



Manual for SRC Willow Growers

Produced by Lantmännen Agroenergi, Sweden.





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Background

Short Rotation Coppice willow is a perennial agricultural crop that is cultivated for the production of wood chips used for heat and power generation. SRC willow can be planted close to its users, thus contributing towards a local energy supply that is sustainable in the long term.

A SRC willow plantation consists of densely planted, quick-growing species of willow. There are a large number of species of naturally growing willow (related to SRC willow) in the northern hemisphere, around 300 in all, but only a few have a growing pattern that is suited to fast-growing SRC willow plantations. Different species of SRC willow have been cross-cultivated since the 1970s in order to produce fast-growing hybrids that are suitable for this kind of cultivation.



The production of wood chips in a well-managed, pest-free plantation can reach 8-10 oven dried tonnes of wood chips per hectare, corresponding to an equivalent energy value of 4-5 m³ oil. The energy ratio in a SRC willow plantation is high compared to other crops. The energy input in establishing, maintaining and harvesting a SRC plantation represents no more than 5% of the total energy value of the crop.

SRC willow plantations can serve several purposes in addition to the production of wood chips. They can at the same time act as a vegetation filter to process nutrients from town / city waste products such as waste sludge, waste water, leachate from refuse tips and ash from heating plants.

At present around 14,600 hectares of SRC willow are being cultivated in Sweden (according to the Swedish Board of Agriculture's statistics for 2006), and around 500 hectares are added every year in the form of new plantations. Every winter SRC willow is harvested from approx. 2,500 hectares for delivery to around 25 heating / power plants in central and southern Sweden.

Planting takes place in the spring and early summer (March-June). Harvesting takes place in the winter (November-April), when growth has finished and the leaves have fallen. The crop is harvested at intervals of 3-4 years. New shoots grow from the coppiced stools after harvesting, which means that there is no need for re-planting.

The life span of a well-managed SRC plantation is estimated to be more than 25 years, which means that an SRC plantation can be harvested at least 5-6 times during its life. When a SRC willow plantation is to be removed, the stools can be broken up and mulched using conventional agricultural equipment and the land can be returned to arable cropping regimes.

Like other agricultural crops, SRC willow needs good management if it is to grow well. The most important element of achieving a high yield in the long term is a successful establishment; any weeds must therefore be controlled effectively. Once the SRC willow plantation is established, it must also be fertilised in order to grow well. Apart from planting and harvesting, most management measures can be performed using standard agricultural equipment.

Establishing SRC willow

Site selection

The site of the plantation should be selected so that the distance to end-user of wood chips is as short as possible. The fields should not be too small with a minimum



recommendation of 5-10 hectares. Large fields are more efficient due to the maximum usage of planted area available and economics of agricultural processing.

As with all other plants, land with good production conditions creates higher yields. The soil's pH level should be between 5.5 and 7.5. Light or medium clays and even heavy clays are suitable for SRC willow cultivation. Sandy soils may also be suitable if the plants have access to water or organic nutrients can be applied to provide moisture retention.

SRC willow grows well in organic soil, although such soil is often difficult to manage in terms of controlling weeds. Organic soils are often also at low altitude, e.g. frost hollows, river flood plains and valley bottoms. If there is a high risk of frost, varieties that are more resistant to frost must be used.

Small parcels of land in areas surrounded by forest should be avoided, as there is a high risk of damage by game. Fields with pronounced undulations and steep inclines can make harvesting difficult and should therefore also be avoided.

As the SRC wood chips produced are transported primarily in bulk transport vehicles, it is important that the SRC willow plantations are easily accessible from roads that are negotiable by heavy goods vehicles even during wintertime.

Archaeological and nature conservation interests must be taken into consideration before you create plantations. As SRC willow will probably be growing on the same site for more than 20 years and the shoots can reach a height of 7-8 metres, it is important to consider how the plantation affects the profile of the landscape. The local authorities and relevant environmental agencies may have views on this matter. It is therefore a good idea to get an understanding of the suitability of a plantation before submitting an application for planting grant and support to the relevant government body.

In the right location, SRC willow can make a positive contribution to the profile of the landscape. In an open landscape, dominated by annual agricultural crops, a SRC willow plantation provides a new environment, where a wide biodiversity of plants, birds and mammals can become established.

Land preparation

Land preparation in the year before planting is very important in terms of eradicating 'couch grass' in the first instance, as well as other perennial weeds. The best way of doing this is to let the field lie fallow for one year, during which you control the couch grass with a glyphosate preparation during the summer. If the area is covered by an arable crop the year before planting, the weed can be controlled after harvesting using the same glyphosate preparation and suitable ground cultivation.

The field must be ploughed during the autumn. If there is any couch grass remaining in the spring, an additional spraying with glyphosate may be undertaken, as late as possible before planting. The couch grass must have grown 3-4 leaves for spraying to take effect. It is important here that the ground is not worked before spraying, if at all possible.

Before planting the land must be harrowed as before normal arable seeding, a well-prepared seed bed means that the earth closes firmly around the willow cutting and counteracts drying out of the cuttings. The depth reached by the harrowing process must be 6-10 cm, this is particularly important in heavy clays. Large stones must be removed from the field, as the harvesting machines cut the SRC willow stems using saw blades, and any stones present make the harvesting process extremely difficult.

Planting

The planting material consists of one-year-old SRC willow rods. These are prepared in the winter and stored until planting at -4°C in a cold storage room, before being delivered in boxes a few days before planting. It is important that the boxes are kept in shaded, cool conditions during planting.



Maps should be produced of the areas to be planted so that growers and contractors can easily plan the planting programme. Reference to access routes and the direction of rows, boundary zones and storage for wood chip must be included on the map.

Planting takes place from mid March until mid-June and should ideally start as early in the spring as ground conditions and the weather permit. Weather permitting, the planting season may be extended to the end of June. Early planting means better prospects of good establishment and healthy growth during the first year.

SRC willow is planted in a twin row formation. The distance between the rows alternates at 75 and 150 cm respectively. The distance between the rows is adapted to allow the harvesting machines to harvest two rows at a time, while at the same time allowing space for harvesters and accompanying trucks to move through the plantation. The distance between the plants in the rows is approx. 59–65 cm.



Planting takes place using a machine that, in one process, cuts the willow rods (1.8 – 2.4 metres long) into cuttings and then plants them. The cuttings are around 18 cm long, and when planted the cutting is pressed down into the prepared ground so that only 1-2 cm protrudes above ground level. This provides the cutting with good soil contact and minimises the risk of drying out.

The total number of cuttings planted per hectare is around 13,000. It is important to plan the planting process with care, so that management and harvesting can be performed as rationally as possible, and also to achieve the best possible utilisation of the space in the field. The rows should therefore be laid out so that they are as long as possible, and ideally the end of the row should be at a track or similar access route. At the end of the row there must be a turning area of 8-10 m, as the harvesting machines need space to be able to turn. If facing deep ditches, the turning area must be 10 m, otherwise 8 m is sufficient. A boundary zone of around 3 m is left around other parts of the plantation.

Controlling weeds after planting

Controlling weeds during the establishment phase of SRC willow is extremely important. Weeds have a negative effect on the SRC willow plants as they compete for light, water and nutrition. In a plantation with a lot of weeds the SRC willow plants will be weaker and will grow more slowly. Controlling of weeds during the planting year takes place in both chemical and mechanical methods.

Directly after planting, before the cuttings have started to produce shoots (ideally within one week), the field should be sprayed with a suitable soil herbicide to prevent weeds spread by seed from developing. Later in the season, once the effect of the herbicide has worn off, mechanical measures may be required to keep the weeds under control.

If weed control is performed solely with a cultivator or similar weeder, the recommendation is to perform three cultivations during the season. If a weed harrow is used, however, 6-8 cultivations are recommended. The type of tool used is less important, the main thing is that control is performed and that weeds are kept in check. Whichever tool is used, it is important that the first round (and subsequent ones) is (are) undertaken in good time in order to be effective. To decide whether it is time to deal with weeds, the following rule of thumb may be of help: control the weeds mechanically if there are 2-3 weeds higher than 2 cm under the palm of your hand. In the UK, this method of weed control is not standard procedure.

Managing the plantation

Weed control in year 1 and the year after harvesting

If the weeds are not fully in check after the planting year, it is important that you also perform mechanical control the following year. As the SRC will be better established by then, as a rule it will be sufficient to perform two rounds at the beginning of the season using a cultivator or similar weeder in order to allow the plants to outgrow the weeds. If required, it is also possible to use chemical control in a growing crop, for example against thistle and or against grass weed. The chemical weed preparations that can be used in SRC willow plantations will, however, often have a relatively minor impact and successful weed control prior to planting is highly recommended.

If weed control has been effective during the establishment year, no additional measures are required subsequently. In this phase the SRC will have developed a larger root system and will form a lot of new shoots, which together provide effective shade over the weeds. If weed control has been less successful, it may be necessary to perform some additional mechanical control, e.g. after a harvest.

Cut Back

In the winter following planting, the year's shoots are cut back in order to let the plants develop a denser growth, i.e. more shoots per cutting. Cutback can be performed using a mower, mowing blade or some form of scythe mower.



Fertilisation

Once the SRC willow plantation is established fertilisation may be required. If so it is usually nitrogen that may need to be added. Nutrition can be added in the form of either commercial fertiliser or sludge from local waste treatment plants. However, sludge must be supplemented with extra nitrogen fertiliser. The need for nitrogen varies, depending on the age of the stock and the development of shoots. In older plantations nitrogen will be released from the layer of fallen leaves that is formed, which means that the need for fertilisation is reduced. In principle, it is the amount of nitrogen contained in the shoots that is removed during harvesting, that must be replaced by fertilisation.

In the UK, however, this application is extremely rare.

Sludge

Sludge such as treated sewage sludge, is commonly applied to SRC plantations in Sweden. In the UK and other countries this is still a developing application. Sludge can be spread in SRC plantations either directly before planting, the year after planting or the year after harvesting, and the most common machines for sludge spreading are Hill spreaders and conventional 'muck spreaders'. Sludge spreading should be discussed with your Lantmännen representative to ensure sludge properties are within the parameters permitted by Lantmännen and relevant environmental bodies.

The composition of nutrients in sludge may not entirely satisfy the requirements of SRC willow. The sludge may supply one or two of the basic elements but other fertilising methods may be required to ensure an adequate nutrient balance.

Harvest

An SRC willow plantation is ready for harvest when the woody biomass reaches approximately 25 oven dried tonnes per hectare or when the diameter of the trunk at the base of the thickest shoots exceeds 6 cm. This usually happens when the shoots are 3-4 years old. SRC willow is harvested in winter, when the plants have gone into hibernation and shed their leaves. Harvesting is performed by a machine that both cuts the rods and processes them directly into wood chips. Combustion of SRC willow can be done by various different methods depending on the end user. This may be for electricity generation through dedicated biomass power stations or through co-firing in coal fired power plants. SRC wood chip is also used as fuel in heating plants as well as combined heat and power plants (CHP).



Removal of a plantation

There can be various reasons to remove a plantation. A grower may decide to convert the land back to grassland or arable land, or perhaps replace an old plantation with newer varieties. The task of removing a plantation is not particularly complicated, as the roots in a plantation are relatively shallow.

When the harvest is complete, the stools remain in place and form new shoots during the spring. Once the shoots are growing healthily during the summer, the entire plantation should be sprayed with a mixture of glyphosate and MCPA (this may vary) to kill off the SRC willow plants. After the stumps have been completely killed the land is worked with a heavy disc tool which cuts up the stools and residual roots without raking them up to the ground surface. Once the stools have been broken down, the land can either be replanted with new SRC willow or converted back to produce other agricultural crops.

Damage and pests in SRC willow

Frost

The most serious damage suffered by SRC willow in Sweden has so far been caused by frost. In the past many plantations in Central Sweden were planted with varieties that were not sufficiently resistant to frost. There have therefore been significant instances of damage to plantations in regions vulnerable to frost. Some of these plantations are now being replanted with varieties that are more resistant to frost. The new, frost-resistant varieties have meant that the cultivation region can now be extended further to the north in Sweden than had previously been possible. In the UK frost damage to SRC has to date not been a major issue.

Leafbeetles

Just as with other plants, there are a number of different organisms that obtain their food from SRC willow. Leaf beetles occur in virtually all SRC willow plantations, and both the larvae and the adult beetles eat the leaves. Usually leaf beetles do not cause any noticeable damage, but the population density of leaf beetles varies from one year to another and between stocks, and in certain years local populations of leaf beetles can be so large that they cause tangible damage to the plantations. There are new varieties of SRC willow that are resistant to leaf beetles. Where beetles are deemed to be a potential threat, after harvesting the grower has the opportunity to treat it using a suitable chemical.

Chemical insect control

Other insects that feed on SRC willow plantations include various species of gall midges, aphids, Auchenorrhyncha, etc., although so far these have only caused minor damage in plantations. The likelihood that chemical control of damaging insects in SRC willow plantations will be used in future is relatively small. Not only is it expensive, but there is also a risk that chemical control will affect the development of damaging insects' natural enemies, and thus disturb the natural balance between these organisms.



Photo: Karin Eklund, SLU



Photo: Nils-Erik Nordh, SLU

Leaf rust

Another significant cause of damage in SRC willow is leaf rust, a fungal infection on leaves that can cause production losses by causing the function of leaves to deteriorate. Serious attacks can result in leaves withering and falling prematurely. Leaf rust occurs primarily in older plantations that were planted using unprocessed clones. New varieties all have good resistance to leaf rust, and some varieties are totally resistant.

Damaged by game

During the establishment phase grazing animals like deer, rabbits and hare (and elk in countries like Sweden) can cause damage in SRC willow plantations. In mature plantations grazing damage is usually limited to the outer edges of the plantation. On newly established sites, fencing may be deemed a necessary precaution if there is evidence of dense animal population that may be likely to cause damage by browsing.

Different SRC willow varieties

To counteract damage and pests, there is an ongoing process of refinement to produce new, robust, resistant varieties. Different varieties can be selected for different cultivation regions. The varieties below are shown in a Swedish context. Matching varieties to specific planting sites in the UK and countries with similar climate is not as important due to less frequent and severe frost periods.

On land that is vulnerable to frost (for example central and northern Sweden, latitude ca 58-63°N*)

Gudrun
Klara
Karin
Tora

On land that is not vulnerable to frost (for example central and southern Sweden, ca 55-58°N)

Tora
Tordis
Sven
Torhild
Inger
Olof

On drier land (for example central and southern Sweden – average annual rainfall approximately 610 mm)**

Tordis
Inger

Annual calendar for SRC

A SRC willow plantation can be managed to a relatively large extent by the grower/landowner himself. Many of the jobs to be done after the plantation has become established can be taken care of by contractors. This is a choice for the grower to make. Managing SRC plantations often means that working time on a farm is freed up for other activities. The work involved in starting a SRC willow plantation and running it is summarised below:

Year before planting

Select plantation site
Notify neighbours if necessary
Apply to the relevant body for establishment grant or subsidy.
Ground preparation and weed control
Order planting material

Planting year

If necessary, supplement weed control before planting
Harrow before planting
Plant
Chemical control of weeds spread by seed
If necessary, supplement by hoeing along rows (not applicable in the UK)
Cut back shoots after the first growing season i.e. Nov - March

Following year

Fertilise (if required)
Weed control (if required)

First harvest year (4 years after planting)

Harvest
Fertilise (if required. Also year 5)

Second harvest year (7 years after planting)

Harvest
Fertilise (if required. Also year 8)

Lantmännen carry out planting and harvesting operations. Depending on country and region, other establishment and management services may be provided.

* in comparison: London 51.3°N, Edinburgh 55.6°N.

** in comparison: UK rainfall varies greatly – from less than 700 mm average per year in many parts of England to 2000 mm average per year in The Lakes District and western Highlands of Scotland.

For more details, advice and support please contact your regional Lantmännen office:

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This manual is intended as a guide for growers only. For more site specific information and guidance, growers are advised to contact their regional Lantmännen representative. Lantmännen cannot accept responsibility for grower activities carried out as a result of following this manual alone. In the UK all chemical use and application rates should be discussed with a Lantmännen representative who can supply site specific recommendations from an approved agronomist. The grower should wherever possible adhere carefully to the recommendations supplied. In the UK, agronomy services are available through Lantmännen Renewable Fuels.

