Chapter 5: Supply of wood biomass – Plantations for energy

Supply and energy use of lignocellulosic biomass
(6 ECTS) 3513129
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Willow plantations (*Salix*)
Short rotation willow plantations

Swedish experience

Willow (*Salix*) has been cultivated as an agricultural crop for bioenergy purposes in Sweden for the last twenty years and is regarded as an important crop for the production of wood fuel for the Swedish energy sector.

During the last two decades, more than 14 000 ha of short rotation willow plantations have been established in Sweden, i.e. about 0.5% of the total arable land in Sweden, making Sweden the leader in commercial plantations of short rotation willow in Europe.
Plantations in Sweden

Between 14000 and 16000 ha have been planted with short rotation willow plantations in Sweden.


Areas planted included most of the traditional agriculture lands of the country.
Productivity of willow SRF

Nordic Europe

Commercial short rotation plantations for bioenergy

(1986-2005)
Short rotation willow plantations

• Since 1975, research on willow has been given priority in Sweden, and thanks to the Swedish experience, it is now one of the most developed energetic crops in Europe.

• During this time, numerous studies have revealed the high potential productivity of willow for bioenergy and shown the feasibility of average annual growth of 10-20 oven dry tonnes (odt) per hectare during the first cutting cycle.

• The studies on willow have also contributed to a better understanding of the establishment and tending of the commercial plantations, as well as the breeding programmes carried out during the last 20 years.

• The more recent plantings included the newer varieties, more vigorous than the older clones, which resulted in shorter rotations and more resistance to frost and diseases.
Introduction

Investments in R+D
Willow grows very quickly in favourable conditions

Growing energy from willow

Boyd, J; Christersson, L; Dinkelbach, L. The Scottish Agricultural College, 2000
Planting

Cut-and-plant machine (Salix Maskiner)
Planting
Planting
Planting

Growing willow together with other trees

In Sweden, willows and poplar have been grown in mixed stands with deciduous or coniferous trees. Alder species are able to fix atmospheric nitrogen, and in a mixed stand the willow may need less fertiliser than in a pure stand. Spruce seedlings grow very slowly and prefer shade in the early years, and are not ready for harvesting until 25 - 50 years after planting. A combination of spruce and willow can be planted side by side, with one row of spruce and two rows of willow. The willow can be harvested 3 - 4 times before the spruce takes over the land area.
Harvesting

Cut-back

Cutback machine (CRL) on reverse drive tractor

Harvesting

Continuous bundler (Salix Maskiner)

Growing energy from willow

Boyd, J; Christersson, L; Dinkelbach, L. The Scottish Agricultural College, 2000
Harvesting
Harvesting
Rotation period: How long?

Simulation by a process model (SECRETS) applied in Belgium

Fig. 1. Effect of rotation cycle (1–6 years) on the simulated yield of a poplar coppice culture. Averages of 150 years simulation are given.
Experience by farmers

Farmers Learn!

It is often forgotten that in a new technology, there is a learning curve that will affect the final outcome.
Projections according to management

Willow yield (t ha\(^{-1}\) yr\(^{-1}\))

- I
- II
- III
- IV

projection

Best growers
Projections & trends

Willow yield (t ha\(^{-1}\) yr\(^{-1}\))

Different levels of productivity
Swedish experience

- The yields increased an average of 0.206 odt ha-1 yr-2.
- The estimated willow yield at the first cutting cycle during 1986-2000 increased from 1.0 to 2.5 odt ha-1 yr-1, in the areas of low productivity (using the minimum yields of oats by district), and from 1.3 to 5.4 odt ha-1 yr-1 in the areas of high productivity.
- Results of the best growers group (class IV) show an average increment of 2.75 odt ha-1 yr-1 per decade, and the latest plantings reach an average of 6 odt ha-1 yr-1.
- Growers with at least 2 years of experience of growing willow achieved higher yields, with an average of 0.34 odt ha-1 yr-1 increase over the rest of the growers.