A Financial Appraisal of Sitka Spruce

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ABSTRACT

An economic appraisal of a range of yield classes of Sitka spruce is presented. The effect of different assumptions of timber price, discount rate and grant structure is shown. The quality of Sitka spruce as a structural timber is discussed. It is concluded that the timber from crops now reaching clearfell age is of satisfactory strength.

A comparison is made between the return from forestry and agriculture. Forestry is shown to be more profitable than agriculture on a large proportion of the soils that are marginal for agriculture.

INTRODUCTION

The capability of Irish land to grow trees satisfactorily has been demonstrated in established plantations over a range of different site types. The growth rates are very impressive being 3 to 4 times the European average. The wet mineral soils are particularly productive as shown in the Leitrim Resource Survey (1973-1979) where 70 per cent of the land was described as yield class 24 or greater.

In Ireland the development of forestry depends on the transfer of land from agriculture. The economics of forestry in Ireland are therefore quite different from those nations with a long forestry tradition as bare land afforestation requires significant capital investments and a long delay before any returns are obtained. In the already afforested areas of Europe the cost of reforestation can be funded from the sale of the previous crop.

The economics of forestry can be examined from many different aspects. These include primary production, downstream developments, provision of employment and import substitution amongst others. This paper concentrates on the economics of forestry from the view point of the primary producer.

The objective of this paper is to provide a framework for estimating the expected return from afforestation of different site types. Estimating the returns from an investment that takes about forty years to mature will, inevitably, depend on many assumptions. It is important that these are appropriate to the particular situation before the conclusions apply.

BASIS FOR THE ANALYSIS

The analysis involves the generation of a cash flow of costs and revenue for the complete crop rotation. The revenue is developed

from estimates of timber yield and size classification together with estimates of wood price, while costs are derived from work study estimates. Direct costs only have been included.

Timber yield

Sitka spruce (Picea sitchensis Bong (Carr)) is the species considered. Yield Tables (Hamilton and Christie (1971)) are used to estimate the volume and breakdown by size class of material from each thinning and clearfelling. Implicit in these tables is the assumption that crops are planted at approximately 1.8 metres spacing and that selective thinning to marginal intensity is carried out. These assumptions differ from current practice in that initial spacing is at least 2 x 2 metres and first line thinning is common. It is considered that the deviation from current practice is sufficiently small to justify using the yield tables. Further, the importance of the analysis is to show the relative importance of different factors such as yield class and price.

The area by yield class for Sitka spruce grown in Forest and Wildlife Service plantations is shown in Table 1. This indicates the relative amounts of the different yield classes expected over a great range of marginal to sub-marginal agricultural land.

Table 1: Percentage area of Sitka spruce by yield class on Forest and Wildlife Service land.

Yield Class (m^3 per hectare per annum)	% Area	Yield Class (m^3 per hectare per annum)	% Area
< 12	18.4	18	14.6
12	11.7	20	11.4
14	14.2	22	7.0
16	14.0	24 +	8.7

Timber prices

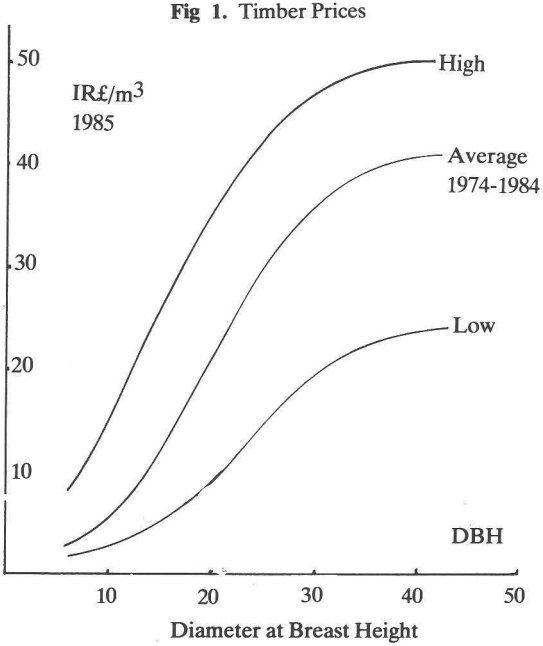
Timber prices, like many raw material prices fluctuate very significantly from year to year. However, an examination of these indicates a relatively stable pattern in the long term. Many forecasts of demand for timber products published in the recent past agree that demand will continue to exceed supply in both Britain, which is our nearest and largest market and in the rest of the European

Economic Community. Further, many of these studies predict that timber prices will at least keep pace with inflation. These analyses include the World Bank (Helterline (1979)), the United States Department of Agriculture (1982), the Economist Intelligence Unit (1981), the Centre for Agriculture Strategy (1980) and the British Forestry Commission (1977).

The assumption can therefore be made that the long term trend of future prices remain the same as in the past. To arrive at the historical level, the prices over a long period are averaged in order to eliminate short term fluctuations. The longer the period the data spans the less likelihood that short term flunctuations will distort the trend.

For the present analysis the average price of all Forest and Wildlife Service (FWS) sales from 1974 to 1984 was calculated. (This was the only period where complete data were available). The consumer price index was used to update the data to 1985 price levels. As timber price is of such importance to the analysis, two alternative prices were used in order to demonstrate the sensitivity of the results to different timber price levels. The highest and lowest prices prevailing between 1974 and 1984 were obtained using the same techniques. The central and the two extreme prices are shown in Figure 1.

Fig 1. Timber Prices



Costs

The relative costs of all operations have been assumed to keep pace with timber prices therefore the effect of inflation can be ignored. Costs of the various forest operations throughout the rotation have been derived from work study estimates in the FWS. These are the costs prevailing in 1985.

The costs are those appropriate for a mineral site type. These costs will vary depending on the circumstances, e.g. need for roading, fencing, etc. However, a central assumption of mean difficulty has been taken (Table 2).

Table 2. Sitka spruce cash flow yield class 20

Year	Operation	Cost (1985 £)	Revenue (1985 £)
0-40	Annual maintenance cost	15	—
0	Establishment	1,218	—
1	Vegetation control	94	—
2	Filling in	11	
17	Road construction	359	
18	Brashing	118	
19	Pruning	268	
19	1st thinning — net return		539
20	Drain and road repair	47	
22	General maintenance	29	
24	Pruning	236	
24	2nd thinning		660
25	Road and drain repair	47	
27	General maintenance	29	
	3rd thinning		992
30	Drain and road repair	47	
32	General maintenance	29	
34	4th thinning		1,513
35	Drain and road repair	47	
40	Clearfelling		12,715

Establishment procedure assumed is as follows

Site ripped.
Fertilising with 250kg unground mineral phosphtate.
Chemical vegation control using tractor mounted sprayer.
Fencing at a density of 70 metres per hectare.

Discounting

As most investors prefer to receive income now rather than later the concept of discounting is used to adjust all costs and revenue taking account of their timing. This reduces the value of all future costs and revenues by the appropriate rate of interest compounded for each year's delay. As cost and revenue are expressed in real terms, the real interest rate (net of inflation) must also be used. The selection of interest rate will however depend on the investor's attitude to delay. An individual with limited resources will be inclined to use higher interest rates, whereas an investor with spare investment capital will tend to use a lower interest rate. The discount rate used by the State in appraisal of forestry is 4 per cent. (the case for forestry (1980, revised 1983)).

Analysis

A sample cash flow for one hectare of yield class 20 Sitka spruce as shown in Table 2 forms the basis for the analyses.

Net discounted revenue (NDR) for a single rotation of Sitka spruce is shown in Table 3. The central timber price assumption has been taken and no allowance made for grants to private growers. The critical effect of yield class is obvious with NDR values at 4 per cent discount rate increasing from –£1,196 for yield class 8 to £3,241 for yield class 24. The price of yield class 24 land is in the region of £1,200 per hectare more than that of yield class 8. There is therefore an increased profit of over £4,000 for an increased investment of £1,200.

The internal rate of return, which is the rate where discounted costs equal discounted revenues, increases from 1 per cent for yield class 8 to 7.5 per cent for yield class 24. This represents a real rate of return over and above inflation of up to 7.5 per cent

Table 3. Returns from a single rotation of Sitka spruce central timber price assumption.

Yield Class (m^3 per hectare per annum)	Discount Rate %					Internal Rate of Return (%)
	2	3	4	5	6	
8	–501	–954	–1196	–1335	–1411	1.2
12	1436	335	–349	–775	–1041	3.5
16	3996	2116	891	91	–443	5.2
20	5413	3249	1781	780	94	6.2
24	7743	5104	3241	1920	979	7.5

Effect of Timber Prices

Predicting timber prices for periods up to 40 years or more is uncertain. The demonstration of how sensitive the results are to different timber prices can help in evaluating the investment. In order to show their effect on the returns the NDR is calculated for the three timber prices, the medium price, which is taken as the most likely to occur, together with two extremes (Table 4).

Table 4. Effect of different timber prices on returns from Sitka Spruce.

Yield Class (m^3 per hectare per annum)	Net discounted revenue assuming 4% discount rate (£ 1985 per hectare)		
	High Timber Price	Medium Price	Low Price
8	–464	–1196	–1656
12	909	–349	–1313
16	2625	891	–550
20	3860	1781	–361
24	5857	3241	386

The effect is seen as significant with the breakeven yield class ranging from approximately 10 to 22 cubic metres per hectare per annum. The two extreme prices are however based on only one year's data, while the medium price is made up from sales over eleven years. The results indicate also the dangers of using a single year's price data as short term fluctuations may lead to distortions in the results.

Several Rotations and Price of Land

The analysis so far has taken account of one rotation only and has not included land price. In Table 5 the returns from an infinite number of rotations are shown, both including and excluding the price of land. The effect of including many rotations is more significant for higher yield classes than it is for lower ones. This results from the shorter rotation length of the higher yield classes. In the case of yield class 24, the NDR at 4 per cent is increased from £3,241 to £4,667 per hectare or 44 per cent.

Land price has been assumed to range from £50 for yield 8 to £1,200 for yield class 24. This is an estimate of the current price for low-lying wet mineral soil (yield class 24) to poor mountain slopes

Table 5: Returns from an infinite number of rotations (Central price assumption).

Net Discounted Revenue 4% Discount Rate (£ 1985 per hectare)

Yield Class	NDR (4%) (Land price excluded)	NDR (4%) Including land price)
8	–1383	–1433
12	–415	–632
16	1084	602
20	2355	1527
24	4667	3422

(yield class 8). There is a significant range in land prices within equally productive forest sites. This will be influenced by location, state of development of the land or other local reasons. This paper only deals with one assumption on land prices.

The increase in profit accruing from higher yield class crops more than compensates for the increased price payable for the better quality land.

Return to Private Investor

The returns to a private forestry investor are increased by availing of grants for afforestation. European Economic Community (EEC) funded grants under the Western Package scheme are available in nine western counties, while FWS grants are available in the rest of the country.

The Western Package grants are cost related representing 80 per cent of the establishment costs payable in two instalments: 75 per cent payable upon completion and 25 per cent four years after planting. FWS grants on the other hand are fixed and payable in three instalments.

Details of grants payable are shown in Table 6. The maximum grant of £800 per hectare is assumed in the case of Western Package areas.

Table 6: Grants available for private afforestation (£ 1985 per hectare)

Western Package Areas		Remainder of Country	
Year 0	600	Year 0	161
4	200	4	62
		8	86

The NDR assuming medium timber prices, infinite number of rotations and taking land prices into consideration is shown in Table 7. The cost of insurance is not included even though this would be a normal cost in private forestry. The effect of the grants on the results is very significant. In the case of the Western Package areas the breakeven yield class is approximately 10 while in the rest of the country, yield classes approximately 14 must be reached before a 4 per cent return on the investment can be achieved.

Table 7: Net return to Private Planters
(average timber prices, land price included, infinite rotations, cost of insurance not included).

Net Discounted Revenue (£ 1985 per hectare)

Yield Class (m^3 per ha. per annum)	Western Package Area	Remainder of Country
8	–612	–1156
12	356	–355
16	1855	879
20	3126	1804
24	5438	3699

WINDTHROW RISK

In some of the more productive wet mineral sites the risk of windthrow may necessitate either changing silvicultural treatment or tolerating wind damage. The silvicultural options include adopting a policy of not thinning and/or reducing rotation length. In Table 8 the effect of profitability of not thinning is indicated. In the

Table 8: Returns from alternative Management options.

Net discounted revenue from not thinning expressed as % of NDR from conventional thinning.

Yield Class (m^3 per ha. per annum	No Thin
24	89
20	90
16	95
12	130

case of the higher yield classes, thinned stands are significantly more profitable than unthinned ones. However as yield classes reduce, the economic benefits of thinning also reduce.

The high wind-risk period is when the crop has obtained vulnerable heights and this can be avoided by prematurely felling the crop. This will lead to reduced profits. The NDR at a range of ages expressed as a percentage of the NDR at the age of maximum mean annual increment is shown in Table 9. These data refer to thinned stands. The general trend is for NDR to increase as rotation is reduced by up to 10 years and then for NDR to reduce rapidly. This is compatible with the fact that the optimum rotation is less than the rotation of maximum volume production. After the optimum is reached however the NDR reduces very rapidly. In the case where no precautionary measures are taken windthrow may result in reduced rotation. Allied to the reduced NDR resulting from this reduced rotation is the possible loss due to damage to the stems by breakage.

Table 9: Returns from reduced rotation.

Net discounted revenue at 4% discount rate expressed as % of NDR at age of maximum mean annual increment (MMAI).

Yield Class	Age of MMAI	MMAI less 5 years	— 10 years	— 15 years
24	100	103	104	98
20	100	103	103	93
16	100	106	108	101

Damage caused by windthrow can in certain circumstances reduce the value of the timber to pulpwood prices e.g. if extensive breakage occurs. This is very site specific and will vary greatly depending on the circumstances. In the drastic situation where pulpwood prices prevail due to stem breakage significant losses may occur.

Wood Quality

The quality of Irish grown Sitka spruce will dictate its utilisation and therefore its price. Quality therefore has an important bearing on profitability. There has been some concern expressed at the

strength bearing capacity of fast-grown Sitka spruce. This results from the emphasis placed by the visual grading rules on ring-width as an indicator of strength. Visual grading, carried out under British standards, indicates that ring width of much of the higher yield class material is too great to be acceptable for structural purposes. This is especially true of wider spaced or very heavily thinned material.

A more recent study has been carried out by the Forest and Wildlife Service and the Institute for Industrial Research and Standards (Fitzsimons, B. F. and Picardo, V. (1986)). Crops now at clearfelling age were sampled by selecting 1,500 planks through the range of yield classes from yield classes 12 to 24 cubic metres per hectare per annum. These planks were graded visually under British rules (BS4978) — British Standards Institution (1973) and mechanically under BS5268 (Curry and Fewell (1981)). The results from the mechanical grading were very satisfactory as shown in Table 10. In the case of visual grading the results were much less satisfactory.

Table 10: Percentage Outturn from Mechanical Stress Grading.

	Percentage by grade		
Yield Class	M 75	M 50	Reject
12	90	4	6
16	95	2	3
20	88	6	6
24	87	6	7
Total	90	5	5

Note: For timber to pass the above strength categories it must attain 75 per cent and 50 per cent respectively of the strength of a 'defined' piece of the same species.

As machine grading is an objective measure of strength it seems that Sitka spruce, grown under the same regime as those crops now reaching clearfelling age, is sufficiently strong for structural load bearing purposes. The initial spacing of these crops was approximately 1.6—1.8 metres and thinning was carried out to marginal or lower intensity.

Returns from agriculture

The returns yielded by agriculture are tabulated in the Farm Management Survey published by the Agricultural Institute

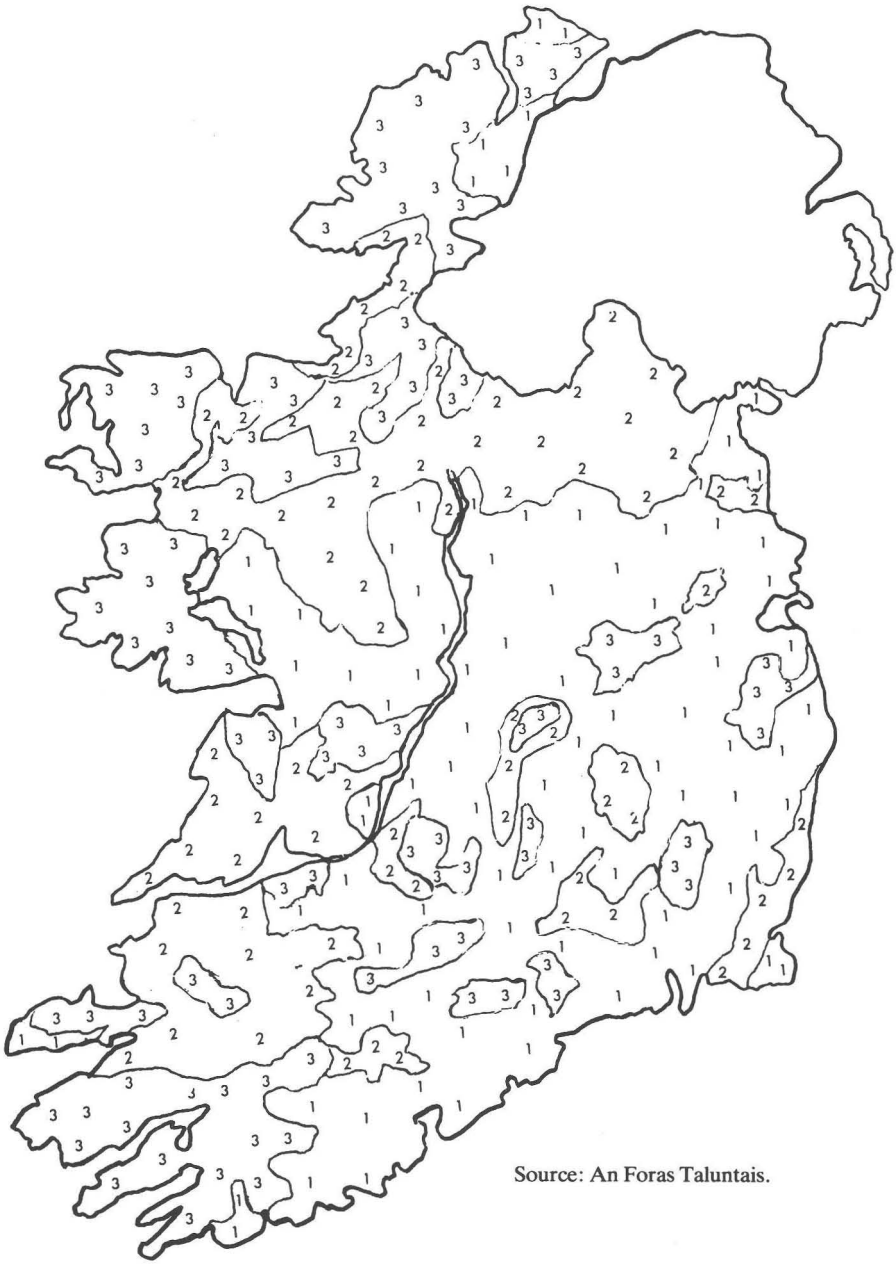


Fig 2. Soil Categories

(Heavey, J. F. et al, 1983). While a direct comparison between different yield classes is difficult, these data can be used to show the relative attractiveness of the different forms of land use. In Table 11 the average management and investment income is shown for soil groups 2 and 3. These soil groups contain the marginal agriculture land that is envisaged as being suitable for forest development. These are classified as limited (soil class 2) and very limited (soil class 3) in their use range for growing agricultural crops. There are very broad classifications ranging over many areas of the country and many soil types. Wet mineral soils are contained in soil 2 while hill land is encompassed in class 3 (Fig 2).

Table 11: Average Management and Investment Income 1983 (£1,985 per hectare)

Soil Class	Management and Investment Income
2	–107
3	–113

Management and investment income is the value of gross output less labour, direct costs and overheads. It is the money available to pay management, land and investment.

The net annual equivalents (forestry) and the management and investment income (agriculture) are directly comparable (Table 11 and 12). The price of land has been excluded in both cases. The returns from agriculture are negative for both soil groups.

Table 12: Net Return to private planter
Average timber price
Land price excluded

Net annual equivalent £1,985 per hectare per year

Yield Class	Western Package Area	Remainder of Country
8	–22	–44
12	22	–5
16	93	54
20	158	105
24	268	198

There is quite a deviation in both agricultural income and returns from forestry on different soil groups. Convery and Dripchak (1983) examined the return from agriculture in greater detail. They showed that the management and investment income from the most profitable 25 per cent of farms in 1981 was £172 per acre higher than from the least profitable 25 per cent. Range was from —£125 per acre to £47 £(1981) . They concluded that "even if farming recovers to the relatively prosperous conditions obtaining in 1979, the lowest 25 per cent will be able to show little or any surplus to reward management and investment income".

It seems reasonable to state that, based on the assumption in this paper, forestry is more profitable than agriculture on a large proportion of the land in soil classes 2 and 3. As these soil classes cover approximately 50 per cent of the land area in the country, available land is not a limiting factor for forestry development.

The actual profitability of forestry may be affected by windblow. This is difficult to assess on a general basis. However, were crops to remain unthinned as a precaution against windthrow the profitability of forestry is still greater than from conventional agriculture in a large proportion of the land in soil categories 2 and 3.

CONCLUSION

The analysis presented indicates that forestry on much of the marginal agricultural land will yield a return of at least 4 per cent on the investment. This applies to soils that can produce yield class 16 cubic metres per hectare per annum or greater. More than 55 per cent of the land owned by the Forest and Wildlife Service falls into this category.

In the case of private investors who can benefit from State and EEC grants the breakeven yield class varies from approximately 12 in the western counties to 14 in the rest of the country.

These conclusions depend on the wood quality of Sitka spruce being of sufficient standard to have a broad utilisation and that all crops are grown to complete rotation. The results of a recent study indicate that the inherent strength of Sitka spruce is quite satisfactory provided that the timber is dried and sawn correctly.

Windthrow can have a significant effect on the profitability of forestry. The adoption of a policy of not thinning can reduce the danger of windblow. This reduces the profit from higher yield crops. In the case of lower yield classes (less than 14), it is more profitable not to thin. The vulnerability to windblow is very site specific and therefore no general recommendation can be given.

ACKNOWLEDGEMENT

I wish to thank Valez Picardo of the Institute for Industrial Research and Standards and Brendan Fitzsimons of the Forest and Wildlife Service for allowing me to use the unpublished data in Table 10.

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