Forestry Commission

Choosing Sitka spruce planting stock

Practice Note

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Over 90% of the Sitka spruce planted in Britain today is from 'improved' planting stock, which is predicted to produce around 25% more timber at final rotation, compared with material imported from the Pacific North West. Forest managers have a choice of improved stock: seedlings raised from seed collected in orchards established around 25 years ago, or rooted cuttings taken from stock plants raised in nurseries using controlled pollinated seed produced by tree breeders. Although the predicted gains in growth rate often appear similar, the predicted gains for quality traits are usually superior for the rooted cutting stock. The down side is that the rooted cuttings are usually more expensive due to the extra production costs at the nursery. Which planting stock gives the best financial return in the long run is dependent on a number of variables. This Practice Note provides guidance to forest managers on how to choose the most appropriate planting stock, depending on thinning regime, rotation length, growth rate, and economic factors such as the premium paid for rooted cutting stock at the time of planting and the likely premium for green logs at harvest.

Introduction

The Forestry Commission set up the Sitka spruce breeding programme in 1963. Individual trees growing in British forests were selected for characteristics such as superior height, diameter and stem straightness, and the first seed orchards composed of superior, tested individuals were planted in the mid to late 1980s. However, it was soon apparent that the new orchards would not yield commercial quantities of seed until 10 years or so after planting and, in a bid to reduce the period of time before improved stock reached the market, a system of vegetative propagation was developed. The idea was that small amounts of superior seed harvested from controlled pollinations could be used to raise stock plants from which cuttings would be taken and rooted in a nursery.

Nursery managers developed and refined this technique to the extent that up to 1000 rooted cuttings could be obtained from a single seed over a 6-year period. The vegetatively propagated (VP) plants were always more expensive than the alternative 'unimproved' bare-rooted seedlings due to the extra labour and capital investment required at the nursery. For most of the 1990s the only improved Sitka spruce stock available was vegetatively propagated as very little seed was produced by the orchards. While seed orchard (SO) stock was unavailable, the predicted increase in growth rate of one full yield class from the VP stock was sufficient to justify its planting, despite the extra cost.

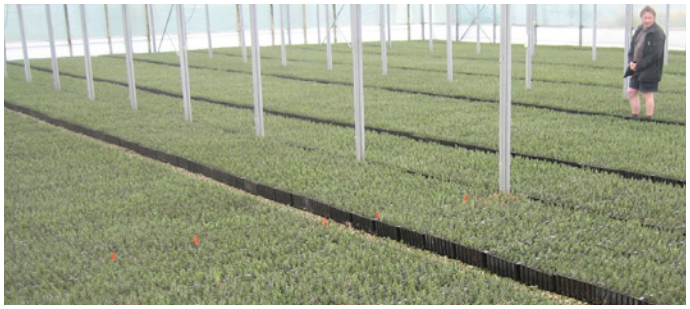
Yield class : An index used in the UK of the potential productivity of even-aged stands of trees based on maximum mean actual increment. It reflects the potential productivity of the site for the tree species growing on it.

Current availability of planting stock

The early-planted seed orchards are now mature and are producing regular quantities of improved seed (Figure 1). There have also been recent developments with the VP stock, which now tends to consist of tested full-sibling families (i.e. just one known mother and one known father) rather than the more diverse multi-parent mixtures of the 1990s (Figure 2). The narrower genetic base of the new VP full-sibling families gives a more uniform final crop. They also have additional improvements in quality such as stem straightness, branching and, often, wood density. However, gains in vigour remain broadly similar to that available from seed orchards and the earlier VP stock. The real benefit of the new VP stock is the prediction that a greater proportion of the crop will satisfy the higher value 'Green log' status.

Figure 1 Harvesting Sitka spruce cones from a mature tested orchard.

Figure 2 Sitka spruce cuttings in a Forestry Comission nursery.



This Practice Note aims to help forest managers faced with a choice of Sitka spruce planting stock by providing guidance on those situations that favour the more expensive full-sibling VP stock, and those where cheaper SO stock would be more appropriate. A decision-support matrix (Figure 3 on page 4) provides a way to assess options for site-specific conditions assuming certain costs and benefits over the rotation.

Green and Red logs: Sawlogs can be categorised into 'Green' and 'Red' classes, according to the quality of timber that can be produced from them. Green logs can be cut into straighter lengths and have fewer knots than Red logs and usually command a premium from the sawmiller.

Choosing suitable planting stock

There are a number of variables to consider when choosing the most suitable planting stock for example:

- Whether or not the site will be thinned.
- The likely yield class of the improved stock on the selected site.
- The likely rotation length of the plantation, taking into account wind restrictions if applicable.
- The extra cost per hectare of VP planting stock relative to SO (may have to be adjusted according to any grant incentives).
- The extra Green log production per hectare of trees raised from VP compared with SO stock.

- The possible shift from small roundwood to sawlogs in the more uniform VP stand (resulting from fewer very small trees compared with SO stock).
- The likely future premium per cubic metre of Green logs, compared with Red logs, at felling.
- The interest rate to be applied to the investment.

This Practice Note provides guidance based on a standard set of assumptions that have been used to produce the decision-support matrix in Figure 3. The recommendations provided by the matrix are based on standard crop of YC18 with a rotation length of 40 years. Further details of the standard assumptions (operating in autumn 2012) are set out in Box 1 together with the other possible variations investigated.

How to use the decision support matrix

The matrix is split into four parts representing thinned (left side) or unthinned (right side) crops, according to either 3.5/3.0% interest rates – applicable to public investments (top half) – or 5% interest rate – which may be more suitable for the private sector (bottom half).

To use the matrix:

- Choose the quadrant that is most suitable for your needs.
- Find your position within that quadrant according to the premium paid for VP stock per hectare at planting (net of any grant) and assumed premium of Green logs at harvest.

Coloured cells, which are explained in the key, illustrate the suggested choice of planting stock.

The matrix can also be used for other rotation lengths and growth rates by moving up or down the most suitable part of the matrix as directed by the adjustment section at the bottom of Figure 3.

In general, there are more green and fewer red cells when the lower interest rate is applied. This is also true when the trees are thinned rather than left unthinned, regardless of interest rates. The combination that favours VP stock is therefore a thinning regime associated with the lower interest rate.

Within any one of the four parts of the matrix, there is a tendency to move from red, through orange, to first light green and then dark green as either the premium for Green logs at felling increases, the premium for VP stock at planting decreases, or a combination of the two.

In many cases SO stock seems the better choice but under various combinations of higher growth rate (YC20+), lower VP cost premiums at planting, and optimistic views of Green log premiums at harvest, VP stock is the preferred option. Independent of the economics, the VP stock will have more uniform and better stem and branch quality relative to early-planted seed orchards.

No account has been taken of any possible savings made at harvest from felling a more uniform crop from VP relative to SO stock. Some mangers may feel that these savings could be considerable, as logistics and processing improves both in the forest and at the sawmill, which should be reflected in higher log value. If managers feel this is relevant, it can effectively be included by increasing the premium expected for Green logs.

Box 1 Standard assumptions made in the comparison of VP and SO planting stock

• Premium to be paid for VP trees at planting:	£150 per ha
Variations also investigated:	£155 per ha to £45 per ha.
• Extra Green logs from VP stock compared to SO seedling:	20%
Variations also investigated:	30%
• Future premium of Green logs relative to Red logs:	£5 per m^3
Variations also investigated:	£6 per m^3 to £15 per m^3.
• Uniformity shift from short roundwood to logs:	5%
Variations also investigated:	0% and 10%
• Growth rate:	YC18
Variations also investigated:	YC12 to YC24
• Rotation length:	40 years
Variations also investigated:	30 to 50 years.

The assumptions relating to extra straightness were derived from predicted gains figures combined with real log outturn in a sawmill study of mature selected trees. The study suggested most typical full-sibling families will give 20% more Green logs than seed orchard crops of Sitka spruce, but that the very best full-sibling families selected mainly for good straightness could give up to 30% extra. These figures were used to adapt a Forest Research wood quality decision support system, which estimates the ratio of Green to Red logs at any given age and yield class.

Figure 3 Decision support matrix.

SO best choice.

SO best choice unless other savings can be made elsewhere at establishment as a result of planting VP stock.

VP best choice with typical full-sibling family.

VP best choice but only if families with very high stem straightness prediction are planted, otherwise plant SO.

Adjustments for different yield classes, rotation lengths and proportions of small roundwood (SRW):

Higher yield class:	Move down 3 cells per yield class (e.g. 3 for YC 20; 6 for YC 22)
Lower yield class:	Move up 3 cells per yield class (3 for YC 16; 6 for YC 14)
Shorter rotation:	Move up 3 cells per 5 years earlier
Longer rotation:	Move down 3 cells per extra 5 years
Expect less SRW:	Move down 3 cells for every 5% switch to sawlogs

Other factors to consider

Another factor to consider in the choice of planting stock is the extra value of Green logs relative to Red logs at harvest. While this has historically hovered at around £5 per m^3, this may not remain the case in the future. It is often best to plan for improved quality, which the VP stock will offer over the SO planting stock currently available. If future demand for timber outstrips supply, then the differential value between Red and Green logs is likely to increase. Also, future carbon markets may assist in increasing this differential if the sawn out-turn from the Green logs tie up carbon for longer time periods due to their higher specification and construction grade. Clonal seed orchards planted more recently have gain predictions for vigour and stem straightness comparable to the average full-sibling family (20%) and so would be a reasonable alternative to VP – although there would not be the same uniformity gains which VP can offer. Finally, nursery managers are constantly trying to lower the cost of VP stock in a bid to make it a more attractive planting choice for forest managers in what is a crucial part of the selection process.

Worked examples

There are clearly many different variables that can change from site to site and so alter the choice of suitable planting stock. There are too many options to show them all but, for illustrative purposes, a number of worked examples using the decision support matrix are provided in Table 1. Forest managers should apply their own circumstances.

Table 1 Worked examples using the decision support matrix (Figure 3).

Assumptions	Process	Recommendation
Example 1 (Use the bottom left matrix)		
– Crop to be thinned – 5% interest rate – VP premium at planting £50 per ha – Premium of Green logs at felling £10 per m^3 – Rotation length 35 years – YC22	Find £50 on the vertical axis and £10 on the horizontal. The cell is dark green. But because the rotation length is 5 years less than the Table default of 40 years, move up 3 cells. This gives light green. Since the growth rate is two yield classes higher than the Table default of YC18, move back down 6 cells, which is off the Table but well into the dark green zone.	Plant VP stock.
Example 2 (Use the top left matrix)		
– Crop to be thinned – 3.5/3.0% interest rate – VP premium at planting £150 – Premium of Green logs at felling £7 per m^3 – Rotation length 45 years – YC16	Find £150 on the vertical axis and £7 on the horizontal. The cell is red. But because the rotation length is 5 years more than the Table default of 40 years, move down 3 cells. The cell is still red. But since the growth rate is one yield class lower than the Table default of YC18, move back up 3 cells which is well into the red zone.	Plant SO stock.
Example 3 (Use the top left matrix)		
– Crop to be thinned – 3.5/3.0% interest rate – VP premium at planting £130 – Premium of Green logs at felling £7 per m^3 – Rotation length 40 years – YC24	Find £130 on the vertical axis and £7 on the horizontal. The cell is red. But since the growth rate is three yield classes higher than the Table default of YC18, move down 9 cells. The cell is now light green.	Plant VP stock from one of the best-straightness families, although more regular VP stock could also be considered.
Example 4 (Use the top right matrix)		
– No-thin crop – 3.5/3.0% interest rate – VP premium at planting £130 – Premium of Green logs at felling £10 per m^3 – Rotation length 40 years – YC20	Find £130 on the vertical axis and £10 on the horizontal. The cell is red. But because the growth rate is one yield class higher than the default YC18, more down 3 cells. The cell is now orange.	SO stock is probably most suitable. The best-straightness families (light green) could be considered if a way can be found of saving further money at planting.
Example 5 (Use the bottom right matrix)		
– No-thin crop – 5% interest rate – VP premium at planting £50 – Premium of Green logs at felling £7 per m^3 – YC22 – Rotation length 35 years	Find £50 on the vertical axis and £7 on the horizontal. The cell is orange. But because the rotation length is 5 years less than the Table default of 40-years, move up 3 cells. The cell is still orange. But since the growth rate is two yield classes higher than the Table default of YC18, move down 6 cells. Off the table but most likely the cell is light green.	VP stock of the best-straightness families.

Useful sources of information

Publications

Benefits of improved Sitka spruce: volume and quality of timber.
Forestry Commission Research Note (FCRN003).

Journals

Improved Sitka spruce planting stock: seedlings from a clonal seed orchard or cuttings from full-sib famlies?
Scottish forestry 66(2).

Websites

www.eforestry.gov.uk/forestdss > Conifer timber quality
Part of the online decision support system for forestry from Forest Research.

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