SHORT ROTATION FORESTRY

Can Short Rotation Forestry play a role in Renewable Energy Demands?

Figure 1: Eucalyptus nitens beside Sitka spruce in Cappoquin, Co Waterford planted in 1992 (photo Kevin Hutchinson)

New research into short rotation forestry may have the potential to offset some of the predicted shortfall in supply of timber for biomass and assist in achieving renewable energy targets. A multidisciplinary team from UCD, Trinity College, UL, WIT and Teagasc hope to evaluate its potential in Ireland.

A new collaborative project called ShortFor funded by the Department of Agriculture, Food and the Marine between University College Dublin (lead organisation), Trinity College Dublin, University of Limerick, Waterford Institute of Technology and Teagasc is underway to explore the potential of short rotation forestry (SRF) in Ireland to meet renewable energy markets. While Ireland's renewable energy targets are set to increase to 16% by 2020 (European directive 2009/28/EC), there is a predicted shortfall of 1.7 million m^3 of forest biomass in Ireland, with demand set to increase to 3.1 million m^3.

The requirement of renewables for electricity generation is set higher at a target of 30% of Ireland's electricity needs by 2020.

There is perhaps a potential role for short rotation forestry (SRF) and other sources of fibre to supply much of this predicted shortfall.

The proposed research programme hopes to identify a wide range of sites with potential for SRF in Ireland and evaluate the potential of a number of new species that may be potentially suitable for SRF.

WHAT IS SHORT ROTATION FORESTRY?

SRF, single or multi-stemmed trees of fast growing species grown on a reduced rotation length (less than 20 years in Ireland) primarily for the production of biomass or fibre, occupies a niche between the highly productive short rotation coppice systems and conventional forestry. It provides more flexibility than a coppice system in that a much wider variety of species can be used and there is the potential to convert stands back into conventional forestry (e.g. due to a change in market environment). Since the objectives differ from conventional forestry, the silvicultural practices need to be modified to suit SRF. For example, Sitka spruce is normally planted at about 2 m spacing in conventional forestry, thus reducing the need for early (often uneconomic) thinning. Trees that are planted at such (relatively wide) spacing will not fully utilise the site during the early years after establishment.

However, planting at wide spacing may be undesirable if the objective is to maximise the amount of biomass produced over a short period of time. Species that are suitable for conventional forestry may also be less suitable for SRF objectives.

Species	Spacing (metres)	Yield Class	Age (years)	Trees/ha	Mean DBH (cm)	Volume m^3/ha	Basic density	Source
Eucalyptus nitens	2 x 2	26	16	740	n/a	418	0.44	Hutchinson et al. (2012)
Eucalyptus gunii	2 x 2	20+	22	700	28	489	0.44	Kent and Hutchinson (2014)
Eucalyptus delicatensis	2 x 2	20+	22	436	32	389	0.44	Kent and Hutchinson (2014)
Sitka spruce	2 x 2	24	15	2083	16.3	210	0.37	Farrelly (2014)
Nothofagus	1.7 x 1.7	18	17	846	20	281	0.60	Tulley (1980)
Grand fir	1.8 x 1.8	30	19	1271	15	235		Edwards and Christie (1981)
Poplar	2.7 x 2.7	14	12	1296	19	248	0.36	Edwards and Christie (1981)
Ash	2 x 2	n/a	20	2074	9.7	68	0.53	Evans et al. (2003)
Corsican pine	2.5 x 2.5	20	21	1388	19	215	0.40	Edwards and Christie (1981)
Common alder	2 x 2	6	14	2300	9	41	0.41	Mockler (2013)
Downy birch	n/a	6	15	3300	9	59	0.51	Mockler (2013)
Lodgepole pine	2 x 2	14	12	2007	12	70	0.38	Mockler (2013)

Table 1: Indicative figures for biomass production of short rotation forestry in Ireland

Figure 2: Eucalyptus delegatensis stand at Kilbora, Co Wexford, planted 1992, c. 22 years old, partially windblown by the February 2014 storm (photo Tom Kent).

RANGE OF POTENTIAL SPECIES

A range of potential species are available that may have potential for short rotation forestry (Table 1). In recent years the potential of Eucalyptus for energy and fibre production has been investigated and shows much potential (Hutchinson, Thompson and Berkery). The species shows extremely rapid early growth and has the potential to produce large volumes on relatively short rotations, with rotations of 16 years highly plausible. While there are more than 900 species of Eucalyptus, possibly eight show some potential in Ireland.

The most impressive, Eucalyptus nitens has been shown to produce yields from 18 to 42 m^3/ha in demonstration plots in Co Wexford (Hutchinson, Thompson and Berkery; Figure 1). In addition recent measurements from a plot of E. gunnii and E. delegatensis in Co Wexford indicate that these species also have some potential where E. nitens is considered unsuitable. Other Eucalyptus also show potential and may be more frost hardy. E. subcrenulata, E. unigera and E. glaucescens show promising early results in a trial established by Teagasc in Athenry and are thought to be frost resistant to -16°C.

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Other species such as hybrid poplar have been shown to grow very vigorously (Figure 3). While certain species may show rapid growth potential they may be unsuitable for certain site types, show increased susceptibility to frost, or be less disease resistant.

It is therefore necessary to investigate a range of potential species. Other conventional forest tree species (e.g. Sitka spruce, Grand fir, Corsican pine) may have potential on different site types and are capable of producing large volumes in 20 years, while information on other species (i.e. Nothofagus and hybrid aspen) is lacking. Therefore more detailed information is needed on species and site suitability and silvicultural practices to manage crops and what the best approach is to optimise returns from SRF in Ireland. Practices need to be developed that optimise the use of natural resources, environmentally and economically, through the application of evidence-based research information.

This new project runs from 2014 to 2017. The main objectives and expected outcomes are as follows:

- Biomass is a relatively low value product, which ideally should be produced close to where it is being used. The current extent of SRF resource and markets (pulp and energy biomass) will be mapped, identifying / predicting likely regions where areas of suitable land are likely to become available (land that is not in competition for food production).
- The potential of SRF to contribute to biomass production and renewable energy targets in Ireland will be explored. The quality and calorific value of the biomass produced by key species as well as the sustainability of suitable management/ production systems will be examined.
- The potential for using genetically improved fast-growing broadleaved and coniferous species will be investigated.
- An efficient production, management and harvesting system for use at farm level will be developed.
- The environmental impact of such management systems will be examined by Trinity College and University of Limerick, considering energy and fertiliser inputs and losses, changes in soil carbon stocks, GHG balance and energy inputs for SRC compared with conventional forest (or other) production systems. The rates of carbon sequestration that can be expected will also be evaluated. The best plant genotypes (species/clones) that are suited to SRF under conditions in Ireland will be determined.
- Field trials will be established to investigate the impact of a number of spacings on species growth characteristics (e.g. yield) on several site types.
- Silvicultural practices (e.g. spacing) that optimise returns will be determined in the long-term field trials.

Figure 3: Hybrid poplar clonal trial at 4 m x 4 m spacing in Kildalton Agricultural College, planted 1996, c. 18 years old (photo Tom Kent)

RESEARCH APPROACH

ShortFor will spend a considerable effort on reviewing the current state of knowledge on SRF systems, both here in Ireland as well as from the UK and other related international sources.

A major task is to identify what resource currently exists and the range of suitable sites possible.

At time of writing a list of twenty Eucalyptus sites planted by Coillte and D Plant Horticulture have been identified, mainly containing E. nitens, E. gunii, E. delegatensis, E. dendiculata, E. cordata and E. unigera. In addition three poplar and six alder sites have been identified (Figure 3).

Information on the location of stands of eucalyptus, Italian alder, hybrid poplar and Nothofagus may be communicated to the project by contacting Mr Tom Kent of WIT (tkent@wit.ie). WIT will carry out field assessments of the productivity of potential SRF species on a range of sites. This work hopes to identify the range of site types suitable for a range of species and match these to the potential sites which may become available for SRF in the future and inform what species and management systems are necessary to supply biomass energy markets.

NEW FIELD TRIALS

A limited number of targeted field trials are planned to test establishment procedures specific to SRF conditions to ensure that a system can be developed that quickly maximises productivity potential and to develop new practices for managing crops to optimise harvest times / rotation length as well as coppicing opportunities. In particular, the growth dynamics of key species will be evaluated in response to different spacings.

One experimental trial has already been established in Johnstown Castle, Co Wexford by Teagasc, and contains E. nitens, Italian alder (Alnus cordata) and Sitka spruce (Picea sitchensis) planted at four different spacings (0.5 x 0.5 m, 1 x 1 m, 2 x 1 m and 2.5 x 2.5 m). It is hoped to compare and contrast growth performance between species and at different spacings. It will be necessary to evaluate growth responses to competition, and optimum spacing for biomass production.

ECONOMIC SUSTAINABILITY

The ShortFor project will evaluate the economic sustainability of SRF systems for renewable wood energy generation by investigating the potential supply and demand of SRF and the operational cost of the methods used to mobilise this resource. It is important that SRF practices should also be environmentally sustainable.

Several key indicators of sustainability will be evaluated by Trinity College Dublin including soil fertility and hydrological balance issues. The effect of stump removal will be evaluated. Carbon stocks will be compared with other short rotation and conventional forest and land-use systems by University of Limerick. Synergistic links with other relevant studies will be exploited.

POTENTIAL IMPACT OF SHORT ROTATION FORESTRY

Economic development – The creation of new supply opportunities for pulp and box wood will allow increased development of markets for larger dimension and higher- value timber products. Such developments will stimulate further job creation in downstream processing and marketing sectors, further enhancing potential for building exports while reducing the need for imports. The expansion of the energy market will also contribute to rural development.

Sustainability of supply – One of the limitations of SRC production systems in Ireland to date is that they have been dominated by very low species diversity. SRF offers an opportunity to operate intensive production of biomass over a wider range of site types using a greater range (and perhaps mix) of species thereby reducing the risk of attack from pests and diseases.

Benefit for Irish society/citizens – The possibilities of planting SRF using an increased range of native species will increase biodiversity in bioenergy crop areas, while safe-guarding and increasing indigenous energy supply.

Contribution to the legislative/ regulatory framework – There is very limited experience of SRF systems in Ireland or the UK. Demand for biomass for energy (and from other markets) may drive investment in SRF in the near future. However, there is a paucity of information to inform policy formation and legislative regulation, leading to the potential for environmental and economic damage. Furthermore, efficient and sustainable production management systems will be developed, allowing for more widespread use of SRF in Ireland.

Improvement of the Irish scientific capacity and capability – The employment of research personnel and postdoctoral researchers will help maintain national expertise in forest biomass and energy sectors, which is essential for the development of this sector.

Sustainability and environmental benefits – The environmental impact of SRF will be assessed, allowing for the development of management prescriptions that deliver optimum efficiency while ensuring sustainability by protecting long- term soil fertility, ability to sequester carbon and protection of water quality.

Information for grant schemes – It is hoped that this research can further assist in the provision of information contributing to the development of grant schemes and incentives to support short rotation forestry. Such schemes if supported by Government may assist in the provision of biomass to the renewable sectors.

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