PROSIECT CARTREFI O BREN LLEOL
THE HOME-GROWN HOMES PROJECT

03 Economic aspects of woodland creation for timber production

Revenue from forestry enterprises

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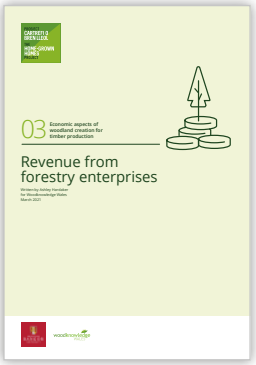

Guidance

This document is part of a series of *guidance notes* aiming to provide practical information for farmers and other landowners interested in investing in forestry. It is designed to help develop a first understanding of economic evaluation of afforestation projects. As such it introduces the basic steps involved in the assessment of such projects to allow some preliminary due diligence when considering an investment in forestry. This does not replace a full assessment and advice by a chartered forest manager.

There are six documents in this series

01 Financial evaluation of afforestation projects - basic steps

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An important reason why farmers and other landowners invest in afforestation projects such as planting woodlands to produce timber is to derive financial revenues. Simply put, revenues are the positive half of generating a profit. Financial revenues primarily accrue from the sale of timber, however there are other revenue streams that farmers and landowners may tap into by planting a woodland. The second step in a financial evaluation of an afforestation project (as outlined in *Financial Evaluation of Afforestation Projects - Basic Steps*) is to estimate the potential revenues that may be generated. Estimating the revenues from afforestation is a difficult task due to production and market uncertainties, with timber revenues being variable based on woodland type, species, site conditions and management prescriptions. In this guidance note we will introduce how to estimate the revenues from forest products and some strategies to increase them.

Revenues from forest products

The concept of *total revenue* (number of units of output × price per unit of output) is the most relevant one in decisions about whether a course of action (e.g., planting a woodland) is a worthwhile undertaking or not. The ultimate source of commercial revenue from a production forestry enterprise is the sale of *forest products*, i.e., usually the sale of standing or harvested timber. The total revenues are based on the amount of timber produced (units of output) by the woodland and the price that timber can be sold for (price per unit of output).

Estimating future timber production

Timber is typically sold by volume and its measurement is expressed in cubic metres (m^3); in some cases, it might be sold by weight. The expected volume of harvestable timber from a plantation woodland is a product of six main factors:

1. Species
2. Productivity or *yield class* (See Box 1).
3. Area
4. Initial tree spacing
5. Proposed management
6. Age at harvesting (rotation length)

Yield tables provide information about the potential tree growth and productivity of a plantation woodland based on these six main factors and are crucial in evaluating the potential revenues from forest products. The principal source of yield tables for use in British forestry is *Forest Yield* (Forestry Commission Software), which provides estimates of tree growth for a range of tree species, planting spacings, yield classes and rotation lengths. Yield tables display values for a variety of outputs, however the values of interest when forecasting future timber production are *stand age* and *volume per hectare*. These provide an estimate of the amount of harvestable timber at the chosen age of harvesting. In the example evaluation in *Financial Evaluation of Afforestation Projects - Basic Steps*, the yield tables for *mixed conifer*s estimated the harvestable volume of timber for the upland option as 611 m^3 (at a stand age of 50 years and a yield class of 14) and the lowland option as 494 m^3 (at a stand age of 40 years and a yield class of 16).

It should be noted that actual production will differ from forecasted estimates because no woodland will grow exactly as predicted and the actual management of a woodland is unlikely to be exactly as planned when carrying out the initial financial evaluations of the project.

Box 1: Yield class

Yield class is a measure of the potential productivity of stands of even-aged trees. It is based on the maximum mean annual increment of cumulative timber production for a given tree species on a given site and managed in line with a standard management prescription. Simply put, it is a measure of the maximum amount of annual solid trunk growth by an area of trees. Yield class is measured in terms of cubic metres per hectare per year (m^3 ha^{-1} $year^{-1}$). So, a stand that is yield class 16 is capable of growing 16 m^3 ha^{-1} $year^{-1}$ over its lifetime. Estimated yield classes for different species on a given site can be derived from the Forest Research *Ecological Site Classification tool*.

Timber prices

Timber sales data from the private sector is not widely disseminated, but it is collated across the public forest estate from monitoring of the average price received by Forestry England, Forestry and Land Scotland, and Natural Resources Wales. The prices of timber received by the public forest estate can be found in *Forestry Commission Timber Price Indices*. These give a reasonable indication of prevailing timber prices for conifer crops. Timber prices are based primarily on two distinct categories or types of sale, these are:

1. Coniferous standing sales where timber is sold standing in the woodland and the purchaser is responsible for harvesting. As at September 2020 these types of sales were returning an average price of £27 per m^3.

2. Coniferous sawlog sales where roundwood is sold at the roadside after harvesting by the seller. As at September 2020 these types of sales were returning an average price of £50 per m^3.

Depending on species and quality, broadleaf prices will either be similar to coniferous standing sales if it is going into the firewood or biomass market or significantly higher if it is a quality hardwood destined for processing by a sawmill and use in construction or furniture making. Broadleaf timber prices are unfortunately not documented like coniferous timber prices, which makes the estimation of timber revenues from hardwoods problematic.

Given that no woodland grows as expected, when it comes to felling a plantation, a mix of small and large logs will be harvested. In practice, this means that at the time of harvest, the actual prices paid for your timber may differ from those forecasted on the basis of average prices (such as those above). This is due to the *price-size relationship* (see Box 2).

Box 2: Price-size relationship

The price of timber depends on the end use and the likely processing costs. Generally, the bigger the log, the more potential end uses there are. A large sawlog (typically destined for boards and planks) could be used for pulp, but a small diameter log (typically destined for pulp and other composite products) can't be sawn into planks or boards. Larger logs typically have lower conversion losses, so the number of final products from one large log is usually more than the same total volume of many small logs. Typically, the price per m^3 of standing timber begins to decline as the mean volume of individual trees falls below 0.4m^3.

Strategies for improving revenues from forestry enterprise

In the example evaluations provided in *Financial Evaluation of Afforestation Projects - Basic Steps* the indicative revenues used in the calculation of the net present values (NPV) of an afforestation project were based on selling un-thinned timber standing in the forest. The revenue from a forestry enterprise (and hence the NPV of the afforestation option) can be improved using four strategies as set out in Table 1:

1. Increase the quantity of the output,
2. Improve the marketing of the output,
3. Change the timing of production of the output,
4. Diversify the revenue stream.

Based on the two afforestation options (upland and lowland planting schemes) used previously, Table 1 provides more information on each of the four strategies to improve the revenues from forest production and the *net present values.* It explains how these four strategies can be incorporated into the discounted cash flow.

Table 1: Strategies for improving revenues from forestry enterprises

Strategy	Description	Incorporation into discounted cash flow
Increase quantity of output	The quantity of output from a plantation woodland can be increased by allowing the plantation to mature beyond the end of the planned rotation length and delaying harvesting. However, this does delay the production of the output, which will have a negative effect on the NPV unless the increase in quantity of output is sufficient to overcome the effects of discounting.	In the cash flows highlighted in green in Table 2, sale of timber was delayed by ten years. The timber volumes for the upland option are now based on a stand age of 60 years, which increases harvestable timber volumes from 594 m^3 per hectare to 744 m^3 per hectare. The timber volumes for the lowland option are now based on a stand age of 50 years, which increases harvestable timber volumes from 494 m^3 per hectare to 687 m^3 per hectare.
Improve the marketing of output	The marketing of output from a plantation woodland can be improved by selling the timber after harvesting at the roadside, rather than standing timber (before harvesting). Opting to sell harvested timber at the roadside will incur additional harvesting costs of around £15 per m^3 (for more information see *Evaluating the financial costs of forestry*).	In the cash flows highlighted in blue in Table 2, timber is now projected to be sold at £45 per m^3 (based on a standing sale price of £50 per m^3 less £15 per m^3 cost of harvesting).
Change the timing of output	The timing of outputs from a plantation woodland can be changed by thinning the timber crop to generate some incomes earlier in the rotation. Yield tables for thinned stands can be found in *Forest Yield*. Planting schemes for commercial timber production will typically be thinned twice, with the first being a *systematic* thin usually taking out one row of trees in three and the second thin being selective taking out trees that are supressed, sub-dominant or of poor form. For more information on thinning see *Thinning Practice: A Silvicultural Guide*. Bringing forward or delaying the final harvest of the crop is another example of changing the timing of output.	In the cash flows highlighted in yellow in Table 2, the timings of revenues from timber are altered to reflect thinning operations. Thinning the upland option produces 50 m^3 per hectare of harvested timber in year 26, 49 m^3 per hectare in year 32 and 430 m^3 per hectare at final harvest in year 50. Thinning the lowland option produces 56 m^3 per hectare in years 25 and 30 followed by 346 m^3 per hectare at final harvest in year 40.
Diversify revenue streams	Increasingly, markets for environmental benefits are becoming an important source of alternative revenue from woodlands. Carbon sequestration is the only environmental benefit currently tradeable in the UK. The Woodland Carbon Code provides a market for credits for the carbon that will be sequestered by afforestation projects. Credits for a tonne of carbon that is going to be sequestered by an afforestation project are called *pending issuance units* (PIU). The amount of PIUs available to be sold by a project depends on independent verification (which does incur a cost of around £1,000 per project).	In the cash flows highlighted in orange in Table 2, additional revenues from the sale of PIUs are added in. The upland conifer option will generate 184 PIUs over the 50-year rotation and the lowland conifer option will generate 182 PIUs over the 40-year rotation. PIUs and are currently selling for around £7 per PIU and can be sold are soon as the project is verified (this could be straight after trees are planted). In the discounted cash flow below, these have been scheduled for sale in year 2 at a price of £7 per PIU.

The improved or alternative revenues from these four strategies can easily be swopped into the discounted cash flow as shown in Table 2. For comparison, the NPV of the upland option is £2,899 per hectare and the NPV of the lowland option is £3,178 per hectare based on the projected revenues and estimated costs for the two example planting schemes outlined in *Financial Evaluation of Afforestation Projects - Basic Steps*.

Table 2: Modified discounted cash flow (£ per hectare). Present value (PV) of revenues and costs are calculated using a discount rate of 3%.

Year	Description	Upland conifer option				Lowland conifer option			
		PV costs[1]	PV grants	Revenues	PV revenues[2]	PV costs[1]	PV grants[1]	Revenues	PV revenues[2]
1-4	Fencing, ground prep, planting, weeding and beating up	8,675				8,675			
1-12	Fencing, planting, maintenance and premium payment		9,194				9,194		
50	Timber maincrop (lowland option)							12,057	2,750
60	Timber maincrop (upland option)			13,057	2,216				
40	Timber maincrop (lowland option)							14,563	4,465
50	Timber maincrop (upland option)			17,647	4,026				
25	Timber first thinning (lowland option)							1,000	478
26	Timber first thinning (upland option)			878	407				
31	Timber second thinning (lowland option							983	405
32	Timber second thinning (upland option			860	334				
40	Timber maincrop (lowland) option)							5,914	1,813
50	Timber maincrop (upland option)			7,371	1,681				
2	Carbon sales			1,407	1,366			1,274	1,237
40	Timber maincrop (lowland option)							8,670	2,658
50	Timber maincrop (upland option)			10,425	2,378				

Summary		Upland conifer option	Lowland conifer option
Increase quantity of output	Total present value of costs	8,675	8,675
	Total present value of grants payments	9,194	9,194
	Total present value of revenues	2,216	2,750
	Net present value	**2,737**	**3,271**
Improve the marketing of output	Total present value of costs	8,675	8,675
	Total present value of grants payments	9,194	9,194
	Total present value of revenues	8,675	8,675
	Net present value	**4,026**	**5,833**
Change the timing of output	Total present value of costs	8,675	8,675
	Total present value of grants payments	9,194	9,194
	Total present value of revenues	2,422	2,696
	Net present value	**2,943**	**3,216**
Diversify revenue streams	Total present value of costs	8,675	8,675
	Total present value of grants payments	9,194	9,194
	Total present value of revenues	3,744	3,895
	Net present value	**4,265**	**4,415**

[1] The present values of costs and grant payments are taken from the discounted cash flow in Guidance note one. For an explanation of these costs refer to that note.

[2] The present values of revenues are calculated using the formula: PV = [value of future revenue or cost] / [(1 + discount rate expressed as decimal number) ^ year into the future]

All four of the strategies would improve the revenues and ultimately increase the *net present value* of the lowland option. All of the strategies (except increasing output by delaying harvesting) would improve the revenues and ultimately increase the net present value of the upland option. Based on this example, diversifying income streams by selling carbon is the best strategy for the upland options and improving the marketing of output is the best strategy for the lowland option.

Practical Guidance & Advice

In this guidance note we have demonstrated how revenues from forestry products are estimated for afforestation projects. The strategies for improving revenues from forestry enterprises presented here are applicable to a wide variety of projects. We hope that this will help you undertake some preliminary due diligence when considering whether to adopt a forestry enterprise or invest in an afforestation project. Before making the final decision we recommend seeking further advice and guidance from a *forest manager or agent*.

You can find more detailed information on financial evaluations of forestry investments *here*:

01 Financial Evaluation of Afforestation Projects - Basic Steps
02 Evaluating the Financial Costs of Forestry
03 Revenue from Forestry Enterprises
04 Accounting for Time
05 Alternative Tools for Financial Evaluation of Forestry
06 Incorporating Uncertainty and Risk

Technical Information

Ecological Site Classification (Forest Research) online tool is available at *www.forestdss.org.uk/geoforestdss*

Forest Yield (Forestry Commission) software is available at *www.forestresearch.gov.uk/tools-and-resources/forest-yield*

Timber Price Indices. Data to September 2020. Forest Research 2020. Available at *www.forestresearch.gov.uk/tools-and-resources/statistics/statistics-by-topic/timber-statistics/timber-price-indices*

Thinning Practice: A Silvicultural Guide. Kerr, G. and Haufe, J. Forestry Commission 2011

More information on the Woodland Carbon Code and the carbon calculator can be found at *www.woodlandcarboncode.org.uk*

About the author
Ashley Hardaker is an interdisciplinary researcher at Bangor University interested in decision analysis in relation to land use, forestry, agroforestry and agricultural systems. He is particularly interested in research to inform decision making surrounding woodland creation in agricultural systems and how they can be designed to deliver public and private economic benefits. He engages with a range of research disciplines including ecosystem services, GIS, economics and operations research. The author is grateful for contributions to these briefing notes from Prof. John Healey of Bangor University

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