Irish Land Use Change and the Decision to Afforest: An Economic Analysis

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Abstract
Considerable variability in the price of commodities, such as milk and cereals, occurred in the 2007-2009 period. This was compounded by a high degree of volatility in the price of inputs such as fertiliser, animal feed and energy. Previously, Irish farms have used the returns from off-farm employment as well as agricultural support payments, such as the Single Farm Payment (SFP) and the Rural Environmental Protection Scheme (REPS), to protect their living standards against low and uncertain agricultural market returns. However, the downturn in the Irish economy has led to a reduction in the availability of off-farm employment as well as the discontinuation of REPS. This in turn may lead to an increase in afforestation on Irish farms, as forestry offers greater certainty through the provision of an annual premium in addition to the SFP. The decision to afforest represents a significant long-term investment decision and therefore, should not be entered into without careful economic consideration. The aim of this paper is to use Discounted Cash Flow (DCF) analysis to calculate the returns from forestry enterprises, taking into account the opportunity costs associated with the conventional agricultural activities which would potentially be superseded by forestry. The returns from forestry were calculated using the Forestry Investment Value Estimator (FIVE), an economic decision support tool developed by Teagasc. These returns are then incorporated into a DCF model along with the agricultural returns foregone from five superseded agricultural enterprises. This approach allows for the calculation of the net present value (NPV) of three different forestry options and shows that the forest investment options examined all offer a positive NPV. The results also indicate that planting fast growing conifer species offers a substantially higher NPV than planting a broadleaf species such as ash. Scenarios which assess the impact of the inclusion of the cost of reforestation after clearfelling and the impact of participation in the Forest Environment Protection Scheme (FEPS) are also examined as part of a sensitivity analysis.

Keywords
Farm forestry, net present value

Introduction
The discontinuation of the Rural Environment Protection Scheme (REPS), the possibility of a switch from the current Single Farm Payment (SFP) to a flat area-based payment and the recent volatility in the price of agricultural outputs and inputs, all suggest that Irish farmers are heading into a period of greater uncertainty and possibly lower farm incomes. Over the past 15 years, the incomes of many farmers

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were buoyed by off-farm employment and the one-off sale of land for development and housing construction. However, with the decline in the construction sector, those sales that do take place in the future are likely to be at substantially reduced prices. In their Spring 2009 Land Market Review, Irish Auctioneers Knight Frank estimate that the Irish property market is now tracking 2004 levels and they "see no reason why agricultural land prices will not follow this trend" (Ganly 2009). The likelihood is, therefore, that given the increased uncertainty regarding the returns to traditional agriculture, changes in land use will receive greater consideration amongst Irish farmers. Converting land from agricultural to forestry production represents one such land use change that is likely to receive more attention in the future.

Despite the presence of establishment grants for forest planting and increases in the value of the forest premium payments, afforestation rates within Ireland have been on the decline since the mid nineties. Breen et al. (2008) argue that the increase in land value brought about by the construction boom of the last 15 years could be a more important factor in this decline than the relative rate of returns between forestry and agricultural enterprises. However, with the downturn in the Irish construction industry and its subsequent impact on land values, it is expected that the relative rate of returns between forestry and agricultural enterprises will once again become a key factor in the decision to afforest. Behan and McQuinn (2005) recommend the need to analyse the economic returns from forestry in the context of existing agricultural policy.

While a number of studies have examined the reluctance of Irish farmers to afforest (Frawley and Leavy 2001, McDonagh et al. 2009, Breen et al. 2008), few studies have conducted an economic appraisal of the land use change decision facing farmers who opt to afforest a portion of their land. When contemplating afforestation, a farmer must consider not only the silvilcultural factors but also the income foregone from the agricultural enterprise that is superseded, or replaced by the forest. To accurately assess the afforestation decision, these foregone returns from the superseded agricultural enterprise should be directly incorporated into the analysis. Therefore, this paper presents an analysis of the returns to three alternative afforestation options in the context of five superseded agricultural enterprises, with sensitivity analysis used to assess the impact of key parameters on the economic returns of forestry.

Background

Trends in Irish Afforestation rates

Major changes in the rate of Irish afforestation, and in the number of landowners planting forests, have occurred in the past 30 years. Until 1980, public afforestation accounted for almost all planting in Ireland. The introduction of support packages for farm afforestation led to a complete reversal of this trend, with farm afforestation currently accounting for close to 100% of afforestation. However, the level of farm afforestation has also experienced significant change, as farmers respond to a variety of incentives and disincentives to afforest, including changes in the value of the forest premium payments, agricultural policy reforms and developments in land markets.

The introduction of the Western Package Grant Scheme in 1985 marked the beginning of supports for private afforestation in Ireland. The Forest Premium Scheme, introduced in 1989 and the Forestry Operational Programme, introduced in 1990, were significant in that as well as providing establishment grants for the planting of forests, the farmer also received an annual forest premium payment for the first 20 years after planting (Gillmor 1998, Farrelly 2008). More recently, the Common Agricultural Policy (CAP) Afforestation Scheme, introduced in 2000, increased the incentives to plant broadleaved species on better quality land, by offering a considerably higher premium payment than that offered for planting conifers.

In 2007, the Forest Environment Protection Scheme (FEPS) was introduced with the aim of providing farmers with an additional payment for including specific environmental measures in their forests to improve both biodiversity and recreation potential. The scheme would also offset the loss of payments to farmers participating in the REPS, if they chose to afforest a proportion of their farm. Interest in FEPS has grown rapidly to the extent that by the end of October 2009, FEPS accounted for 50% of the 2009 planted area (pers. comm. Fogarty, 2009). However, as a result of the closure of REPS to new applicants, entry to FEPS is now limited to farmers who are already participating in REPS.

Figure 1 presents the trends in Irish private and public afforestation from 1982 to 2009. Despite regular increases in the grant and premium, the trend since the mid-nineties has been largely downward, despite a short revival in private afforestation from 1999 to 2002. In 2008, approximately 6,128 hectares (ha) were afforested, which is well below the current national annual afforestation target of 10,000 ha (National Development Plan 2007-2013). This trend continued in 2009 as just over 6,600 ha were afforested by the end of the year (Forest Service 2009).

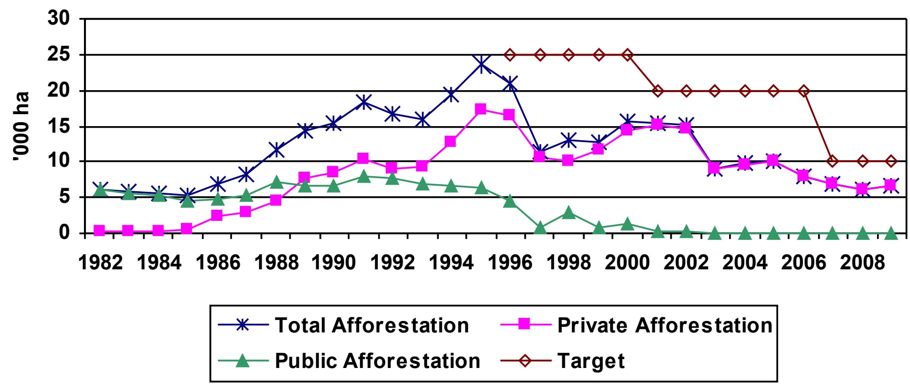

Figure 1: *Irish afforestation levels 1982 – 2009. Source: Forest Service Statistics (2009).*

Prior to 2005, Irish farmers could potentially avail of a number of "coupled" premium payments (i.e. payments that were linked to production levels), such as Special Beef Premium or Area Aid Payments, to supplement their market based income (value of sales less costs). With the introduction of decoupling, these payments that were previously paid on the basis of the number of eligible animals or hectares of a crop were now replaced with a single annual decoupled payment. This payment, referred to as the SFP, is paid on the basis of historical production levels rather than current production levels. The decision to decouple these direct payments from production allowed farmers to leave their agricultural land un-stocked but in "good agricultural and environmental condition" (European Commission, 2003) or to convert it to forestry and still receive their SFP income support. This offered a potential windfall for Irish farmers who could continue to receive their SFP while also receiving a forest premium for 20 years. However, despite this potential gain, Irish afforestation levels have continued to decline from 10,030 ha in 2005 to 6,128 ha in 2008.

The reluctance of Irish farmers to afforest has been the focus of a number of published works, with Frawley and Leavy (2001) and McDonagh et al. (2009) both using farm surveys to identify farmers' primary motivations for not planting. Taking into account that the McDonagh et al. (2009) survey was conducted almost ten years after that of Frawley and Leavy, and that a significant agricultural policy reform had taken place in 2005, the results of the surveys were remarkably similar. Frawley and Leavy (2001) found that 88% of the farmers surveyed were not considering afforestation. Frawley and Leavy (2001) also found that 51% of those farmers, who stated they would not plant, perceived the main difficulty with farm forestry as "farm too small/need the land". The most recent work conducted by McDonagh et al. (2009) echoes the earlier findings of Frawley and Leavy (2001). They found that for 48% of the farmers who stated that they would not plant, the most important barrier to planting land was that they needed all of their land for agriculture. This is despite the introduction of the SFP and the potential for farmers to plant up to 50% of their land without losing any payments. Surveyed farmers also cited the fact that there were no REPS payments on forests as a significant barrier to the decision to afforest (McDonagh et al. 2009). Earlier work conducted by Ní Dhubháin and Gardiner (1994) also found that Irish farmers were largely unwilling to plant land; only 10% of those farmers surveyed stated an intention to plant. Furthermore, of those farmers who stated an intention to plant land in the future, 58% said that their land was "good for nothing else" while 39% of those who said they would not plant said they did not have suitable land (i.e. they felt their land was "too good for forestry").

Similar studies conducted by Watkins et al. (1996) in the UK also found that new policy instruments such as special farm woodland planting grants and regional forestry initiatives did not bring about any significant change in the general opposition of farmers to the conversion of agricultural land to woodland.

In addition to the factors cited above, Breen et al. (2008) provide a discussion of the motivations for farmers' reluctance to plant, citing the introduction of environmental regulations which have restricted the afforestation of large tracts of land, particularly of less productive marginal and peat soils. Breen et al. (2008) also note that the significant increase in the value of agricultural land from 1992 to 2007 was another likely factor in the reluctance of farmers to afforest their land.

A land use change from agriculture to forestry in Ireland is a permanent decision, due to the legal requirement under the 1946 Forestry Act to replant after clearfelling a forest. Given the high prices that were paid for agricultural land in recent years (Ganly 2009), this permanency was a major obstacle to planting. Wiemers and Behan

(2004) used a real options approach to examine the role of uncertainty in the decision to plant, with particular attention paid to the potential value of agricultural land for development. They concluded that for farmers whose land had development potential, the returns to forestry would need to increase by more than 150% in order to trigger an investment in forestry. It remains to be seen as to whether or not the decline in the wider economy, and in particular the decline in the construction industry, will lead to a long-term reversal of current trends and an increase in the rate of farm afforestation.

McCarthy et al. (2003) used a panel regression model to examine the factors that influenced afforestation rates in Ireland. They found that the afforestation grant, forest premium payments, expected forest returns and the area in REPS were all statistically significant at the 1% level. However, agricultural returns were not statistically significant. They noted that in the early 1990s most of the land planted was marginal land, and this may explain why agricultural returns are not significant in explaining the afforestation rate.

Each of the three studies conducted over a period of 15 years examining factors affecting farmers' willingness to plant (Ní Dhubháin and Gardiner (1994), Frawley and Leavy (2001) and McDonagh et al. (2009)), indicated that the size of the farm and the need to retain all their land for agriculture were significant factors in the decision not to plant. This response may be motivated by the farmer's perception of him/herself as a farmer rather than a forester, and therefore they may believe that they need to retain all of their land in agricultural production. However, it may also be a reflection of the individual farmers' perceptions regarding the relative rate of returns from agriculture and forestry, and a belief that agricultural activities offer a greater return than forestry. Therefore, this paper uses a discounted cash flow (DCF) analysis to compare the returns to three alternative forest options, each with five superseded agricultural activities.

Materials and methods

A discounted cash flow analysis

Given the long-term nature of farm afforestation, this paper uses the DCF method to evaluate the afforestation investment decision. The investment returns from the decision to afforest are evaluated as an alternative farm enterprise. Risk and uncertainty elements need to be considered when developing forest management models (Diaz-Balteiro and Romero 2008), so the effects of variation in key parameters, such as yield, price and production life-span, on the performance of each investment can be evaluated. As the afforestation grant and forest premium are paid on a per ha basis, the evaluation of the alternative investment decisions is also conducted on this basis.

The DCF approach to calculate the returns from forestry is prevalent in the literature and has been employed by a number of authors including Brukas et al. (2001), Nieuwenhuis and Gallagher (2001), Rasul and Thapa (2006), and Hepburn and Koundouri (2007). A number of criteria exist for evaluating the returns from a long-term investment decision; with net present value (NPV) being one of the more commonly used. The DCF method evaluates an investment decision in terms of its NPV, which is defined as the sum of the project's net cash flows discounted at the businesses' opportunity cost of capital (Boardman et al. 2001). The investment project is deemed to be 'worthwhile' if it generates a positive NPV.

While the DCF approach represents a deterministic analysis of the returns to the investment decision, sensitivity analysis allows for the impact of variability in key parameters such as grants and replanting costs on the returns to the afforestation investment decision to be evaluated. The discount rate used will also have an effect on the present value of returns from a forestry investment. A 5% discount rate was used in this study, primarily as it is the rate most commonly recommended for examining the relative value of different long-term agricultural land use options (e.g. Toivonen and Tahvanainen 1998, Clinch 1999, Styles et al. 2008).

The farm afforestation decision entails converting land from a conventional agricultural enterprise to forestry. As a result of this change, the margin previously earned by this superseded agricultural enterprise will be foregone and must be accounted for when evaluating the returns to the farm afforestation decision. While Venn (2005) noted that land cost is an important factor in forestry investment decisions, Lewandowski et al. (2000) point out that some studies have omitted it from the calculation of the returns to the investment decision. Given the importance of the opportunity cost of land, in this analysis it is accounted for through the inclusion of foregone returns from a number of superseded agricultural activities. Therefore, our calculation of the NPV for forestry takes into consideration the cash margin foregone from selected superseded enterprises, which are deducted annually from the gross margin earned by the three alternative forestry enterprises. Our baseline analysis assumes that the superseded activity is land rental, and the opportunity cost of the market rental value of the land is included. Given the prevalence of grassland based agriculture in Ireland (covering approximately 80 percent of Ireland's agricultural area, Department of Communications, Marine and Natural Resources 2007), the average rental value of grazing land is used.

In addition, a number of alternative superseded enterprises have also been included as part of a sensitivity analysis. Data from the Irish National Farm Survey (NFS) have indicated that sheep, tillage and cattle farmers have signaled the greatest intention to convert land to forest (Ryan et al. 2008); therefore the superseded enterprises chosen for the sensitivity analysis were lowland sheep, store to finished beef, spring barley and winter wheat. Thus, the results presented in subsequent sections comprise the estimated investment returns from a decision to switch a hectare of land from a conventional enterprise to forestry.

One of the strengths of DCF is its capacity to allow for the comparison of investments with different cash flow profiles, such as annual versus multi-period systems, allowing for the timing of cash flows from year to year over the project life (Clancy et al. 2009). The model assumes that there are no changes in the productivity of the forestry enterprises or of the superseded enterprises throughout the project lifespan.

Cost and Return Estimation of Forestry Options

The capital invested in forestry comprises the start-up costs of the enterprise in the initial period, less planting grants, less the average working capital released from the superseded enterprise. The returns from forestry were taken from the Forestry

Investment Valuation Estimator (FIVE), developed by the Forestry Development Unit in Teagasc. The NPV of different forestry options can be calculated using this forest advisory and research support tool. In this paper, FIVE was used to calculate the costs and returns to three alternative forest options. These costs and returns are then inputted to the DCF model, where the annual returns from the superseded enterprises are included, to compare the NPV of the three alternative forest options. FIVE was constructed using Forestry Commission yield models (Edwards and Christie 1981), to give the estimated timber volumes depending on the assigned Yield Class of the land. FIVE allows for the inclusion of five alternative tree species: Sitka spruce (*Picea sitchensis*, (Bong.) Carr.), Norway spruce (*Picea abies* (L.) Karst.), Japanese larch (*Larix kaempferi* (Lamb.) Carr.), lodgepole pine (*Pinus contorta* Douglas) and ash (*Fraxinus excelsior* L.)/sycamore (*Acer pseudoplatanus* L); the appropriate GPC (Grant/Premium Category) is selected for the species mix being examined. The level of grants and premiums payable are calculated based on the GPC, with total planting costs and initial maintenance costs assumed to be equal to the value of the afforestation and maintenance grants.

The conifer roundwood prices were based on 10 years of standing sales data provided by Coillte Teoranta[1], while Irish and UK data were used to estimate a price/ size curve for broadleaves. The roundwood price data, along with the tree size and volume data from the yield models, allow for the calculation of revenues from roundwood sales. Standard harvest losses were deducted and it was assumed that the harvestable material was sold at average prices. The road cost net of grant was also included in the analysis.

Data and assumptions regarding superseded enterprises

This section presents a description of the assumptions made relating to costs and revenues of the five superseded enterprises. Table 1 details the gross margins and average working capital released per ha from the superseded enterprises.

Table 1: *Gross margin and working capital released for enterprises superseded by forestry.*

	Grazing land rental value € ha^{-1}	**Spring barely € ha^{-1}**	**Winter wheat € ha^{-1}**	**Sheep € ha^{-1}**	**Store to finished beef € ha^{-1}**
Gross margin[i]	236	260	435	389	210
Working capital released[ii]	-	291	487	436	1,392

[i] Gross margin for production enterprises assume average levels of technical efficiency.

[ii] Working capital released is the average capital tied up in stock and variable inputs for each enterprise.

[1] The Irish State Forestry Board.

The grazing land rental value was calculated as the average paid per ha by farmers engaged in this activity in the NFS (Connolly et al. 2008) from 2005-2007. Any rental value less than €20 ha^{-1} was considered a nominal value, and so was excluded from the analysis. To avoid problems of allocation of fixed costs associated with owned machinery, calculations assume contractor charges for all field operations. All machinery and labour costs are therefore assumed to be variable costs. For a variety of reasons, such as the requirement that planted land be kept in forestry for perpetuity (Breen and Ryan 2008), it is likely that only a small part of individual Irish farms will be converted to forestry. This is borne out by average farm forest size of 7.9, 7.4 and 7.9 ha established in 2006, 2007 and 2008 respectively (Forest Service 2008). Thus, the size of each superseded enterprise may be reduced, but they are unlikely to be eliminated at farm level. In this context, the reduction in fixed costs (e.g. labour) from reducing a conventional enterprise is likely to be quite small (Clancy et al. 2009).

The contractor prices were obtained from survey data reported in Management Data for Farm Planning 2006/2007 (Teagasc 2007) and inflated to 2009 prices using FAPRI-Ireland (Food and Agricultural Policy Research Institute) input cost and output price projections (Binfield et al. 2007). Obtaining long range forecasts of costs and prices is a formidable task in any farm investment appraisal (Clancy et al. 2009). In this analysis, estimates of input costs assumed normal input levels under average production conditions as estimated by enterprise specialists. Average levels of technical efficiency, based on National Farm Survey data, were assumed for all the superseded enterprises. Prices for all inputs and outputs of the superseded activities are conservative estimates based on medium term FAPRI projections. The resulting normalised margins for forestry and the superseded enterprises are held constant over the economic life of each project. The level of the premium payment for forestry is the current rate available in the Afforestation Scheme.

Afforestation options

Sitka spruce has been the most widely grown tree for commercial purposes in Ireland, and is typically planted with another conifer species such as Japanese larch in order to comply with the species diversity requirements of the afforestation scheme. In recent years, there has been an increase in the planting of broadleaves in Ireland (Forest Service 2009). The increase in broadleaf planting was largely a result of higher premium payments for broadleaf species and more recently the introduction of FEPS has led to a further increase. Based on the recent average farm forest sizes, this analysis assumes that most farmers plant between 6 and 12 ha. Therefore, this analysis uses the Grant and Premium rates for 6 - 12 ha. The three afforestation options included reflect the compositions of many Irish farm forests:

- SS: This option assumes a plantation that is comprised of Sitka spruce and Japanese larch and is consistent with Grant and Premium Category (GPC) 3.
- Ash: This option assumes a plantation that is comprised of ash and is consistent with GPC 5.
- Mixed: This option assumes a plantation that is comprised of Sitka spruce, Japanese larch and ash and is a combination of GPC 3 and GPC 5.

Table 2: *Assumptions used in alternative afforestation options.*

	SS	***Ash***	***Mixed***
Species mix	Sitka spruce 80% Japanese larch 20%	Ash 100%	Sitka spruce 48% Japanese larch 12% Ash 40%
Productivity (Yield Class)	Sitka spruce –22 Japanese larch –12	Ash –10	Sitka spruce –22 Japanese larch –12 Ash –10
Grant and Premium Category (GPC)	GPC 3	GPC 5	GPC 3 (60%) GPC 5 (40%)
Forest Environment Protection Scheme (FEPS)	No	No	No
Establishment grant (€ ha^{-1})	2,700	4,000	3,220
Establishment cost (€ ha^{-1})	2,700	4,000	3,220
Cleaning/filling-in (€ ha^{-1})	873	1,200	1,004
Grant maintenance (€ ha^{-1})	873	1,200	1,004
Rotation length	40 years	40 years	40 years
Productive area	85%	85%	85%
Forest management	Thin	Thin	Thin
Annual maintenance and insurance cost (€ ha^{-1})	35	35	35
Roading year	Year 15	Year 15	Year 15
Roading cost net of grant (€ ha^{-1})	90	90	90

Sensitivity analysis

Sensitivity analysis was conducted to examine the impact of two key factors on farm forest returns. The inclusion of reforestation costs on the NPV of each option was analysed as well as the impact of participation in FEPS. The initial afforestation costs are covered by the provision of a planting grant. However, as discussed above, in Ireland after clearfelling forest owners are legally obliged to re-plant and the cost of this re-planting is not covered by a grant. One argument for including replanting costs as part of the first forest rotation is that the profit from the first rotation is not realisable without incurring the replanting cost. On the other hand, it could be argued that replanting is part of the cost of the second rotation and should not be included as a cost against the first rotation. Similar to Clinch (1999), the cost of reforestation is not included in the baseline scenarios of this analysis. However, the cost of reforestation is included as part of the sensitivity analysis in order to assess its impact on the forest NPV's. The cost of reforestation was estimated as €3,000 per ha for conifers and €3,500 for broadleaves due to the higher stocking rate for broadleaves (Pers. comm. Phillips 2009).

Table 3: *Assumed cost of reforestation.*

Afforestation option	*€ ha^{-1}*
SS	3,000
Ash	3,500
Mixed	3,200

Further sensitivity analysis was conducted to examine the impact on NPV of FEPS participation. Farm forest owners who are currently in REPS may avail of an additional FEPS payment. While entry to REPS 4 is not possible after July 2009, farmers currently in REPS (approx 62,000) are still eligible to apply for FEPS (Pers. comm. DAFF 2009). As farmers in REPS have the option to enter FEPS, and as 50% of the land being planted currently is in FEPS, we included the FEPS payment in a sensitivity analysis. This analysis assumes a FEPS payment of €200 annually for five years, with no loss of REPS payment. It is not possible to avail of FEPS if only conifers are being planted, so the FEPS sensitivity analysis is only run for the mixed and ash forest options.

Results

An initial baseline comparison of the NPV of land for all three afforestation options is made with land rental as the superseded enterprise. Despite receiving the lowest level of forest premium payments per ha, the SS option returns the highest NPV (€4,406). In comparison the Ash option, which received the highest level of forestry premium, had the lowest NPV, mainly as a result of the significantly lower estimated volume of timber produced.

Table 4: *Baseline investment performance of three different afforestation options.*

		Net present value (€ ha^{-1})[i]
Superseded: Land Rental	Sitka spruce	4,406
	Ash	2,568
	Mixed species	3,670

[i] At a discount rate of 5%.

Table 5 presents the NPV for the three afforestation options, when the alternative superseded enterprises were winter wheat, spring barley, lowland sheep production and store to finished beef. All of the forestry options examined with the exception of ash superseded by winter wheat, offer a positive NPV. However, there is a considerable degree of variability in the size of the respective NPV's for different forestry options. For example, the SS option where the superseded agricultural enterprise was store to finished beef has the highest NPV, €6,156. This is largely due to a combination of the high level of working capital released by not having to purchase cattle, and the high timber returns achieved from the Sitka spruce forest. However, for the ash plantation where the superseded enterprise was winter wheat, there is a negative NPV of - €273.

Table 5: *Investment performance of afforestation with alternative superseded agricultural enterprises.*

Farm enterprise superseded		***Net present value** (€ ha^{-1})*[i]
Spring barley	SS	4,279
	Ash	2,440
	Mixed	3,542
Winter wheat	SS	1,565
	Ash	-273
	Mixed	829
Lowland sheep	SS	2,282
	Ash	444
	Mixed	1,546
Store to finished beef	SS	6,156
	Ash	4,318
	Mixed	5,420

[i] At a discount rate of 5%.

Impact of inclusion of reforestation costs

The first stage of the sensitivity analysis compares the baseline NPV with a second scenario where we assumed a reforestation cost is incurred after clearfelling (See Figure 2). While the replanting cost is estimated to be between €3,000 and €3,500 ha^{-1}, the change in the NPV is substantially smaller, varying from €368 for Sitka spruce to €430 for ash. This reflects the fact that the replanting cost is incurred at the end of the investment decision and as a result is highly discounted.

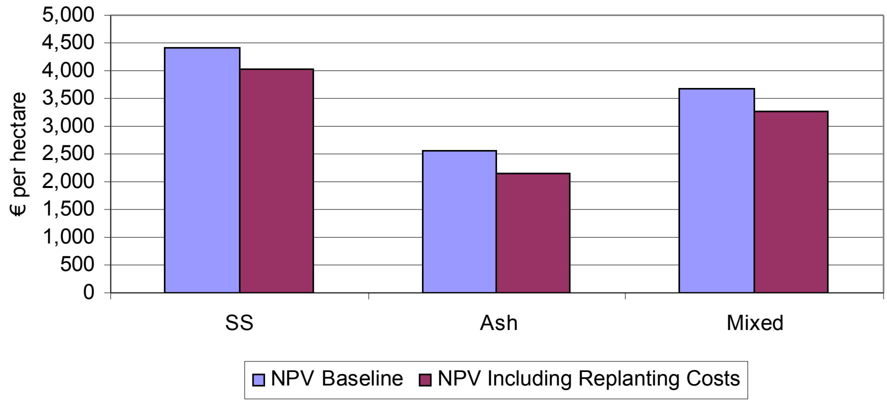

Figure 2: *Impact of Inclusion of Replanting Cost on the Net Present Value for the three different afforestation options.*

Impact of Participation in FEPS

The results indicate that participation in FEPS will lead to a higher NPV per ha for both forestry options when compared with the baseline superseded enterprise of land rental. The increase in the NPV for ash is €787. However, Figure 3 shows that the returns are still lower than the returns to the Sitka spruce option. The increase in the NPV for the mixed forestry option is €701, however it is still less profitable than the SS without FEPS. This analysis takes into account that participation in FEPS will lead to a lower productive area, 80% compared with 85%, due to the greater requirement for biodiversity area (pers. comm., Phillips 2009). The lower productive area will result in reduced volume production and a consequent reduction in income from roundwood sales, which has a more adverse effect on the mixed forest option than on the ash option, as a greater proportion of the returns to this option come from roundwood sales.

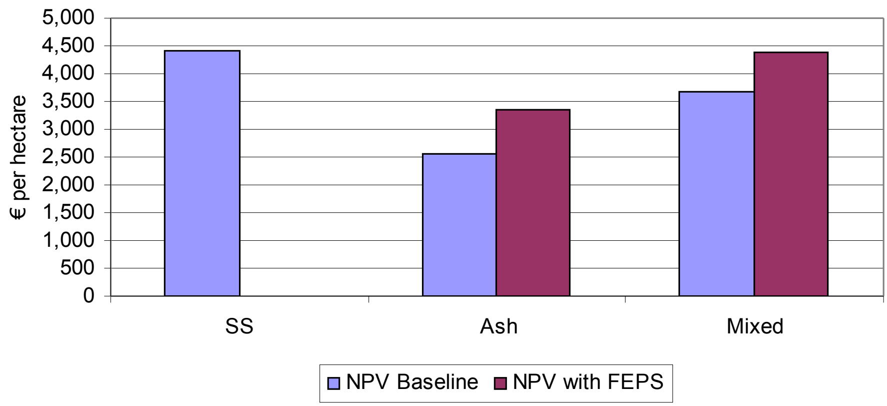

Figure 3: *Impact of FEPS participation on the net present value for the three afforestation options*

Discussion

The main approach to analysing forestry investment decisions is the use of traditional DCF techniques such as NPV (Duku-Kaakyire and Nanang 2004). However, these analyses have not, to date, included the income foregone from a superseded enterprise, thus making direct comparisons between our findings and the literature inappropriate. All of the forestry options examined, with the exception of ash superseded by winter wheat, offer a positive NPV. This finding is supported by Donnellan and Hennessy (2008) who compared the returns to forestry with the returns to a number of other enterprises and concluded that only dairy and winter wheat offered a higher gross margin per ha than forestry. Given the wide range of available combinations involving alternative afforestation options and superseded enterprises, we focus on a limited number of combinations of such investment options. Therefore, it should be noted that combinations which were not examined in this paper may yield different findings.

Despite the stated reluctance of a majority of Irish farmers to afforest (Ryan et al. 2008), the forest investment options examined offer a positive NPV, with the exception of ash where the superseded enterprise is winter wheat. There are already signs that trends are reversing, and that forestry is becoming a more attractive option for farmers. The number of applications for planting approval to the end of September 2009 is up 78% on the same period in the previous year (Forest Service 2009). Possible reasons are the continuing downward trend in returns from conventional agricultural systems and the higher forestry returns as evidenced in this analysis.

The results indicate that planting fast growing conifer species offers a substantially higher NPV (approximately €1,840 ha^{-1}) than planting a broadleaf species such as ash. However, in recent years Ireland has seen an increase in the planting of broadleaves, which may be a reflection of the higher annual premium payments payable on broadleaves, as well as changes in the preferences of farm-foresters and increased afforestation on better quality soils. It should also be noted that while the DCF methodology shows the highest return from the Sitka spruce option, the analysis does not consider any potential future earnings from the forest for its conservation, biodiversity or amenity value.

The low afforestation rate that has been witnessed over the past 10 years has in part been attributed to the economic growth and its consequent impact on the construction sector and land values. The requirement to reforest after clearfelling imposes restrictions that limit the price that can be realised for forest land. While the DCF approach allows for a comprehensive analysis of the returns to forestry when compared with the returns foregone from alternative agricultural enterprises, it does not evaluate the potential loss in the land value that might arise from the decision to afforest.

A final point worth making is that the forest premium payments received and the revenue from roundwood sales (up to a threshold) are tax-free, while it is likely that the revenue from each of the superseded enterprises would be subject to tax. The impact of the afforestation decision on the tax liability of an individual farm will vary considerably, depending not only on the value of the returns to the enterprise that is foregone, but also on the returns from other enterprises on the farm and the value of non-farm income.

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