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- Estimates timber revenues for the main conifer species.
- User can select timber prices and rotation type.
- Estimates the revenue loss for felling earlier than rotation age.
- Results can be exported to file for analysis.
- Provides an estimate of yield class.

Felling Decision Tool - Conifers

Henry Phillips¹

Background

In Ireland, the main management goal for conifer crops is generally the production of wood-based commodities such as sawlogs, pulpwood and energy wood or woody biomass. In this context, the optimal rotation is mostly dictated by economic drivers in interaction with factors influencing wood volume growth and rotation length, such as tree species, crop stability and site productivity or yield class.

Although it is outside the scope of this note, increasingly forest management needs to consider an expanding range of forest values beyond traditional wood products, such as recreation, landscape, biodiversity conservation, and climate change mitigation.

Until now the majority of clearfelling in Ireland has been concentrated in the public estate. Significant portions of the private forest estate, particularly conifers, that were afforested in the 1980s and the early 1990s are now approaching a stage where forest owners may be considering the timing of felling operations. The choice of rotation length i.e. the decision when to clearfell, is an important decision with the potential to either maximise returns to the owner or result in significantly reduced revenues.

Against this background and the recommendation of the COFORD Wood Mobilisation Group² to provide information to make owners aware of the possible impact of felling age on overall financial returns, the Forest Service commissioned a report on the assessment of the impact of forest felling age on overall financial return to forest owners. The report analysed the impact of felling age on returns to owners under a number of management and rotation prescriptions and found that felling of crops prior to the age of financial maturity could result in significant revenues forgone. A requirement of the report was to develop a web-based application to assist owners in deciding when to fell.

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². COFORD Wood Mobilisation Group. 2015. *Mobilising Ireland's forest resource*. COFORD, Dublin.

Financial rotation

The financial rotation maximises the profit or return to the owner. Profit can however be defined in a number of ways, the most common being in terms of net present value (NPV) which is the surplus of discounted revenues (benefits) over discounted costs at the chosen discount rate. The financial rotation is therefore the rotation age which maximises the NPV. Alternatives consider profit in terms of discounted revenue only or annual net revenue ignoring the impact of timing of returns. For ease of use, the felling decision tool defines the financial rotation as the rotation age which maximises the discounted revenue (DR) at the chosen discount rate. In practical terms, provided that the majority of costs are incurred during the early part of the rotation, there is little or no difference between using maximum NPV or maximum DR with the advantage that the latter only requires information on revenues.

The financial rotation varies with yield class, the type and frequency of thinning, the discount rate and timber prices. While the financial rotation provides the highest financial return i.e. maximum discounted revenue, for a given management prescription (thin or no thin), there can be valid reasons as to why it is not feasible for a forest owner to grow their crop(s) in line with the financial rotation including (a) technical e.g. not possible due to stability concerns or market requirement is for a smaller average tree and (b) personal considerations e.g. immediate need for cash.

Estimates of volume

Estimates of volume and other crop parameters (top height, mean tree and basal area) for Sitka spruce and lodgepole pine south coastal were obtained from GROWFOR. For all other species the Forestry Commission yield tables³ were used.

Timber prices

The timber prices are based on Coillte standing conifer prices and were corrected to take account of the impact of retained pulpwood⁴. This was necessary as published standing prices include the small and large sawlog content only, which attracts a higher price and excludes the lower value pulp and stakewood content. This therefore results in overstated prices. Prices were adjusted for inflation using the consumer price index (CPI) as published by the Central Statistics Office (CSO) and expressed in 2015 values.

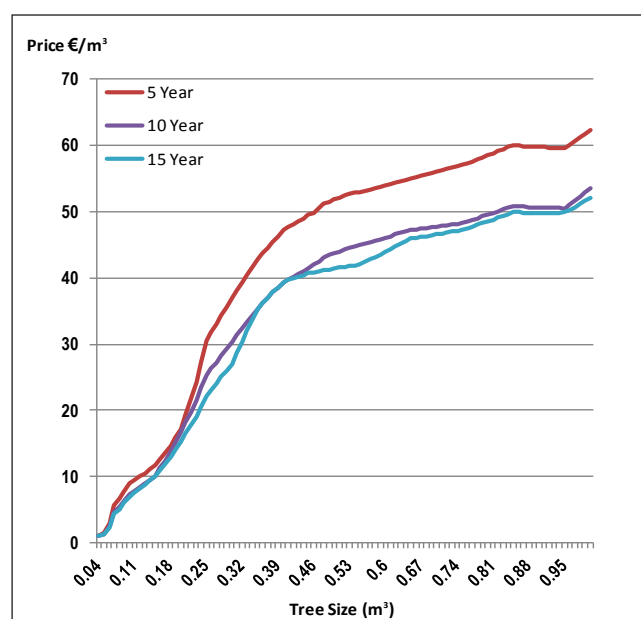


Figure 1: Average standing timber prices for conifers

It is important to remember that these prices are **average** prices. In addition, as most of Coillte's sales comprises spruce species (Sitka and Norway spruce) and thinned crops, the prices should be treated with caution when used with other conifer species e.g. Scots pine or Douglas fir or for no thin crops. In this instance the outputs from the felling decision tool should be treated as indicative only. Finally actual prices for an individual plantation will vary depending on a number of factors including:

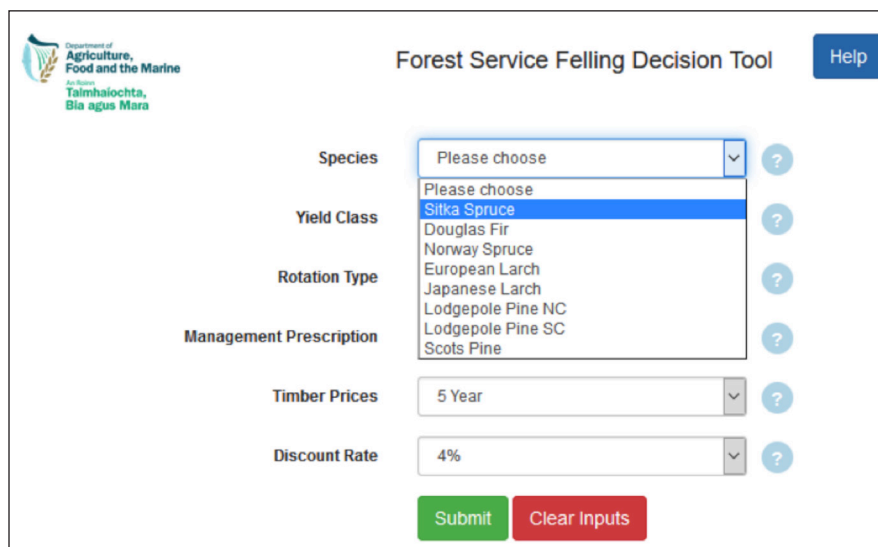
- Quality of the crop
- Access - both county roads and internal forest roads
- Distance to the nearest mill
- Volume for sale
- Timber markets
- Site factors (slope, waterlogged areas)

³ Matthews, R.W., Henshall, P.A., Duckworth, R.R., Jenkins, T.A.R., Mackie, E.D., and Dick, E.C. (2016) *Forest Yield: a PC-Based yield model for forest management in Britain*. Forestry Commission, Edinburgh

⁴ Since the mid 1990s Coillte has operated a pulpwood buyback/retained pulpwood clause for all standing sales.

The tool

The purpose of the felling decision tool is to provide owners with information on estimated timber revenues and crop parameters (volumes, top height, mean tree size) that will assist them in deciding when to clearfell their crops and show the implications of felling earlier or later than the financial rotation age or their selected rotation type final fell year.



Using the tool

The tool is designed for ease of use by foresters and non-foresters and requires only basic information on species, yield class, rotation type and thinning regime to be input by the user.

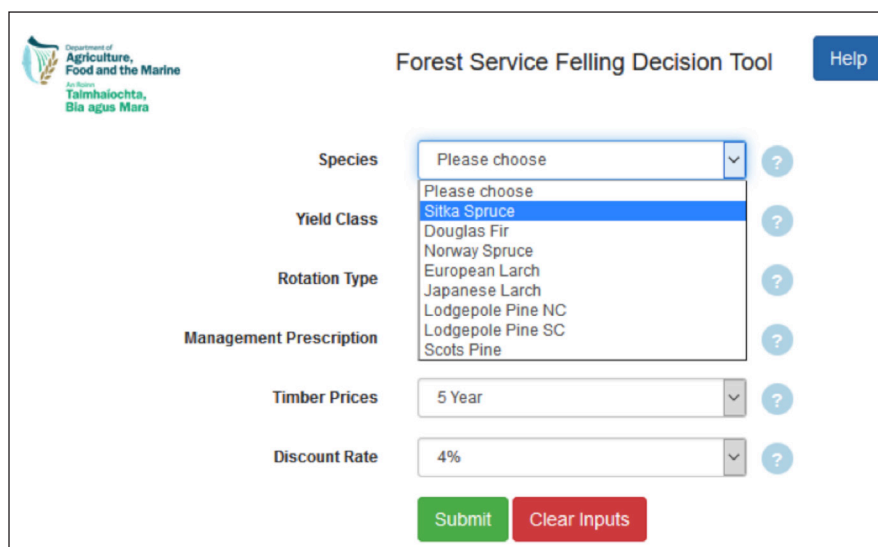
There are two levels of help available: the quick help along side each input which provides basic advice, and a

comprehensive help file that users can download or open to browse through to find the topic they require.

The starting point is to first select the tree species as this then determines what yield classes, rotation types and thinning regimes are potentially available to choose.

Species:

To select a particular species click on the *Species* field and choose one from the drop-down menu. There are seven species and two provenances for lodgepole pine - south and north coastal - from which to choose. If your tree species is not included, you can use a best approximation, for example Japanese larch for hybrid larch or Sitka spruce for grand fir.

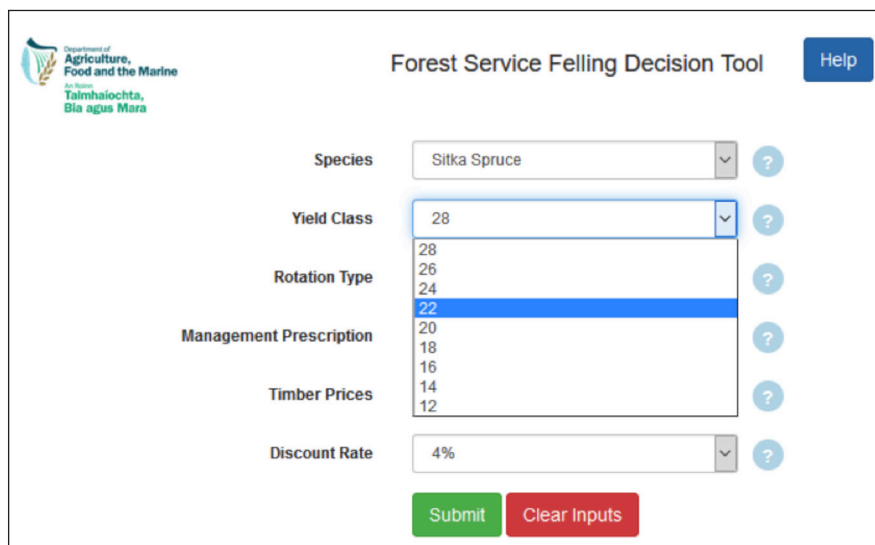


Yield class:

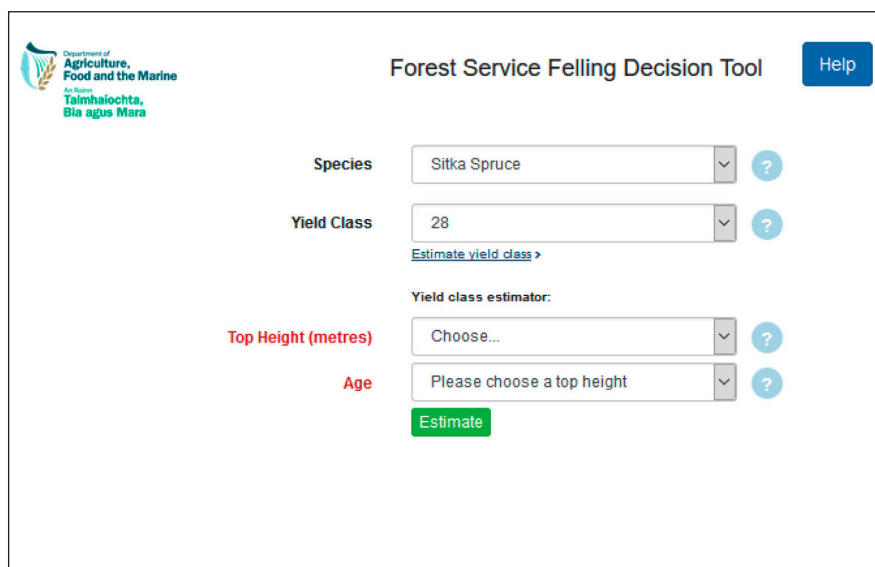
Once the user has selected a species, the next requirement is for a yield class (see Appendix 1 on estimating yield class). The range of possible yield classes depends on the species selected. For example if Sitka spruce is selected the user is required to select a yield class from 14 to 28 while if Japanese larch was the chosen species, the yield class range is from 6 to 14.

If you do not know the yield class or are unsure, then click on the *Estimate yield class* and you will be prompted to choose a top height from a drop-down menu. The range of top heights depends on the species selected and are shown in increments of 0.5 metres from a starting value of 4 metres.

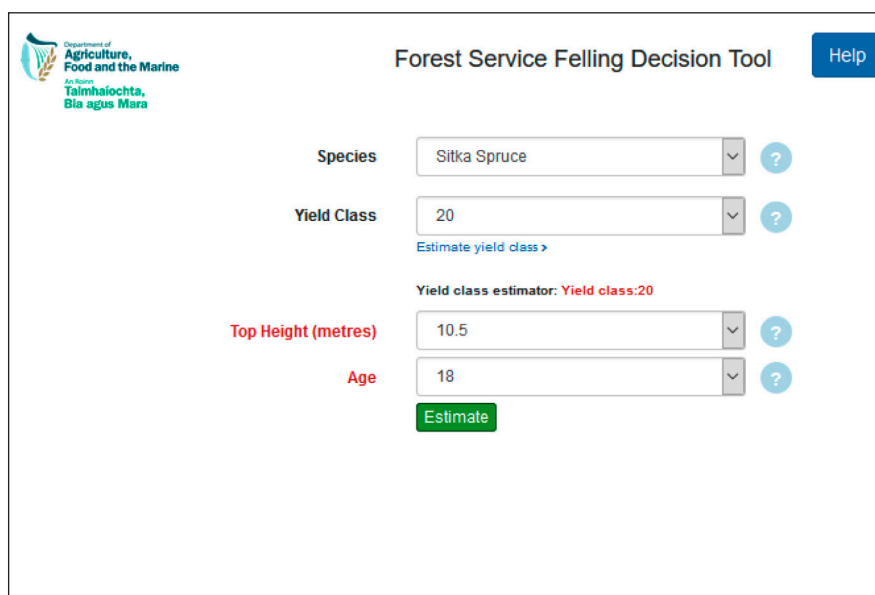
When you are finished using the yield class estimator click on the *Estimate yield class* to close the application.



The screenshot shows the initial state of the 'Forest Service Felling Decision Tool'. The 'Species' dropdown is set to 'Sitka Spruce'. The 'Yield Class' dropdown is open, showing a list of values: 28, 26, 24, 22, 20, 18, 16, 14, and 12. The 'Rotation Type' dropdown is also open, showing the same list of values. The 'Management Prescription' dropdown is set to '20'. The 'Timber Prices' dropdown is set to '4%'. The 'Discount Rate' dropdown is set to '4%'. There are 'Submit' and 'Clear Inputs' buttons at the bottom.



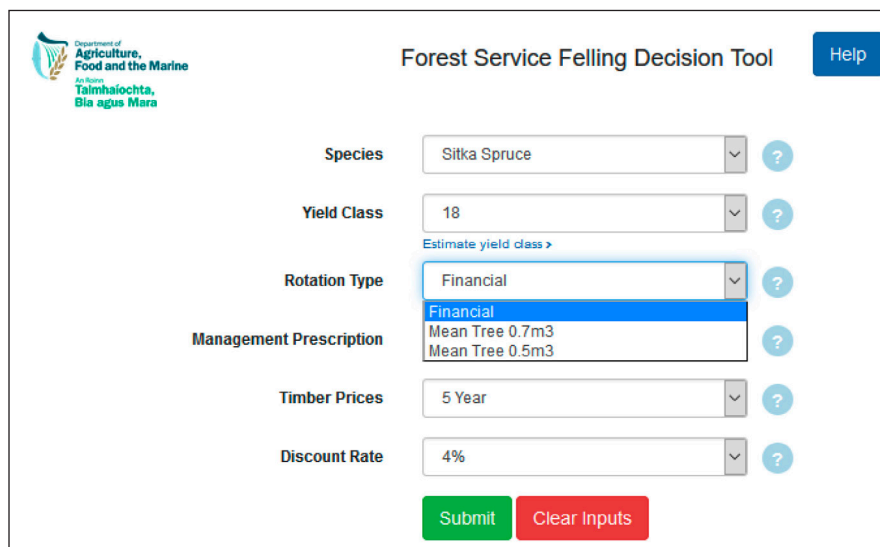
The screenshot shows the 'Yield class estimator' screen. The 'Species' dropdown is set to 'Sitka Spruce'. The 'Yield Class' dropdown is set to '28'. There is a link 'Estimate yield class >'. The 'Yield class estimator:' section has a 'Top Height (metres)' dropdown set to 'Choose...' and an 'Age' dropdown set to 'Please choose a top height'. There is an 'Estimate' button at the bottom.



The screenshot shows the final state of the 'Forest Service Felling Decision Tool'. The 'Species' dropdown is set to 'Sitka Spruce'. The 'Yield Class' dropdown is set to '20'. There is a link 'Estimate yield class >'. The 'Yield class estimator:' section has a 'Top Height (metres)' dropdown set to '10.5' and an 'Age' dropdown set to '18'. There is an 'Estimate' button at the bottom.

Rotation type:

Click on *Rotation type* and choose a rotation from the drop-down menu. The financial rotation will provide the maximum return to the owner. However it may not be possible to grow the crop to this age due to crop stability or the owner's requirement for cash sooner. The 0.7 m³ rotation will provide a mean tree volume of 0.7 m³ at the time of clearfell. This rotation will in general be shorter for most yield classes especially if the crop has been being thinned. The 0.5 m³ rotation will result in a mean tree of this size at time of clearfell. The rotation will be shorter than either the financial or 0.7 m³ rotations but will also result in significantly lower clearfell revenues.

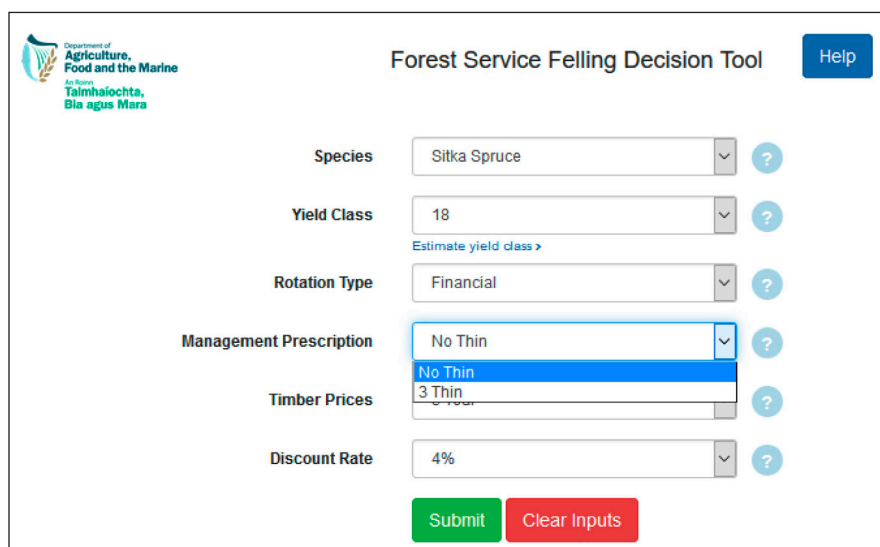


The screenshot shows the 'Forest Service Felling Decision Tool' interface. The 'Rotation Type' dropdown menu is open, showing options: 'Financial', 'Mean Tree 0.7m3', and 'Mean Tree 0.5m3'. The 'Financial' option is highlighted. Other fields include 'Species' (Sitka Spruce), 'Yield Class' (18), 'Timber Prices' (5 Year), and 'Discount Rate' (4%). There are 'Submit' and 'Clear Inputs' buttons at the bottom.

Field	Value
Species	Sitka Spruce
Yield Class	18
Rotation Type	Financial
Management Prescription	Financial Mean Tree 0.7m3 Mean Tree 0.5m3
Timber Prices	5 Year
Discount Rate	4%

Management prescription:

Click on *Management prescription* and choose a regime from the drop-down menu. The possible thinning regimes depend on the species selected. They include no thinning, 3 thin, regular thinning (thinning every five years) and crown thinning. All of the thinnings assume marginal thinning intensity, which is defined as the maximum thinning volume that can be removed without impacting on the volume production of the stand. If your thinning regime is not present, then select the nearest approximation. For example, if you plan to thin your crop twice, then select the 3 Thin regime.

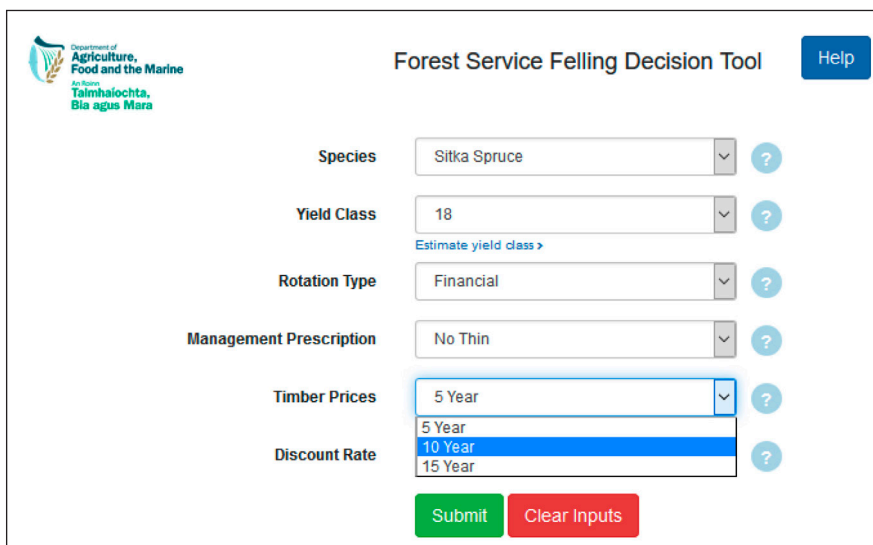


The screenshot shows the 'Forest Service Felling Decision Tool' interface. The 'Management Prescription' dropdown menu is open, showing options: 'No Thin', '3 Thin', and '5 Year'. The 'No Thin' option is highlighted. Other fields include 'Species' (Sitka Spruce), 'Yield Class' (18), 'Rotation Type' (Financial), 'Timber Prices' (5 Year), and 'Discount Rate' (4%). There are 'Submit' and 'Clear Inputs' buttons at the bottom.

Field	Value
Species	Sitka Spruce
Yield Class	18
Rotation Type	Financial
Management Prescription	No Thin 3 Thin 5 Year
Timber Prices	5 Year
Discount Rate	4%

Timber Prices:

Click on *Timber prices* and choose a price from the drop-down menu. The choice of timber price will impact directly on the estimates for thinning and clearfell revenues. If your crop is relatively young then you should select the 15-year average prices. Alternatively if your crop is between 15 to 25 years old then select the 10-year average prices, and for older crops choose the 5-year average prices. Note that the timber prices are based on mainly thinned crops and may overestimate revenues for no thin stands.

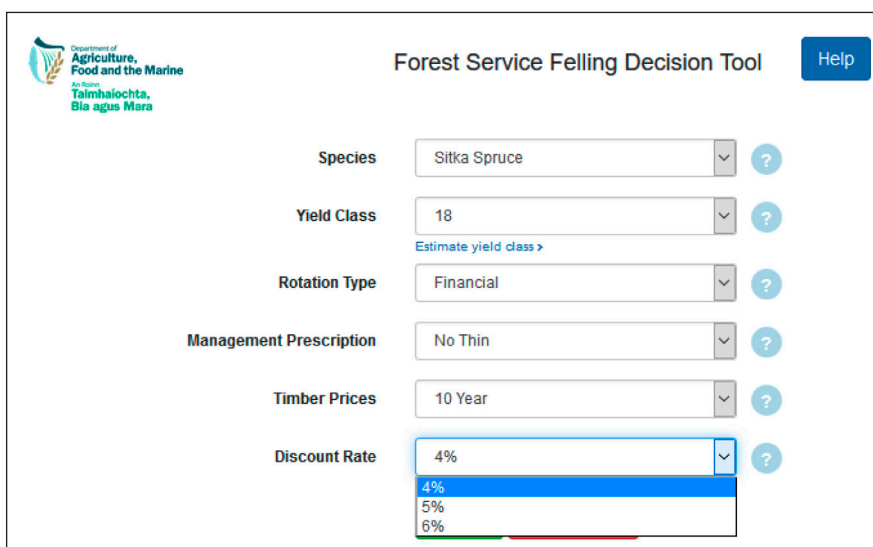


The screenshot shows the 'Forest Service Felling Decision Tool' interface. It includes a logo for the Department of Agriculture, Food and the Marine (An tAonad Talmhaíochta, Bia agus Mara) and a 'Help' button. The input fields are: Species (Sitka Spruce), Yield Class (18), Rotation Type (Financial), Management Prescription (No Thin), Timber Prices (5 Year), and Discount Rate (5 Year). The 'Timber Prices' dropdown is open, showing options for 5 Year, 10 Year, and 15 Year. There are 'Submit' and 'Clear Inputs' buttons at the bottom.

Discount rate:

The discount rate is used with the timber revenues to determine the optimum financial rotation. The discount rate expresses the owner's time preference for funds and their perception of risk. The discount rate has no effect on thinning or clearfell revenues, only on discounted revenues. Traditionally a 5% rate has been used in Irish forestry. A higher rate will shorten the financial rotation while a lower rate will have the opposite effect.

Once the user has selected the species, yield class, management prescription, timber prices and the discount rate, then click on the *Submit button* to retrieve the required results from the felling decision database.



The screenshot shows the 'Forest Service Felling Decision Tool' interface with the same inputs as the previous one, but with 'Timber Prices' set to '10 Year' and 'Discount Rate' set to '4%'. The 'Discount Rate' dropdown is open, showing options for 4%, 5%, and 6%. The 'Submit' button is highlighted in green.

Results

The results show the user input values across the top row and below this the financial rotation, age of maximum mean annual increment (MMAI) and the estimate of clearfell revenue for the chosen management prescription. Then depending on the rotation, the results show the estimated crop values if felled up to ten years before the rotation age and up to five years after this age.

The estimates of thinning and clearfell volumes are shown net of average reductions for open space (roads and unproductive areas) and harvest losses. The estimates of thinning and clearfell revenues are shown net of reductions for the estimated cost of sales.

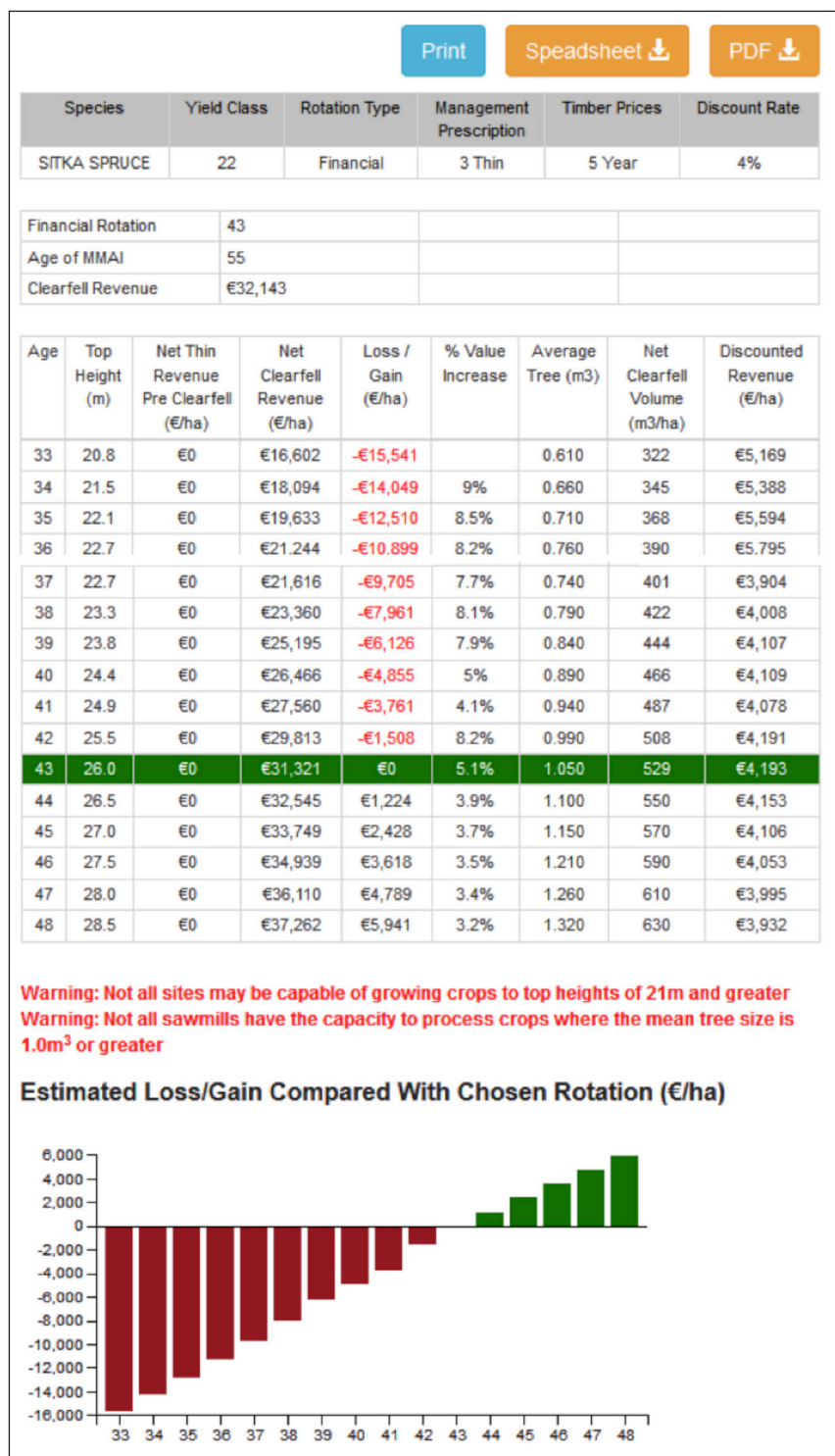
The estimated net clearfell revenue per hectare is shown together with the gain or loss if the crop is felled earlier or later. For example if the owner wished to fell the crop at age 33 then the estimated clearfell revenue per hectare is €16,602. However the crop at this age is increasing significantly in value year-on-year and delaying the fell decision for even another three years will result in an estimated increase in net revenue of €4,642 per hectare.

Directly below the table of results, the graph illustrates the implication of felling earlier or later than the chosen rotation.

Based on the results, the owner can now make a more informed decision on whether to fell the crop or retain for a further number of years. The % value increase provides an indication of the return the crop is making by retaining it for another year. As mentioned previously the revenue values are estimated based on average prices and the values achieved by individual plantations may vary significantly depending on timber quality, access, distance to mill etc.

The estimated top height and average tree size are shown for each of the sixteen years of results. The results will issue a warning where the top height exceeds 21 metres and/or where the mean tree size exceeds 1.0 m³ at the rotation age.

In the event that the growth model does not go as far as the rotation, then the results show the final ten years of available information.



Exporting results

If the user wants to retain the inputs and results for further use or to adjust the results then they can click on the *Spreadsheet* button and will be prompted to select either to open the results in MS Excel or to save the file for further use. If you want to export the results to a pdf (portable document format) file, then click on the *PDF* button. In this instance only the table of results and not the graph will be exported.

Alternatively the user can print the results by clicking on the Print button. Once the results have been printed, click on the *Close* button to return to the main screen

Species	Yield Class	Rotation Type	Management Prescription	Timber Prices	Discount Rate	
SITKA SPRUCE	22	Financial	3 Thin			
Financial Rotation		43				
Age of MMAI		55				
Clearfell Revenue		€32,143				
Age	Top Height (m)	Net Thin Pre Clearfell (€/ha)	Net Clearfell Revenue (€/ha)	Loss / Gain (€/ha)	% Value Increase	Ave Tree
33	20.8	€0	€16,602	-€15,541	0.0	0.0
34	21.5	€0	€18,094	-€14,049	9%	0.0
35	22.1	€0	€19,633	-€12,510	8.5%	0.0
36	22.7	€0	€21,244	-€10,899	8.2%	0.0
37	23.2	€0	€23,051	-€9,092	8.5%	0.0
38	23.8	€0	€24,771	-€7,372	7.5%	0.0
39	24.4	€0	€25,922	-€6,221	4.6%	0.920
40	24.9	€0	€27,580	-€4,563	6.4%	0.970
41	25.5	€0	€29,625	-€2,518	7.4%	1.030
42	26.0	€0	€30,891	-€1,252	4.3%	1.090
43	26.5	€0	€32,143	€0	4.1%	1.140
44	27.1	€0	€33,376	€1,233	3.8%	1.200
45	27.6	€0	€34,595	€2,452	3.7%	1.260
46	28.1	€0	€35,795	€3,652	3.5%	1.310
47	28.6	€0	€36,970	€4,827	3.3%	1.370
48	29.0	€0	€38,131	€5,988	3.1%	1.430

Appendix 1: Yield class

Yield class is an index of the potential productivity of even-aged stands. It is based on the maximum mean annual increment achieved by a given tree species growing on a given site and managed according to a standard management prescription. It is measured in units of cubic metres per hectare per year.

The top height of a stand is the average total height of the 100 largest diameter trees per hectare. Usually, top height is assessed by measuring the heights of a number of sample trees throughout the plantation with the number depending on the area and amount of variability in the crop.

The top height is then compared with age and the yield class read from the relevant table.

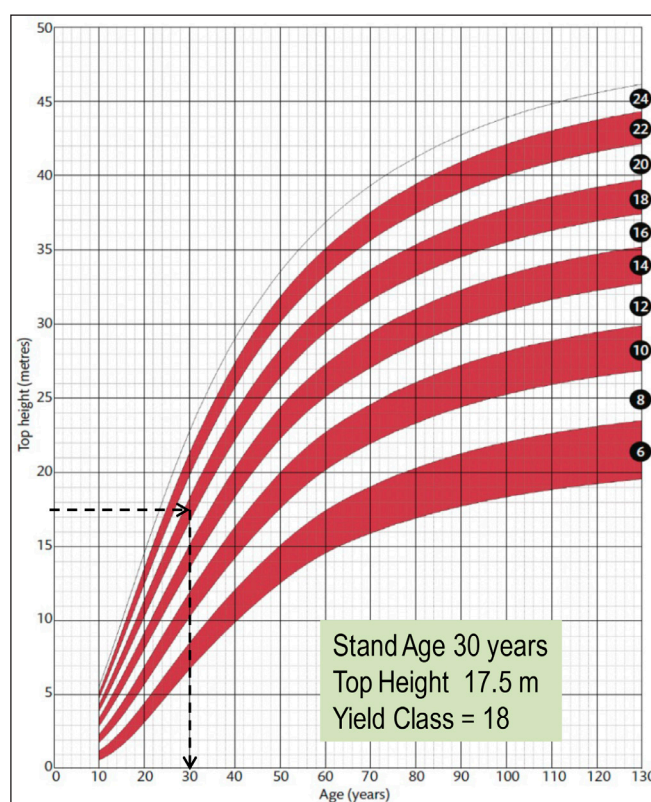


Figure 1: Figure 2 Top height v age curves for Sitka spruce⁵

⁵ Matthews, R.W., Jenkins, T.A.R., Mackie, E.D. and Dick, E.C. (2016). *Forest Yield: A handbook on forest growth and yield tables for British forestry* Forestry Commission, Edinburgh. i-iv + 1-92pp