The Potential Economic Returns of Converting Agricultural Land to Forestry: An Analysis of System and Soil Effects from 1995 to 2009

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Abstract
Private land owners have been responsible for the majority of annual afforestation in Ireland since the mid-1990s, but planting rates have generally been declining since 2002. Although the decision to plant may be driven by a number of factors, the profitability of forestry as a land-use option should be an important driver and offer some insight into trends in afforestation rates. As farmers undertake most afforestation in Ireland it is important to account for the opportunity cost of lost agricultural income when analysing the financial outcome of planting. In addition, soil quality plays an essential role in dictating the productivity and profitability of both agriculture and forestry. This study examines the effects of soil quality and superseded agricultural system on the potential profitability of afforestation by farmers between 1995 and 2009. Data from the National Farm Survey were employed to identify the annual gross margins for six agricultural systems on six soil types that differ in terms of quality. The measures of soil quality were translated into potential yield classes for forestry using an existing productivity model and Teagasc's Forest Investment and Valuation Estimator was employed to calculate the net present value of afforestation for each of the systems and soil types. The results demonstrate how the competitiveness of forestry as a land-use option is influenced by soil quality and superseded enterprise and how forestry has become more competitive with agricultural enterprises over the period of analysis.

Introduction

The development of Irish afforestation policy has focused on soil quality to a large degree. State afforestation during the 20th Century was generally limited to lower quality marginal and sub-marginal soils to avoid competition with agriculture (OCarroll 2004). Afforestation of private land was limited for most of the century, although some form of financial support was available. However, with the introduction of annual payments to offset the loss of income during forest establishment private landowners began to show more interest in planting forests. Farmers undertook over 80% of all afforestation in Ireland between 1995 and 2009 and they are likely to continue to be the main planters of forests given the decline of public planting and the maintenance of higher premium payments for farmers

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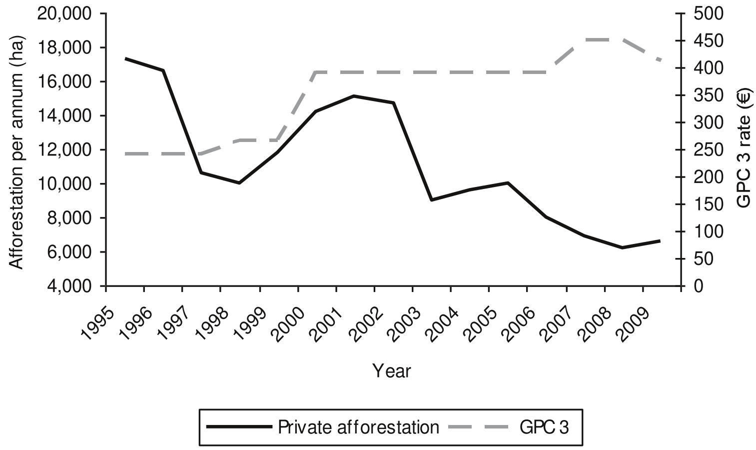

Figure 1: *Private afforestation levels and the Grant/Premium Category (GPC) 3 rate between 1995 and 2009 in Ireland.*

compared to other private planters. Greater emphasis has been placed in recent years on the environmental outcomes of afforestation and restrictions have been placed on planting on unenclosed land and in environmentally sensitive areas. This combination of factors suggests that the establishment of forests on improved agricultural land by farmers will continue to be central to afforestation policy in Ireland. Thus, competition between agriculture and forestry, particularly in terms of enterprise and land quality, is of particular relevance to current policies and the development of future policies. Since the early 1990s, farmers have been able to avail of grants that cover the full cost of planting and annual premiums to offset the loss of agricultural income during forest development. Although funding has been increased on a number of occasions, afforestation rates have been generally declining since 2002 (Figure 1).

It is well recognised that the characteristics of farm and farmer can have a significant impact on the decision to plant forests (Collier et al. 2002, Howley et al. 2012), but the financial outcome of planting should still play an important role in this process. Previous examinations of the economics of forestry in Ireland have revealed the importance of state supports for forestry and competing agricultural policies in explaining variations in afforestation rates (McCarthy et al. 2003). Behan and McQuinn (2005) modelled a panel dataset of afforestation between 1986 and 2001 across five regions in Ireland and found that the relative rate of return between forestry and agriculture had a significant and positive effect on planting rates. However, McCarthy et al. (2003) found that agricultural gross margin itself did not explain afforestation trends at the county level. Breen et al. (2010) demonstrated how forestry can compete financially with other land uses by calculating the net present value (NPV) of moving from a range of agricultural enterprises to Sitka spruce (*Picea sitchensis* (Bong.) Carr.), ash (*Fraxinus excelsior* L.) or mixed forestry. The study focused on less profitable agricultural enterprises as these were deemed to be the most likely to be superseded and found that replacing store to finished-beef with Sitka spruce resulted in the greatest NPV. Such results help to explain why cattle and other livestock farmers have been seen to be more likely to enter forestry (Ryan et al. 2008, Howley et al. 2012).

One of the fundamental factors in any land-use decision is soil quality. This factor dictates what enterprise can be engaged in and how productive it will be. Forestry is recognised as a robust land-use option that is less restricted than agriculture by poor site conditions. The fact that much of Ireland's forests exist on poorer quality sites is a result, in part, of both state policy and landowner decision making. Although agricultural enterprise may be a reflection of soil quality, a more detailed examination of the role of soil type in the financial implications of land conversion to forestry is warranted. In addition, examining the relative changes in the profitability of forestry over time may offer an insight into afforestation rates and patterns. This study examines how the NPV of converting agricultural land to forestry has been affected over time by changes in the opportunity cost of agricultural systems on different soil types. Data were derived from the National Farm Survey (NFS), which collects detailed information from a representative sample of farms in Ireland, including a six-category soil quality variable. This variable was converted to yield class estimates to reflect a more realistic financial outcome of afforestation. The impact of converting land from four agricultural systems to commercial forestry between 1995 and 2009 was analysed using the Teagasc Forest Investment and Valuation Estimator (FIVE).

Methods

The National Farm Survey

The NFS is Ireland's contribution to the EU Farm Accountancy Data Network (FADN) and collects detailed information from a representative sample of farms in Ireland. Data from approximately 1,200 farms are collected each year and farm systems are classified by enterprises defined in Commission Decision 78/463 and its subsequent amendments. These categories have changed over time. Table 1 gives examples of enterprises that would generally be included in the systems. Two

Table 1: *Enterprises included in NFS systems used in Ireland.*

System	Enterprise examples
Dairy	Specialist milk production
Tillage	Specialist cereals, oilseeds and protein crops, Field crops combined with non-dairying grazing livestock, Specialist root crops, Various field crops combined
Cattle	Specialist cattle - mainly rearing
Sheep	Specialist sheep, sheep and cattle combined

additional categories, Dairy Other and Cattle Other, were included in the original analysis but are not reported as they contain a diverse variety of enterprises.

Gross margin (GM) is a measure of agricultural profitability generated from the NFS data and is defined as gross outputs minus direct costs, such as outlays on fertilisers and feed stuffs. In addition to economic measures, the physical characteristics of farms are collected in the survey, including a six-level measure of soil quality defined primarily by the diversity of uses for which land can be used. Average GMs for each type of soil were derived for the four agricultural systems for each year between 1995 and 2009, where data were available. The GM values used in the calculations are net of subsidies. Farmers can currently plant most of their land and retain their single farm payment, but previous to decoupling converting to forestry may have resulted in the loss of some financial support. This is an important limitation of the study, as in some circumstances the loss of supports may have amounted to a significant cost.

Forest Investment Valuation Estimator

A discounted cash flow approach was adopted to generate the net present value (NPV) of converting a hectare of different soil categories from six agricultural systems to forestry. The standard formula for NPV is:

$$NPV = \frac{\sum_{t=0}^{T} R_t - C_t}{(1+i)^t} \quad (1)$$

Where R represents revenues, C represents costs, t is the relevant year and i is the discount rate. For this analysis it was assumed that a combination of 80% Sitka spruce and 20% Japanese larch (*Larix kaempferi* (Lamb.) Carr.), which represents a common composition over the period of analysis, was established. The Teagasc Forest Investment Valuation Estimator (FIVE) was employed to calculate the NPVs (see Breen et al. (2010) for more details of the FIVE). This Excel-based tool employs the UK Forestry Commission yield models (Edwards and Christie 1981) to predict future timber outputs based on species, yield class, rotation and thinning regime. Timber outputs, from thinnings and clearfell, were valued using 10-year average conifer roundwood prices reported by Coillte and adjusted to the relevant year using the consumer price index (CPI). Thus it is assumed that timber prices did not change over the period of analysis in real terms. Costs of inspection paths, insurance and reforestation were included in the calculation and it was assumed that all afforestation costs would be covered by the available grant. The relevant farmer premium rate (Grant/Premium Category 3) available in the given year was employed in all calculations and included for the first 20 years of the rotation. Before 2000, payments were specific to the agriculturally disadvantage status of an area and the payment associated with the most severely disadvantaged areas was included for this period. Financially optimum rotations were used for each yield

Table 2: *Soil categories and expected yield classes for various land-category types in Ireland.*

Soil Category	Limitations of Soil	Expected Yield Class ($m^3 ha^{-1} yr^{-1}$)
1 Wide	No limitations	24
2 Moderately wide	Minor limitations	24
3 Somewhat limited	Higher elevations, heavier, poorer structure	20
4 Limited	Poor drainage	20
5 Very limited	Agricultural potential greatly restricted	18
6 Extremely limited	Mountainous, steep slopes, shallow soil	14

class and varied between 38 and 44 years. A percentage of revenue from thinnings and clearfell was subtracted to cover the costs of timber sales.

Soil quality affects both agricultural and forest productivity. To ensure a realistic reflection of land conversion, the NFS soil categories were translated into forest yield class estimates based on the soil productivity models for Sitka spruce in Ireland described in Farrelly et al. (2011). Table 2 outlines the categories and identifies the estimates of the associated yield class that may be achievable on such sites. The soil and system specific GMs were incorporated into the NPV calculations as an annual cost to account for the opportunity cost associated with converting land to forestry. Thus, soil type is reflected in both the opportunity cost of the agricultural income foregone and the productivity of the forest. The NFS sample is representative of farms at the level of system and size but not soil type. Thus, although the GMs are valid for the farms included in the sample, they are not representative of all farms in Ireland.

Results

Tables 3 to 6 display the soil category (SC) specific NPVs per year for converting 1 ha of land from agriculture to forestry, with the associated sample size in brackets. Values that are derived from particularly small samples ($n \leq 3$) are highlighted with asterisks. This is of particular note with the lowest soil category, 6 or Extremely limited, which includes very few farms and the associated NPVs should be treated with particular caution. As timber prices are assumed not to change in real terms over time, the temporal variability in the figures stems primarily from changes to the premium rate and the profitability of agriculture. The sample sizes reflect the demands that different agricultural systems have for land quality with a higher proportion of dairy and tillage farms occurring on better quality soils.

There is significant variability between systems but forestry does not appear to compete with Dairy under any conditions for the average farm values included in the sample. It is interesting to note the significant diversity in the tillage figures but in general the results would suggest that forestry has not been competitive with tillage, at least on soils of reasonable quality, over the time period. The NPVs for

Table 3: *Soil category (SC) and yield class (YC) specific NPVs (€ ha^{-1}) for forestry replacing a dairy system in Ireland. The soil categories are defined in Table 2.*

Year	SC1 / YC24	SC2 / YC24	SC3 / YC20	SC4 / YC20	SC5 / YC18	SC6 / YC14
1995	−18139 (90)	−22533 (38)	−17592 (51)	−13916 (53)	−7797 (20)	−22996* (1)
1996	−18332 (91)	−81595 (37)	−16202 (61)	−13530 (66)	−8961 (22)	−24405* (1)
1997	−16788 (109)	−19554 (27)	−15419 (57)	−13245 (81)	−8909 (21)	–
1998	−15623 (112)	−17013 (26)	−14271 (49)	−12341 (74)	−7294 (18)	−4090* (1)
1999	−15777 (110)	−14087 (26)	−14811 (51)	−11900 (81)	−5828 (18)	−2546* (1)
2000	−17391 (142)	−15365 (25)	−15107 (56)	−12301 (84)	−8667 (23)	−5060* (1)
2001	−19945 (156)	−22022 (42)	−16558 (57)	−14700 (96)	−10724 (27)	−6282* (1)
2002	−15288 (143)	−16823 (31)	−13710 (51)	−8800 (79)	−5723 (26)	−2420* (1)
2003	−14933 (151)	−17733 (42)	−15599 (49)	−12886 (82)	−8715 (28)	−3484* (1)
2004	−17649 (140)	−16860 (42)	−16426 (47)	−14947 (78)	−8812 (26)	−6211* (1)
2005	−15785 (141)	−15471 (36)	−14662 (44)	−11537 (75)	−7922 (27)	−542* (1)
2006	−12249 (139)	−15923 (34)	−13486 (43)	−10558 (69)	−6139 (26)	–
2007	−19048 (138)	−23132 (31)	−21206 (40)	−15556 (65)	−10017 (21)	–
2008	−18500 (127)	−18881 (31)	−16660 (36)	−10774 (57)	−5957 (17)	–
2009	−6575 (120)	−8216 (27)	−6313 (36)	−2150 (56)	−1618 (14)	–

*Very small sample size (n ≤ 3)

forestry replacing cattle and sheep enterprises, however, suggest that forestry may be a highly competitive alternative land-use option.

The results also suggest that soil category has a significant effect on NPVs within systems. The effects of annual variation in the agricultural gross margins can be removed by calculating the average NPV per soil category and enterprise over the time period, with the original figures adjusted using the consumer price index

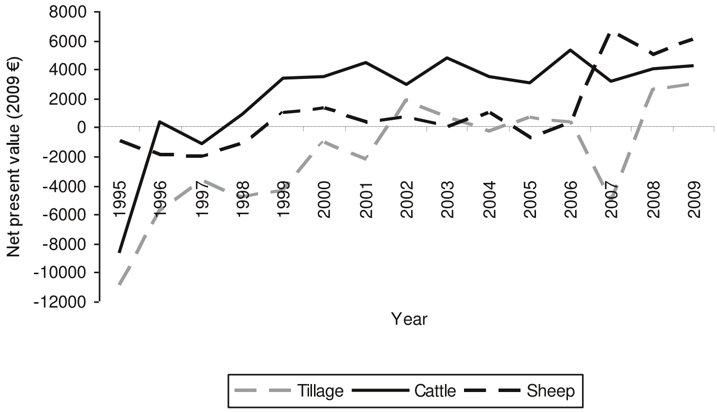

Figure 2: *Adjusted NPVs (expressed in 2009 equivalents) for forestry replacing tillage, cattle and sheep systems on soil category 1 for the period 1995 to 2009.*

(CPI) and expressed in 2009 equivalents (Table 7). These figures show a distinctive trend in increasing forestry profitability on lower quality soils.

In addition to the effects of soil and system, the results suggest that forestry has become more competitive over the time period although as values are expressed in the relevant year the total effect may be confounded by inflation. Figure 2 displays the NPVs for cattle, sheep and tillage systems on soil category 1 (SC1) expressed in 2009 prices. By adjusting the values using the CPI, the values are more comparable and show a general, although not consistent, positive trend in the profitability of forestry over time on this soil type. For brevity only the values for SC1 are included, but similar increases over time are evident for other soil categories and for the Dairy system, although the NPV of the latter is never positive.

Discussion

The results of this study offer a realistic financial analysis of the conversion of land use from a range of agricultural systems to forestry, taking account of the effects of soil quality on productivity. Based on the farms in the NFS, the results suggest that forestry is unlikely to compete financially with dairy systems under any circumstances. This is unsurprising given the profitability of the system and the fact that it is concentrated on better quality soils. The results for replacing tillage land are more inconsistent and are likely to be heavily influenced by variability in yield (e.g. impact of weather conditions) and direct costs. In general, farms in this study that are engaged in cattle and sheep enterprises would benefit financially from converting land to forestry. This finding is consistent with other Irish studies, which concluded that farmers engaged in livestock enterprises are the most likely to benefit financially from converting land to forestry (Breen et al. 2010) and are more likely to have planted previously (Howley et al. 2012).

The influence of soil quality on the profitability of planting was identified with a distinctive trend of NPVs increasing as soil quality decreased (Table 7). This can

Table 4: *Soil category (SC) and yield class (YC) specific NPVs (€ ha^{-1}) for forestry replacing a tillage system with positive values in bold. The soil categories are defined in Table 2.*

Year	SC1/YC24	SC2/YC24	SC3/YC20	SC4/YC20	SC5/YC18	SC6/YC14
1995	−7451 (54)	−7439 (35)	−8466 (11)	−4620 (2)	2444* (1)	–
1996	−4040 (51)	−4457 (36)	−6865 (12)	−1866 (2)	−3971* (2)	–
1997	−2616 (50)	−4510 (43)	−8468 (9)	−1621 (2)	**1802* (1)**	–
1998	−3466 (50)	−6438 (35)	−7364 (11)	−2795 (2)	**2404* (1)**	–
1999	−3211 (34)	−4377 (31)	−3019 (9)	**279 (2)**	**3596* (1)**	–
2000	−831 (44)	−8036 (33)	−11230 (8)	**424 (2)**	**4646* (1)**	–
2001	−1799 (48)	−7549 (37)	−679 (8)	−29 (2)	**3222* (2)**	–
2002	**1549 (54)**	−2057 (40)	−708 (12)	**1676 (2)**	**5* (1)**	–
2003	**600 (62)**	−2266 (38)	−2254 (9)	**3009 (3)**	–	–
2004	−300 (67)	−2319 (36)	−2285 (10)	**934 (4)**	–	–
2005	**641 (52)**	−3214 (27)	−1742 (8)	**1424 (3)**	–	–
2006	**312 (50)**	−4138 (24)	−5217 (8)	**2259 (2)**	–	–
2007	−5175 (59)	−6344 (26)	−4099 (10)	**274 (1)**	–	–
2008	**2699 (59)**	−2029 (29)	**360 (12)**	**5709 (2)**	–	–
2009	**2928 (48)**	**832 (25)**	**2596 (11)**	**6970 (2)**	–	–

*Very small sample size (n ≤ 3)

likely be attributed to the robustness of forestry as a land use compared to agriculture; relatively good productivity can be achieved on poorer quality sites (Farrelly et al. 2011). The positive trend in NPVs over time is particularly interesting, especially in light of the fact that planting rates have generally declined since 2002. The forest premium was increased a number of times over this period, which offers some explanation of the rise in NPVs. However, there was a decline in agricultural profitability during this period as input prices rose while output prices

Table 5: *Soil category (SC) and yield class (YC) specific NPVs (€ ha^{-1}) for forestry replacing a cattle system with positive values in bold. The soil categories are defined in Table 2.*

Year	SC1/YC24	SC2/YC24	SC3/YC20	SC4/YC20	SC5/YC18	SC6/YC14
1995	−5952 (9)	**8234** **(5)**	**1747** **(30)**	−1914 (57)	**1583** **(42)**	**2428*** **(2)**
1996	**224** **(7)**	**2152** **(2)**	**435** **(24)**	**1190** **(41)**	**1544** **(23)**	**1696*** **(2)**
1997	−825 (22)	**905** **(15)**	−167 (49)	**1036** **(87)**	**636** **(29)**	**1021*** **(3)**
1998	**688** **(20)**	**2009** **(15)**	**1748** **(43)**	**2690** **(79)**	**2396** **(25)**	**1881*** **(3)**
1999	**2506** **(20)**	**2732** **(17)**	**1878** **(54)**	**3635** **(88)**	**3382** **(27)**	**1775** **(4)**
2000	**2668** **(24)**	**1596** **(20)**	**3079** **(54)**	**4386** **(87)**	**3628** **(21)**	**2707** **(4)**
2001	**3645** **(27)**	**2690** **(25)**	**1985** **(61)**	**3820** **(88)**	**4789** **(19)**	**4059*** **(3)**
2002	**2494** **(31)**	**4379** **(27)**	**3476** **(73)**	**4524** **(108)**	**4217** **(27)**	**4366*** **(3)**
2003	**4165** **(26)**	**3829** **(30)**	**3200** **(52)**	**4701** **(102)**	**4102** **(29)**	**4145*** **(3)**
2004	**3111** **(25)**	**2263** **(35)**	**2646** **(68)**	**4465** **(101)**	**4106** **(39)**	**4287*** **(3)**
2005	**2807** **(36)**	**2824** **(38)**	**3150** **(55)**	**4398** **(95)**	**5253** **(32)**	**4456*** **(1)**
2006	**5119** **(37)**	**3060** **(30)**	**2586** **(50)**	**5383** **(87)**	**5520** **(27)**	**4027*** **(2)**
2007	**3227** **(37)**	**1679** **(32)**	**4389** **(51)**	**6145** **(89)**	**6062** **(28)**	**–**
2008	**4205** **(41)**	**4966** **(29)**	**5730** **(51)**	**5595** **(81)**	**4984** **(32)**	**4764*** **(2)**
2009	**4224** **(39)**	**4942** **(36)**	**5860** **(52)**	**6290** **(74)**	**5869** **(31)**	**2564*** **(1)**

*Very small sample size (n ≤ 3)

remained relatively stable (Hynes and Hennessy 2012). The results of this study suggest that the financial reward for converting agricultural land to forestry is unlikely to be a driver of the decline in planting rates. Forest-related land-use decisions are driven by a combination of market drivers, policy variables, owner characteristics and land conditions (Beach et al. 2005). Thus future investigations of afforestation patterns may benefit from examining additional factors that may be

Table 6: *Soil category (SC) and yield class (YC) specific NPVs (€ ha^{-1}) for forestry replacing a sheep system with positive values in bold. The soil categories are defined in Table 2.*

Year	SC1/YC24	SC2/YC24	SC3/YC20	SC4/YC20	SC5/YC18	SC6/YC14
1995	−614 (29)	−687 (38)	**728 (40)**	**1144 (37)**	**3108 (58)**	**2012 (7)**
1996	−1353 (22)	−1951 (30)	−178 (45)	**1193 (28)**	**2913 (58)**	**1675 (5)**
1997	−1428 (19)	−884 (27)	−974 (28)	−360 (27)	**2565 (47)**	−304* (3)
1998	−809 (19)	**1075 (23)**	**1927 (24)**	**1377 (28)**	**4344 (42)**	**3783* (3)**
1999	**709 (14)**	**2149 (30)**	**2950 (25)**	**2623 (22)**	**4613 (38)**	**4027* (3)**
2000	**1059 (16)**	**2902 (29)**	**2793 (24)**	**3722 (21)**	**5867 (37)**	**3518* (2)**
2001	**332 (17)**	**205 (34)**	**2069 (25)**	**2667 (20)**	**4515 (36)**	**3038* (2)**
2002	**546 (15)**	**1302 (34)**	**2883 (24)**	**3323 (19)**	**4558 (35)**	**3693* (2)**
2003	**26 (14)**	**3874 (34)**	**2213 (27)**	**3084 (22)**	**3490 (37)**	**2673* (3)**
2004	**887 (16)**	**3120 (32)**	**3409 (29)**	**3924 (20)**	**5836 (34)**	**4175* (3)**
2005	−645 (17)	**2056 (28)**	**3624 (30)**	**3399 (16)**	**4864 (35)**	**4189* (3)**
2006	**274 (17)**	**2677 (29)**	**3157 (31)**	**4411 (18)**	**4576 (36)**	**3243* (3)**
2007	**6797 (11)**	**4860 (30)**	**4027 (27)**	**4385 (19)**	**5764 (38)**	**4796 (4)**
2008	**5184 (12)**	**5567 (26)**	**4780 (31)**	**5196 (15)**	**6933 (40)**	**4648 (4)**
2009	**6092 (15)**	**5770 (26)**	**5503 (30)**	**5320 (14)**	**5493 (35)**	**3477* (3)**

*Very small sample size (n ≤ 3)

discouraging farmers to convert to forestry. Land prices can have a significant effect on farmer's decision to enter forestry (Kula and McKillop 1998), which may offer some explanation of reductions in planting during years of high economic growth. A negative attitude amongst farmers towards forestry has been identified as a barrier to planting in previous surveys, although regional variances may exist (Ní Dhubháin and Gardiner 1994, O'Leary et al. 2000). Similarly, farmer motivations may play an

Table 7: *Average soil category specific NPVs (2009 € ha⁻¹) for forestry replacing the agricultural systems, adjusted using the consumer price index and expressed in 2009 values.*

System	SC1/YC24	SC2/YC24	SC3/YC20	SC4/YC20	SC5/YC18	SC6/YC14
Dairy	−19603.05	−27229.61	−18380.64	−14572.27	−9189.15	−9167.08
Tillage	−1951.58	−5392.43	−5211.61	**554.49**	**2322.32**	−
Cattle	**2244.23**	**3134.88**	**3117.51**	**4206.74**	**4410.44**	**3688.20**
Sheep	**1052.99**	**2244.17**	**2880.49**	**3405.87**	**5426.76**	**3765.59**

important part in their land-use decisions with the perceived lifestyle benefits of farming and the productivist mentality of some farmers limiting their interest in adopting what amounts to a major change in enterprise away from traditional farming (McDonagh et al. 2010). Farming and the production of food may thus provide a satisfaction that forestry and the production of timber lacks even where the latter is the financially optimum land use. Given the requirement to replant after clearfelling, the decision to plant trees is essentially a permanent one, which may act as a further disincentive. Restrictions on afforestation in environmentally sensitive areas may have a negative impact on afforestation rates locally (Collier et al. 2002). In addition, thresholds of forest cover may be reached in some parts of the country where land availability is restricting expansion (Upton et al. 2012). Uncertainty surrounding the outcome of renegotiations of the EU Common Agricultural Policy may also be influencing a farmer's decision on a long-term and permanent land-use change, such as forestry, although this issue has not been examined in detail.

Although an exact breakdown of the area of land under different agricultural systems is not available, approximately 80% (3.4 million ha) of all agricultural land in Ireland is used for grass, including pasture, silage and hay, 11% (0.5 million ha) for rough grazing and only 9% (0.4 million ha) for crop production (Hynes and Hennessy 2012). As the sampling for the NFS is based on system and farm size rather than soil quality it is not possible to identify the proportion of Irish farms or agricultural area would benefit from conversion from the results of this study. However, the results suggest that land that was previously used as rough grazing or grass production on lower quality soils might produce a greater financial return if used for forestry. Ireland may adopt a significant expansionary agricultural policy in the future with the Food Harvest 2020 strategy laying out targets for agricultural production, including a 50% increase in milk output (Department of Agriculture, Fisheries and Food 2010). It is difficult to identify how such targets will impact on land use, but if increased output leads to an increase in the profitability of competing agricultural systems, the relative profitability of afforestation may suffer in the absence of a comparable increase in revenue from increased timber prices or supports. Alternatively, if increases in agricultural production are focused only on the best quality land, this could result in the availability of marginal land for alternative uses (Feehan and O'Connor 2009).

A number of potential shortcomings of the study should be noted. The data employed in this analysis are based on actual farm data derived from the NFS, whereas income from timber production is derived from theoretically optimal management. It is recognised that farms in Ireland may not be managed in a financially optimal way and that decoupled payments may be partly subsidising unprofitable farm production (Howley et al. 2012). Thus, a comparison between optimal forest management and real agricultural enterprises may be somewhat biased. In a survey of farmers who had planted forests, Ní Dhubháin et al. (2010) found that although the majority had employed professional foresters to establish their forest, most planned to manage it themselves but lacked knowledge of management practices. As the private estate matures, the potential will arise to examine the management efficiency of private owners over a full rotation and produce a more accurate financial examination of land conversion. It is also important to note that the analysis was based on an average hectare, but farmers may possess a number of parcels of different levels of quality, which may or may not produce a financial benefit if converted to forestry. In addition, this study focuses on a single rotation of between 38 and 46 years and it is important to note that subsequent rotations would not benefit from premium payments, which could have a significant impact on farm income. Although reforestation costs are accounted for in the calculation which reflects future costs, the approach does not examine the longer time horizon, which may be of particular concern to some farmers, such as those with successors.

The agricultural gross margins included in the study are net of subsidies and it is thus assumed that farmers who planted would not lose out on agricultural subsidies. With the introduction of the single farm payment in 2005, farmers had the option of consolidating their entitlements on unplanted land and thus retain their payment. In this study, it was assumed that before this period farmers could increase stocking levels on unplanted land and thus not lose out on subsidies after afforestation. An examination of the effect of entering forestry on agricultural subsidies would require a detailed breakdown of enterprise, stocking rates, and land ownership and subsidy schemes at the individual farm level; this was deemed to be beyond the scope of the study. Future research in this area may attempt to examine this issue in more detail but is unlikely to substantially change the overall findings of the study. In addition, it was assumed that timber prices did not change in real terms over the period. This approach follows the assumptions of previous authors (e.g. Clinch 1999, McCarthy et al. 2003) and was considered reasonable given the limited availability of timber price data and the long-term nature of the investment. Finally, economic examinations of land conversion are increasingly accounting for environmental and social outcomes (e.g. Clinch 1999). This study focused solely on the financial outcome of land conversion for the landowner. Future examinations of the issue might benefit from accounting for the more general economic outcomes of such a conversion, including effects on employment and local economic activity and net carbon sequestration.

Conclusion

The financial consequences of converting agricultural land to forestry is of primary concern to forest policy in Ireland and to the achievement of afforestation goals in particular. Historically, forestry has always been associated with lower quality soils in Ireland. This study highlights the competitiveness of forestry with other land uses and the importance of soil quality in understanding the potential financial impacts of land conversion. Forestry is a good financial option on land used for cattle and sheep farming, with the potential for lower quality soils to deliver significantly higher NPVs from forestry than agriculture. In addition, forestry has become more competitive over the time period 1995 to 2009, which is in contrast to patterns in afforestation rates.

Practical Implications

- Forestry can be a good financial option for cattle and sheep farms in Ireland over a single rotation but is unlikely to compete financially with dairy systems.
- Soil quality plays an important role in understanding the financial outcome of converting land to forestry. The results suggest that forestry has a greater competitive advantage on poorer quality soils.
- Forestry has become more competitive over time in comparison to agriculture, which suggests that decreases in afforestation rates in recent years have not been driven solely by the financial outcome of land conversion.

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