*) species, the representatives of the sections black poplar (*Aigeiros*), balsam poplar (*Tacamahaca*), silver as well as grey poplar and aspen (*Leuce*) are important in Germany. Black poplars are primarily parents in hybridization. In grey poplars and aspens, coppicing is insufficient for this kind of cultivation. Hybrids of Asian and North American balsam poplars (*P. maximowiczii*; according to the new nomenclature *P. suaveolens*) and *P. trichocarpa* as well as black poplars (*P. deltoides* and *P. nigra*) are best suitable. As compared with the other representatives, the balsam poplar is characterized by easy propagation through cuttings, pronounced quick growth, dense stand compatibility, as well as strong resistance to diseases.

Of the total of 300 willow (*Salix*) species, primarily the basket willow (*Salix viminalis L.*) is grown as short rotation coppice. Preferred locations for these species are lowland areas, hills, as well as creek and river courses. Other species suitable as short rotation coppice are *Salix smithiana* and *Salix dasyclados*.

Location requirements and yields

Poplars and willows are rather undemanding with regard to soil quality as long as the locations were used for agriculture in the past. The decisive factor is good water supply, which must be guaranteed by sufficient precipitation (if possible more than 500 mm per year or more than 300 mm during the vegetation period) and high soil water storage capacity or good ground water connection. In this respect, willows are significantly more demanding than poplars. Poorly ventilated soils can lead to yield losses. Other important conditions are the root penetration ability of the soil, no excessive game population, and good practicability during the harvesting period in the winter.

Under the mentioned conditions, suitable poplar species can be expected to provide average dry matter yields of 8 to 12 t per hectare and year. Willow yields range between 5 and 9 t of DM (ha a). Depending on the growth conditions, the age of the coppice, the species, and the duration of one rotation, yields can vary substantially.

Fertilizing

Currently, only a few experiences regarding

poplar and willow fertilizing are available. All in all, the nutrient requirements of these two tree species are very low. Only during the first 5 to 10 years does the application of ~ 30 to 70 kg N/ha provide a certain yield increase, in particular for willows. After the harvest (generally after three to five years), checks of the P, K, and Mg soil contents as well as the pH-value are recommended. If necessary, basic fertilizing must be carried out.

Soil cultivation and planting

High yields require optimal plant bed preparation by means of ploughing, grubbing, and harrowing. On fields with strong associated vegetation, the use of total herbicides is necessary before the plough furrow in autumn.

Poplars and willows can be planted in different positions and forms both vertically and diagonally as dormant cuttings (0.2 m), rod cuttings (< 2.5 m), or stick cuttings (< 4 m) or horizontally as lying rods (< 2.5 m) and in the case of willows as chopped one to two-year growths ~ 8 cm in length, which are planted in furrows. For reasons of labour management, dormant cuttings *(Fig. 1)* approximately 1 to 2 cm in diameter and about 20 cm in length have established themselves. They are gained from one-year shoots. Rod cuttings and stick cuttings are particularly suitable for low planting densities and extensive cultivation forms with long rotation periods.

On small fields or under the conditions of a small-plot cultivation structure, manual planting with the aid of a planting line or a marker and a planting iron is a proven technique. For planting on large areas, conventional agricultural planting equipment or partially mechanized special planters are used. Planting arrangement and planting density are determined by the final product (chips, bundles, or log wood) and the available harvesting equipment. For this reason, the harvesting equipment to be used later must already be considered when cultivation is planned.

With regard to planting arrangement, a basic distinction between single and double-row arrangement is made. For planting density, the tree species, the variety, and the rotation period are other decisive factors.

The best planting time is early spring as soon as the soil is practicable. Ideally, planting takes place between mid-March and mid-April at a soil temperature of more than 5 °C. In principle, planting in autumn is also possible. In this case, however, weed infestation and difficult planting stock acquisition are potential problems. The survival rate of willows is generally higher than the survival rate of poplars (~ 90 to 100 %). Among poplars, however, differences between clones exist. Suitable varieties of poplars also allow survival rates of more than 90% to be reached.

Depending on the weather, the cuttings need approximately two to four weeks after planting until they sprout. Afterwards, they grow relatively quickly until they are 10 cm tall. During this phase, the nutrient supply of the cutting is consumed. Later, increased root growth sets in while in particular poplars stop growing taller.

Cultivation measures on coppice fields are generally limited to the first and second year. During this phase, the growing trees must be protected in particular against excessive weed pressure and browsing by game, if necessary.

Harvesting

The trees may only be harvested during the dormant period between November and March because harvesting measures taken while the trees carry leaves after sprouting in the spring or during the main growth phase, for example, cause vitality losses of the coppice shoots or even the death of the coppice. In order to avoid damage to the trees and the soil, the ground should be easily practicable for vehicles. Optimally, the soil is frozen. For maximum yields, harvesting intervals (rotation periods) of 5 to 15 years are considered favourable for poplars. For willows, the favourable interval ranges between 3 and 6 years. The advantages of shorter harvest intervals (less than 5 years) must be seen in more cost-effective harvesting techniques and faster capital backflow.

For the harvest, special headers for forage choppers or mowing choppers are used, which are front-mounted to tractors. The latter are currently only available as a prototype. These techniques produce chopped wood in one work step. The chopped material can be transported in a trailer drawn by a separate tractor, which runs parallel to the harvesting machine. As an alternative to transport vehicles running parallel, trailers attached to the harvesting machine can be used. If trailers are equipped with a reloading device (e.g. high tippers), it is not necessary to uncouple the trailer from the transport vehicle and to reattach it to a different one, which is otherwise required.

On small areas, a motor-manual technique based on a power saw and a mobile hoe can be applied. However, this technique is very labour-intensive.

Reintegration of the coppice area into crop rotation

After the last harvest, the area planted with trees can be reconverted into a conventional field area at any time (reconversion of areas, clearing). The root stocks can be cleared with the aid of mulchers and root cutters. The mulcher first cuts the stock above the surface, while the root cutter penetrates 20 to 40 cm into the soil and cuts the roots. These two work steps prevent resprouting almost completely. If nevertheless some sprouts develop, they can be destroyed using disc or rotary harrows and/or suitable follower crops or herbicides. After clearing, a fast growing intermediate crop with high N requirements should be planted which guarantees good soil covering and binding of released nutrients in the summer months. As an alternative, summer cereals are also highly suitable.

Storage and drying

The required moisture degree of the chopped wood depends on the combustion technique.

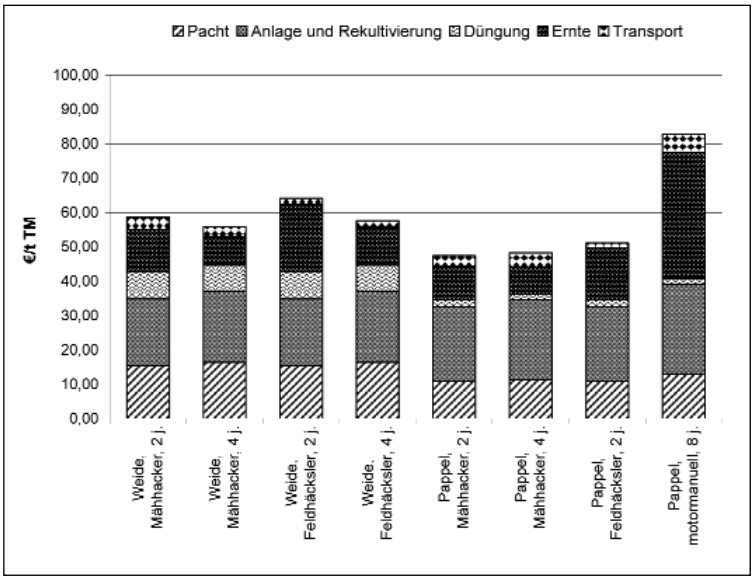

Fig. 1: Apportioning the production and supply costs to the cost blocks in variant 1: carry-off of fresh wood chips, no interim storage

Small and medium-sized furnaces with underfeed stokers require fuel with a maximum water content of 20 to 30%. Larger furnaces with feed grate firing can burn moister material having a water content up to approximately 60 %.

Due to the high water content of 50 to 60% during the harvest, chips stored in heaps or clamps heat up to about 60 °C. This leads to mould infestation and dry matter losses which exceed 25 % per year in some cases. Without additional labour and expenses, this can only be avoided if the storage period is limited to less than 10 days or coarse chips are produced during the harvest which cause losses of less than 15 % per year.

Expenses for the supply of poplar and willow chips

In the supply cost diagram (*Fig. 1 and 2*), process chains with a mounted mowing chopper (rotation period: two and four years), a forage chopper with a mounted cutter (rotation period for poplars: only two years because the equipment is not suitable for larger diameters; willow: two and four years), and a motor-manual technique (only for poplars, rotation period: 8 years) are considered.

Variant 1 comprises the haulage of the freshly harvested chips over a distance of 4 km and unloading at the destination. In this variant, no dry matter losses are included in the calculation. Variant 2 is based on the assumption of intermediate storage with dry matter losses (15% for coarse chips (mowing chopper and motor-manual technique), 25% for fine chips (forage chopper)).

The supply expenses for chips of poplar and willow wood are composed of the costs of planting, care, harvesting, as well as storage and transport, if required. In addition, the expenses for the clearing of the root stocks and the area costs must be taken into consideration.

The calculations are based on a mean yield level of 10 t DM/(ha a) for poplars and 7 t DM/(ha a) for willows.

More in-depth information can be found in the KTBL booklet 79 ("Produktion von Pappeln und Weiden auf landwirtschaftlichen Flächen"), which has just been published and is available from the distribution service for KTBL publications (order number 40079) for 9 € (ISBN 978-3-939371-64-9).

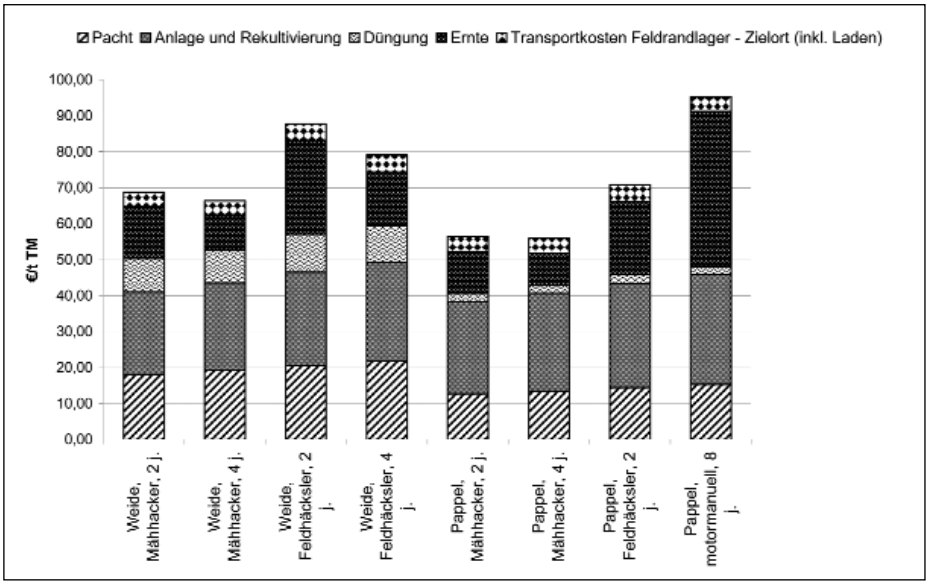

Fig. 2: Apportioning the production and supply costs to the cost blocks in variant 2: interim storage at field edge, storage losses 15 % (mowing chopper and motor-manual harvest) or 25 % (forage chopper) of dry matter, carry-off

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