Best Practice Guidelines
For Applicants to Defra's Energy Crops Scheme

Growing Short Rotation Coppice

ENGLAND RURAL DEVELOPMENT PROGRAMME

defra
Department for Environment Food and Rural Affairs

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Introduction

This booklet has been produced by the Department of Environment, Food and Rural Affairs (Defra) to introduce farmers to a new crop. It provides guidance on the choice of site, planting techniques, crop management and harvesting methods required when growing short rotation willow or poplar coppice as an energy crop. The booklet summarises current agronomic techniques and, therefore, may need to be modified as further experience is gained. Please check that you have the latest copy of the booklet with the Defra office at Crewe.

This booklet should be read in association with the Energy Crops Scheme booklet, "Establishment grants for short rotation coppice and miscanthus" which outlines the requirements for claiming grant to establish the crop.

There is further information on short rotation coppice in the Forestry Commission Information Note "The establishment and management of short rotation coppice – a practitioner's guide" (Tubby and Armstrong, 2002).

Why grow energy crops?

Energy crops are used as fuel in power stations and heating systems. In substitution for fossil fuels, they have the potential to reduce emissions of the greenhouse gas carbon dioxide. Energy crops will need to contribute if the UK is to meet its:

- obligation under the Kyoto Protocol to reduce greenhouse gas emissions by 12.5 per cent below 1990 levels by 2012;
- domestic goal to generate 10% of the nation's electricity from renewable sources by 2010.

This provides a significant opportunity for the energy crop industry.

Currently the major energy crop grown in the UK is short rotation coppice (SRC), primarily willow, although poplar has been used occasionally and may be planted more commonly in the future following the production of varieties more suited to coppicing. This booklet concentrates on willow SRC, although a section relating specifically to poplar has been included.

Defra provides grants to assist with the establishment of SRC under the Energy Crops Scheme (ECS), part of the England Rural Development Programme (ERDP). Grants are also available for setting up SRC producer groups to facilitate harvesting and supply to the energy market. Full details can be found in the ECS booklets "Establishment grants for short rotation coppice and miscanthus" and "Grants for establishing producer groups".

For details of support available for energy crops, contact the Defra office at Crewe or visit the ERDP website: www.defra.gov.uk/erdp/erdphome.htm

Woodchip boiler for heat

ARBRE power station fuelled by woodchip

What is SRC?

SRC (short rotation coppice) consists of densely planted, high-yielding varieties of either willow or poplar, harvested on a 2 – 5 year cycle, although commonly every 3 years. The osier, a shrub willow, is parental stock to the majority of willow varieties planted for use as an energy crop. SRC is a woody, perennial crop, the rootstock or stools remaining in the ground after harvest with new shoots emerging the following spring. A plantation could be viable for up to 30 years before re-planting becomes necessary, although this depends on the productivity of the stools.

Willow SRC is planted in the spring using planting material produced by specialist breeders and equipment specifically designed for the purpose. The willow will grow rapidly in the first year reaching up to 4m in height. During the winter after planting the stems are cut back to ground level to encourage the growth of multiple stems i.e. coppiced. Generally three years after cutback and again during the winter, the crop is harvested. The equipment used for harvesting will have been specifically developed for the purpose and depends on the fuel specification of the customer/end-user. Most operations other than planting or harvesting can be completed using conventional farm machinery.

In the UK, yields from willow SRC at first harvest are expected to be in the range 7 – 12 oven dry tonnes per hectare per year (odt/ha/yr) depending on site and efficiency of establishment.

Willow SRC 3 months after planting

Mature willow SRC

Where to grow SRC

The key determinants of SRC yield are water availability, weed control, light and temperature.

Willow SRC will produce good growth where there is sufficient soil moisture available within 1 metre of the soil surface. It can withstand seasonal flooding but not permanent waterlogging. Where land is prone to flooding most years, the willow will survive but consideration must be given to operational requirements, particularly the need to harvest in winter. Annual rainfall of 600-1000mm is ideal.

SRC in the landscape

SRC can be established on a wide range of soil types from heavy clay to sand including land reclaimed from gravel extraction and colliery spoil. Clay or sandy loams that retain moisture but are well aerated are ideal soils. Establishment may be slow on heavy clays as they tend to be cold in spring although, once established, SRC grown on these soils can be highly productive. Where compaction may prove to be a problem, sub-soiling to a depth of 40cm will be necessary to ensure maximum root development. Soil pH should be in the range 5.5 – 7.

Site selection

A site must meet the requirements of the ECS, these can be found in the Establishment Grants booklet.

As a perennial crop, SRC is likely to be in the ground for up to 30 years and can reach 7-8 metres in height prior to harvest. Its impact on the local landscape, ecology, archaeology and public access must therefore be considered alongside the operational parameters.

Under the ECS, a proposed SRC site is assessed and consultation takes place to ensure there will be no significant adverse impact on the environment. This consultation takes up a significant part of the 3-month application process time. To speed the process potential growers may wish to contact organisations that may be affected by the planting of the crop in advance, e.g. local councils for bylaws relating to public rights of way or the county archaeologist to check the records for any important archaeological remains. Where a proposed site is adjacent to a river or on a floodplain, the Environment Agency should be consulted.

Another factor to consider is soil erosion. Compared to many crops, SRC has large areas of open ground within the crop during establishment. On light, sandy soils this can lead to wind erosion of the soils and also some damage to the newly emerged shoots due to abrasion. On sloping sites, soils can be eroded following heavy rain.

Willow roots, which are fibrous in nature, will penetrate down to field drains and it is recommended that SRC is planted at

least 30 metres from any drains that are considered important. When choosing a site consider the life of the drainage system in relation to the expected life of the SRC plantation.

To be eligible for grant the proposed site must be at least 3ha in total, although this can be made up of smaller plots. However, to ensure economies of scale for all field operations larger plantations are better. The most appropriate field shapes are those that minimise the need for short row lengths or require no changes in direction during field operations. Choosing fields that can be harvested economically is of critical importance. For ease of operations the ideal site would be flat or with a slope of no more than 7%. It is strongly recommended that the slope of the field should not exceed 15%.

Appropriate access must be available for all machinery involved in establishing and harvesting the crop. Gate widths should be at least 4.5m but it is recommended that if new gates have to be installed they should be up to 7.2m in width. Bridge height or weight restrictions should also be considered where necessary. Ideally areas for transferring and storing the harvested crop should be adjacent to the coppice.

Plantation design

The plantation design should fit in with the surrounding landscape and advice relating to this can be obtained from Forestry Commission Guideline Note 2 (Bell & McIntosh, 2001). Operational requirements must also be taken into account. Headlands of at least 8 metres in width are necessary at both ends of the rows to allow for vehicle turning. Where only one trailer will be available at harvest or the harvester has an integral trailer, row lengths should be restricted to a maximum of 200 metres to avoid the need to reverse along the rows to off-load. Where two or more trailers will be available, row lengths can be longer. However, if liquid sludge is to be applied using an umbilical system, the maximum row length should be 400 metres. Rides of 4 metres should be left along the edges of the crop to allow machinery access for willow beetle control if required. A maximum of 20% open ground is allowed within a SRC plantation under the ECS.

Edge of SRC plantation

Land preparation

The importance of efficient land preparation for SRC cannot be stressed too highly. As SRC is a long-term, perennial crop, ensuring ideal conditions at establishment will reap benefits at first and all subsequent harvests.

Weed control is a critical part of coppice establishment. Complete eradication of all invasive perennial weeds is essential prior to planting. One or two applications of a glyphosate-based herbicide, applied at the appropriate rate, should be carried out in the summer/autumn prior to spring planting. Ideally the first herbicide application should take place in mid-summer with a follow-up application in autumn to control any further flush of weeds. An additional application just before planting in spring may be necessary on some sites. Spring spraying alone is unlikely to be effective.

If required the site should be sub-soiled to a depth of 40cm to remove compaction. It should then be ploughed to a depth of at least 25cm and left to over-winter. On lighter land it may be more appropriate to spring plough. Power harrowing of the site should be carried out immediately before planting.

Sludge cake, well-rotted farmyard manure or other bulky organic manure with a low available nitrogen content can be incorporated into the soils prior to ploughing.This is particularly beneficial on light soils where it will increase moisture retention and help to condition the soil. The Defra Code of Good Agricultural Practice for the Protection of Water (1998) must be adhered to when applying organic manures.

Rabbits, if present, must be kept out of the crop at least during the first two years and ideally up to first harvest, to allow the crop to mature beyond its vulnerable stage. Rabbit fencing should be erected to British Standard, buried and turned out. Defra and the Department of Trade and Industry (DTI) have produced a leaflet on rabbit management techniques for SRC (McKillop & Dendy, 2000).

Planting material

Planting rods

Access to the ECS is not restricted to specified varieties of willow. However, several willow varieties, bred specifically for use as SRC energy crops, are listed in the Forestry Commission Information Note "Poplar and willow varieties for short rotation coppice" (Tabbush, Parfitt and Tubby 2002). The recommended varieties have been through trials to ensure high yields, erect growth habit and resistance to, or tolerance of, disease. The list is updated as information on new varieties becomes available and provides a useful source of information when selecting planting material.

Melampsora rust is the most common fungal disease of willows. Ideally, a mix of willow varieties with diverse rust tolerance characteristics, referred to as "mix types", should be used. Details of these varietal characteristics are available in the Forestry Commission Information Note referred to above or from material providers. Recent research has also shown that mixed planting can lead to reduction in damage caused by willow beetles, the main pest species of willows.

European Plant Breeders' Rights protect the majority of varieties and crop harvested on the farm cannot be used as planting material. Further information can be obtained from the holders of Rights.

Planting material	
Planting rods	Cut and trimmed willow stems, generally 1.5 – 3m long
Cuttings	Cut fresh from rods and between 18 – 20cm in length

Willow cuttings colour-coded by variety

Willows are planted either as cuttings or rods. Only licensed producers should conduct willow propagation. Rods or cuttings are taken from one-year-old material that is harvested between December and March when the plants are dormant. They must be either planted immediately or stored at -2 to -4˚C, where cuttings will remain viable for several weeks and rods up to 3 months. They should only be taken from cold store and delivered to the planting site on the morning of planting. If rods/cuttings are left in temperatures above 0˚C a break in their dormancy will occur, adventitious roots will develop and the buds may burst. This will lead to a reduction in water and nutrient content and consequently reduced viability.

Establishment

Planting

Willows are planted either as cuttings or rods, depending on the type of planting machinery used. Details of the latest machinery available to buy or hire can be obtained from British BioGen's Energy Crops Network (see 'Contacts' section).

At present, the most commonly used machines are 'step planters'. Willow rods of 1.5-2.5 metres length are fed into the planter by two or more operatives depending on the number of rows being planted. The machine cuts the rods into 18-20cm cuttings, inserts the cuttings vertically into the soil and firms the soil around each cutting. 15,000 cuttings per hectare is the current standard commercial planting density using this method. Lower density planting may lead to thicker stems and consequently larger chip size. Therefore, planting densities down to 12,000 cuttings/ha may be appropriate where quality of chip is of more importance than yield.

For small areas of planting, modified cabbage planters can be used for planting cuttings directly. These machines are not economic for planting large areas however.

A 'lay-flat planter' is being developed which lays whole rods horizontally into furrows opened by discs at 2-8cm depth. The rods are laid end to end with a slight overlap, the soil covers them and is consolidated to minimise moisture loss. Distance between rows can be controlled but as the shoots tend to grow randomly along the length of the rods there is no way to accurately control density.

Planting should ideally take place after the last frosts but as early as February if soil conditions allow. Planting can be successful as late as June but late planting is best avoided as the longer the first growing season the better in order to take the plants successfully into winter and cutback. Another factor is that late planting has to rely on planting material from cold store, i.e. harvested earlier in the year. This will restrict the material available, especially as cuttings start to lose viability after a few weeks in storage.

A 'step planter'

Willows should be planted in twin rows 0.75 metres apart and with 1.5 metres between each set of twin rows. This spacing allows standard agricultural machinery fitted with wide tyres to work across the crop. A spacing of 0.59 metres along the rows when planting cuttings will give a planting density of 15,000/ha, the commercial standard (see diagram opposite).

The site should be rolled immediately after planting to consolidate the soil

A 'lay-flat planter'

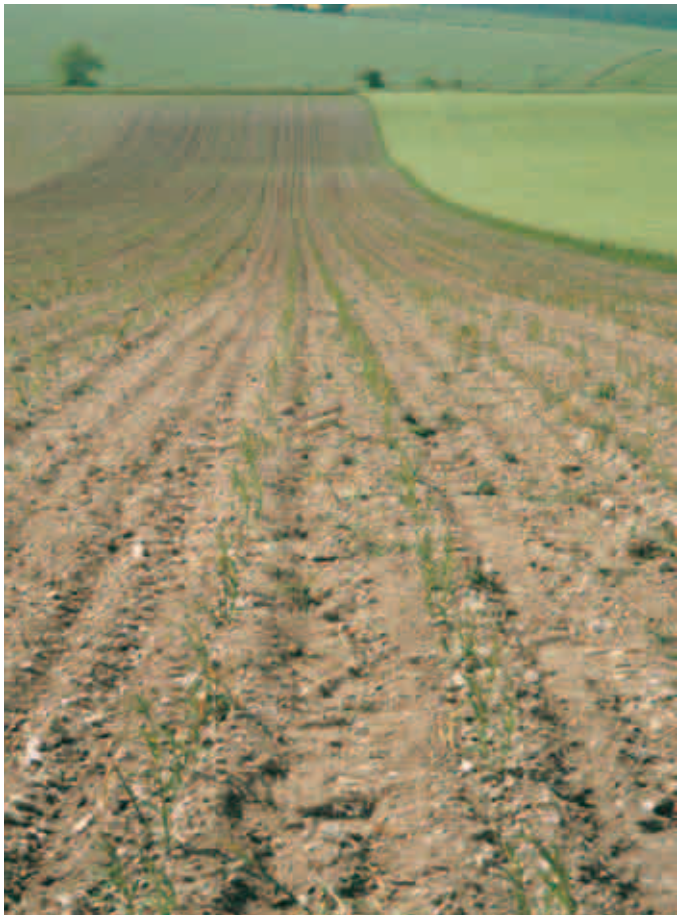
for effective herbicide application. Pre-emergence residual herbicide should be applied within 3-5 days of planting.

If the site was previously grassland or long-term set-aside, leatherjacket control should be applied. For commercial reasons it is better to apply the insecticide at the same time as the pre-emergence residual herbicide but ensure that it is before root or shoot development.

Establishment year management

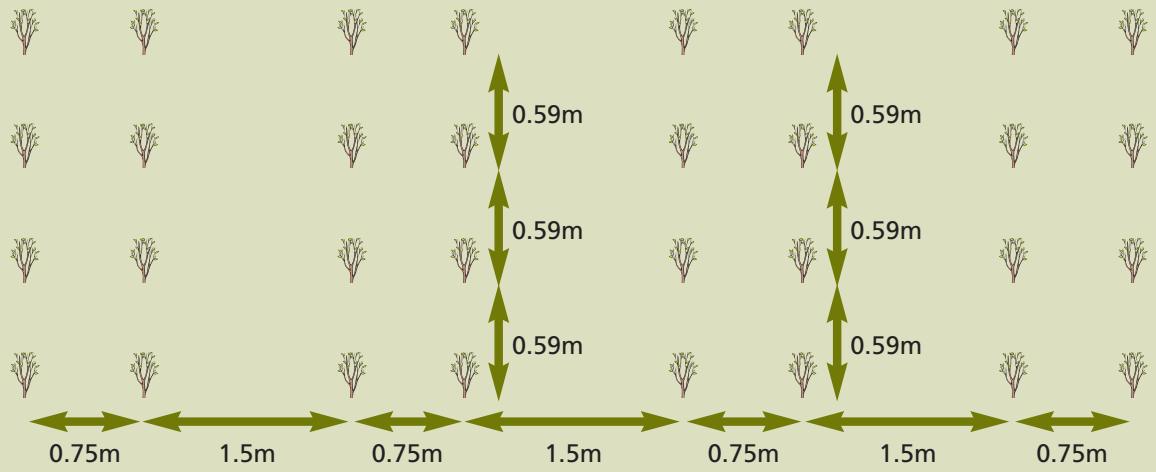
From each cutting 1 – 3 shoots will arise and reach up to 4 metres in height by the end of the first growing season, depending on soil conditions. In the case of rods, shoots develop randomly along the length of the rod but the stem heights will be similar to those from cuttings.

No fertiliser should be applied during the establishment year.



Growth shortly after planting

Recommended planting design



Plantation prior to cutback

The coppice should be monitored carefully for pests, weed growth and general health during the establishment year. If remedial weed control proves necessary, a hooded band sprayer, specifically designed for use on SRC, should be used.

Cutback

During the winter following planting the willow is usually cut back to within 10cm of ground level to encourage the development of the multi-stemmed coppice. The work should be carried out as late as possible in the winter but before bud-break, generally late February. The most effective machines are modified mowers/reapers as these give a clean cut to the stems.

A contact herbicide should be applied after cutback to control those weeds that have grown during the establishment year. It is important that the herbicide is applied before coppice bud-break

otherwise the crop will be damaged. Generally the use of systemic/translocated contact herbicides should be avoided due to the risk of crop damage although some, e.g. amitrole, have been shown to be safe when applied before bud-break.

Another option is to use a mix of amitrole and pendimethalin (residual herbicide) after cutback. The addition of the residual herbicide helps maintain weed-free conditions until canopy closure. Again, if used, this mix must be applied before bud-break.

5 – 20 shoots will emerge from each cutback stool depending on the variety. Within 3 months of cutback, canopy closure will have occurred providing natural weed control due to reduced light at ground level.

SRC stool

Calendar of activity

The following table provides an indication of the timing of major activities during the first two harvest cycles of a willow SRC plantation under a 3-year rotation.

	Year	Period	Activity
Pre-planting	-1	Jan - Jun	• Consider site selection and liaise with neighbours, local authorities, archaeologists, etc. • Prepare evidence of market for SRC • Prepare and submit Defra Establishment Grant application
		Jun - Sep	• 1st application of glyphosate-based herbicide
		Oct - Dec	• 1st or 2nd application of glyphosate-based herbicide • Incorporate sludge cake if required • Sub-soiling • Ploughing • Ordering cuttings
Establishment	1	Jan - Mar	• Erect rabbit fencing where necessary
		Mar - May	• 2nd or 3rd application of a glyphosate-based herbicide • Power harrowing and **planting** • Rolling and application of pre-emergence residual herbicide (together with leatherjack control if necessary) • Monitor for pests and check rabbit fencing
		Jun - Dec	• Monitor for pests, maintain rabbit fencing and check overall crop health • Remedial weed control if required

2	Jan - Feb	• **Cutback** and gap up as necessary
	Feb - Mar	• Application of contact herbicide
	Apr - Jun	• Apply liquid sludge/fertiliser as required • Monitor for pests and check rabbit fencing
	Jun - Dec	• Monitor for pests and diseases and maintain rabbit fencing
3	Mar - Aug	• Apply liquid sludge/fertiliser if required and practicable • Monitor for pests, particularly willow beetle
4	Mar - Aug	• Apply liquid sludge/fertiliser if required and practicable • Monitor for pests and diseases, treat as necessary
	Oct- Dec	• Agree harvesting dates and delivery schedule with end user • **Harvesting** and delivery to end user as fresh material • Harvesting, storage and drying
5	Jan - Feb	• Harvesting, storage and drying
	Feb - Mar	• Apply contact herbicide if necessary • Apply liquid sludge/fertiliser as required • Storage and drying of harvested material • Delivery of chip to end user
	Mar - Aug	• Monitor for pests, particularly willow beetle and spray as necessary • Storage and drying of harvested material • Delivery of chip to end user
6	Mar - Aug	• Apply liquid sludge/fertiliser if required and practicable • Monitor for pests and diseases, treat as necessary
7	Mar - Aug	• Apply liquid sludge/fertiliser if required and practicable • Monitor for pests and diseases, treat as necessary
	Oct - Dec	• **Harvesting**

General management

Headlands and rides

Headlands and rides should be grassed and cut twice a year. This regime provides some support for vehicle movements at harvest whilst also encouraging the establishment of beneficial flora.

Fertilisation

Digested, i.e. treated, sewage sludge can be applied to SRC as a fertiliser if it is considered feasible by the local Water Company under UK sludge regulations and their own guidelines. Accurate nutrient requirements of the crop are still under research but where treated sewage sludge has been applied the subjective view of growers is that it is beneficial. Under the Code of Good Agricultural Practice for the Protection of Water (COGAP 1998), no more than 250kg organic nitrogen/ha/year can be applied to agricultural land. Willow SRC has a low demand for nitrogen (N) and the current UK recommendations for application are 40, 60 and 100kg N/ha/yr for the 1st (i.e. after cutback), 2nd and 3rd years of the harvest cycle respectively (Johnson P. 1999). Where the soil has high residual N levels from previous cropping or a high soil organic matter level, these rates should be reduced.

No fertiliser should be applied during the establishment year, i.e. from planting until after the post-cutback herbicide application has had time to be effective.

Unfortunately, due to the growth form of SRC and the equipment currently available, fertiliser application can be difficult in year 2 of the harvest cycle and impossible in year 3. Opportunities to work over the crop usually have to be taken in year 1 after cutback and, where possible, in year 2. However, treated sewage sludge in liquid form can be applied using a dribble bar fed by an umbilical system. This allows the sludge to be applied directly to the ground surface through a series of pipes fed from the dribble bar with no contamination to the crop and it can be used on coppice up to 2.5 metres in height. Application should be at the rates given above.

Liquid sludge application using dribble bar

The use of composted sewage sludge applied using standard agricultural spreaders is being investigated to assess the benefits of applying up to 3 times the annual limit of total N, i.e. 700-750kg N/ha, in 1 application. Currently sludge cake or composted organic wastes, which contain very little plant available N, may be applied at rates of 500kg N/ha in 1 application every 2 years, in areas not sensitive to nitrate leaching (COGAP 1998). The potential of composted sludge is that it could be applied after cutback and again after harvest when there are few practical difficulties with working over the crop, although the height of the stems must be less than 50cm. Only 5-10% of the nitrogen would be released per year, i.e. during the growing season when temperatures rise the composted sludge would provide up to 70kg N/ha/yr for each year of the 3-year harvest cycle. The remaining nitrogen is held within the organic component of the compost and is not leached out. Defra will issue more guidance on this as results from the investigations become available.

Nitrate Vulnerable Zones

A mature SRC plantation, i.e. after establishment, will have a dense, widespread root system and this, combined with a long growing season, enables the crop to efficiently utilise nutrients. Research, in the UK and areas of Scandinavia with similar growing conditions, has shown that the uptake of available nitrogen by SRC is very effective and, consequently, nitrate leaching is much lower than that from fertilised grassland or arable land.

Also with SRC there is no soil disturbance to promote mineralisation.

Nitrate leaching has been recorded in the following situations:

- after green cover removal in the land preparation phase,
- during the establishment year where nitrogen has been applied as fertiliser, and
- after final removal of the crop.

It is therefore important that no fertiliser is applied during the establishment year, i.e. after planting and before cutback. The root system will not have fully developed and would not be able to utilise the additional nutrients.

Although from research to date SRC will prove to be a beneficial crop for planting within Nitrate Vulnerable Zones, it is essential that all Defra regulations relating to these zones are complied with.

Pests and diseases

Rust is the most important disease of SRC, caused by a number of fungi called Melampsora. Rusts can infect both the leaves and stems of willow and, as they can adapt rapidly to changing circumstances, can successfully infect a whole crop if appropriate measures are not taken.

Monocultures of willow, i.e. block planting of single varieties, are highly susceptible to rust damage. The UK and European Plant Breeding Programmes, one of whose aims is to identify varieties that are resistant to rust, recommend that at least 5 different varieties be planted in a random mix at each site. The Forestry

Melampsora rust on willow leaves

Commission Information Note by Tabbush, Parfitt and Tubby (2002) gives details of appropriate mixes. The use of fungicides is not recommended for economic, practical and environmental reasons.

Chrysomelids (willow beetles) are the most important insect pest of willow SRC. Their numbers can build up rapidly in spring and, as both adults and larvae feed on the leaves, they can cause considerable damage to the crop. For example, removal of 90% of the leaves in summer can reduce the yield by as much as 40%. Adult willow beetles overwinter in rotting wood, under the bark of trees and in similar habitats short distances from the coppice. As temperatures start to rise in the spring, the adults move into the edge of the coppice, start feeding, mate and then gradually move further into the crop.

If beetle numbers reach 100 adults or more shaken from the canopy per square metre of ground surface, then either a local application of an appropriate insecticide directed specifically to where the beetles are congregating or a spray applied from the edges of the coppice if the beetles are more dispersed, will save the crop from further damage. Overspraying a mature plantation would prove costly, not only financially but also ecologically as the insecticides used are

Willow beetle larvae

Adult willow beetles

not specific to their targets and would therefore damage many non-target and beneficial insects. Beetle populations do tend to fluctuate between years so a large infestation one year does not necessarily mean that it will occur again. Planting a mix of willow varieties can have a beneficial effect as the beetles tend to feed preferentially on some varieties before moving onto others and this slows their spread through the coppice.

Browsing animals such as rabbits and deer can also cause damage to SRC but mainly during establishment.

The Game Conservancy Trust has produced a booklet describing integrated pest management techniques for SRC (Tucker & Sage, 1999) which includes sections on willow beetles and rust.

Harvesting

Harvesting generally takes place on a 3-year cycle, the first harvest being 3 years after cutback. The work is carried out during the winter, after leaf fall and before bud-break, usually mid-October to early March. SRC can be harvested as rods, chips and billets (see table below).

End-users will generally require the fuel in the form of wood chip, to a maximum size. They may also need the wood chip dried to a particular moisture content (MC). For example, willow is generally in the range 45-60% MC at harvest but end-users may want a MC below 30%.

The type of harvesting machinery used will depend on the end-user's requirements. Details of the latest machinery available to buy or hire can be obtained from British BioGen's Energy Crops Network (see 'Contacts' section).

Rod harvesting

A number of machines are available for rod harvesting most of them producing loose rods which need to be off-loaded into heaps on the headlands or on farm. There is some wastage with this method as rods are left in the field and after collection from headlands. However, loose rods do dry by natural convection and do not deteriorate with time. 'Bundler' harvesters cut whole stems, bind them and then cut them into bundles 2.5 metres long. The bundles can be stacked on headlands or on farm and can dry down to approximately 30% MC in 3-4 months.

Chipping of dried whole rods or bundles tends to result in shattering of the material rather than chipping; therefore, where chip size and quality are important, chipping fresh material is recommended

Direct-chip harvesting

Specifically designed SRC headers for direct chipping of the crop have been fitted to forage harvesters: the stems are cut, chipped and then blown into an accompanying trailer. Although direct-chip harvesting is currently more efficient than rod harvesting, storage and drying of the fresh wood chip does cause problems. Stored, fresh wood chip can heat up to 60˚C within 24 hours and start to decompose. During decomposition calorific value, i.e. the energy value of the fuel, is lost. Also the fungal and bacterial spores produced during decomposition constitute a health hazard.

As the fuel will be needed all year, storage, drying and prevention of decomposition must be considered. The use of grain driers, ventilated-floor-driers and low-rate aeration using ducts are all

Harvested material	
Rods	Harvested stems up to 8m in length
Billets	Cut material, 5 – 15cm long
Chips	Cut material, up to 5 x 5 x 5 cm in size

being investigated, although it is currently considered uneconomic to dry wood chip by any method other than natural air-drying. It is important to ensure that the energy used in producing wood chip for fuel is kept to a minimum.

Billet harvesting

Intermediate between rod and direct chip harvesting is billet harvesting. The stems are cut whole, cut further into billets and blown into an accompanying trailer. Due to the spaces between the billets, natural ventilation occurs within storage piles preventing the difficulties associated with chip storage. However, depending on the fuel specification of the end-user, the billets may need to be chipped prior to use.

Direct-chip harvesting

Yield

SRC yields will vary according to the location of the site. Soil type, water availability, general husbandry, and pest and weed control will also affect yield. Yield following the first harvest of a number of commercial sites was in the range 5-9 odt/ha/yr. However, planting densities at many of these sites were 12,000 cuttings/ha rather than the current standard of 15,000 cuttings/ha. Yields should also increase at second and third harvests. Average yields from experimental plots growing new varieties, some of which are now commercially available, have reached more than 18 odt/ha/yr. Breeding programmes continue to produce varieties that out-perform older varieties.

Harvested woodchip

Biodiversity

Despite the fact that it is essential to eradicate weeds during the establishment of SRC, once the crop is mature the growth of a ground flora is beneficial. Ground cover encourages the presence of invertebrates, which in turn leads to an increase in the number of small mammals and birds found. At least three times the number of plant-eating species spend part of their life cycle in the canopy of willow SRC compared to conventionally grown barley and wheat (Sage & Tucker, 1998).

High numbers of bird species are also found throughout the year and over the 3-year harvest cycle. For example, skylark, lapwing, yellow wagtail and snipe are often found in newly planted, cutback and harvested SRC. Species of high conservation value such as bullfinch, reed bunting and song thrush have been noted to regularly hold territories in SRC during the breeding season.

Headlands and rides provide further habitat opportunities for a wide range of plants and animals, for example, 14 species of butterfly have been recorded on SRC headlands.

Many of the species that use the habitats associated with SRC will predate pest species. For example, two of the birds commonly associated with SRC, the garden and willow warblers, are two of the most important consumers of defoliating invertebrates. Therefore, any management practice that enhances the conservation potential of the crop is likely to prove valuable for pest management.

Headland flora

Removal of SRC

After the final winter harvest, the stools should be left and allowed to shoot the following spring. When shoots of more than 15cm in height have developed, the entire coppice should be over-sprayed with a glyphosate-based contact herbicide to kill the willow. Running either a sub-soiler or a large diameter disc along the rows close to the stools will sever the main structural roots, which run horizontally from the stools. When the shoots have died back, the stools themselves can be mulched by use of a bush-hogger (heavy-duty grass-topper or pulveriser) into the top 5-10cm of soil. The field can then be grassed for the first year following removal and (if appropriate) used for standard arable cropping the following year. Using this method, final harvest to re-seeding, will take 18-24 months.

To shorten the process, the final harvest can be taken in late summer/early autumn and the stools again allowed to shoot. When the shoots are 15cm or more in height, the herbicide should be applied, the structural roots cut and, following death of the shoots, the stools mulched. Depending on soil type, the stools can be ploughed in prior to winter. This will allow an early re-seeding the following spring.

Poplar SRC

Poplar has been used as a short rotation coppice crop on a small scale to date, often planted adjacent to willow SRC to provide visual diversity.

Site

Poplar grows best in deep fertile soils, although it will grow in most conditions. The main exceptions are shallow soils and sites that remain waterlogged. Soil pH should ideally fall in the range 5.5 - 7.5, although research suggests that there are varieties tolerant to soil pH outside this range.

Preparation of the site should be the same as that for willow SRC, taking care to ensure eradication of all weeds. The soil should be well cultivated to a depth of at least 25cm. Where compaction is present, sub-soiling should be carried out to a depth of 40cm.

Planting material

Most new poplar varieties have been bred for high yield but as a single stem crop. Also a number of varieties planted in the mid-1990's succumbed to rust as their resistance broke down. However, current breeding programmes aim to produce high yielding varieties that will coppice more readily and have long term resistance to rust. The current recommended and approved poplar varieties for SRC are listed in the Forestry Commission Information Note, "Poplar and willow varieties for short rotation coppice" (Tabbush, Parfitt and Tubby 2002).

Poplar varieties are controlled under the Forest Reproductive Material Regulations,

Poplar SRC

which are in place to improve the quality of poplar varieties, increase production and ensure that the most suitable varieties are used. These Regulations also control the marketing of poplar varieties so that reproductive material is only available from registered sources.

Planting

Planting should take place as early as possible in the spring but avoiding frost. The density of planting has generally been lower than that for willow at 10-12,000 cuttings/ha. The cuttings are 20-25cm long and must have an apical bud within 1cm of the top of the cutting. This means that poplar cannot be planted

using 'step planters', as the cuttings have to be manually processed to ensure the presence of the apical bud. Consequently, modified cabbage planters have to be used but due to the ridged nature of poplar stems, the cuttings occasionally block the planter mechanisms. The 'lay-flat planter' is currently being tested for planting poplar rods.

Management

Weed control is very important in the establishment year, so after planting and rolling a residual herbicide should be applied within 3-5 days. Cutback takes place late in the winter following planting. Due to its apical dominance, poplar will generally produce only 1-3 shoots after cutback.

Melampsora rust is also the most common disease of poplar, although different species of rust affect poplar and willow. Different poplar varieties have different susceptibilities to rust so it is important to read the latest version of the Forestry Commission's 'varieties' Information Note referred to above. As with willow, it is recommended that a mix of varieties be planted.

Willow beetles are also an important pest of poplars and should be treated either by spraying localised colonies or, if the population reaches 100 or more adult beetles per square metre of canopy, edge spraying the coppice in early spring. Overspraying the entire plantation would be ecologically and financially inadvisable.

Yields

Research has shown that poplar can often outperform willow in terms of yield but this appears to be site specific and highlights the fact that choosing the appropriate varieties for a site is essential. Unlike willow, poplar tends to produce better yields when allowed to grow for four years or more from cutback.

Harvesting

As poplar produces fewer, heavier stems, careful consideration must be given to the harvesting machinery used; it must be capable of dealing efficiently with large diameter, rigid stems. Details of the latest machinery available to buy or hire can be obtained from British Biogen's Energy Crops Network (see 'Contacts' section).

Removal

The removal of poplar SRC at the end of its life is more problematic than willow. The rooting system of poplar includes a large taproot that grows down into the soil. Removal of the stools (following final harvest and spraying off of the shoots) will generally require a large excavator.

References

Bell S, McIntosh E 2001. Short Rotation Coppice in the Landscape. Forestry Commission Guideline Note 2. Forestry Commission, Edinburgh

Defra 1998. Code of Good Agricultural Practice for the Protection of Water. Defra Publications, London

Defra 2000. Establishment grants for short rotation coppice and miscanthus. Defra Publications, London

Defra 2000. Grants for establishing producer groups. Defra Publications, London

Forest Reproductive Material Regulations 1977. HMSO

Forest Reproductive Material (Amendment) Regulations 1992. HMSO

Johnson P 1999. Fertiliser requirements for short rotation coppice. ETSU report B/W2/00579/REP/1

McKillop I G, Dendy J A 2000. Advice on rabbit management for growers of short rotation willow coppice. DTI/Defra, Central Science Laboratory, York

Sage R, Tucker K 1998. Integrated crop management of SRC plantations to maximise crop value, wildlife benefits and other added value opportunities. ETSU B/W2/00400/REP

Sludge (Use in Agriculture) Regulations 1989. HMSO

Sludge (Use in Agriculture) (Amendment) Regulations 1990. HMSO

Tabbush P, Parfitt R, Tubby I 2002. Poplar and willow varieties for short rotation coppice. Forestry Commission Information Note. Forestry Commission, Edinburgh

Tubby I, Armstrong A 2002. The establishment and management of short rotation coppice – a practitioner's guide. Forestry Commission Practice Note. Forestry Commission, Edinburgh

Tucker K, Sage R 1999. Integrated pest management in short rotation coppice – a grower's guide. Game Conservancy Limited, Fordingbridge, Hampshire

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