Investigating the feasibility for an Agroforestry Carbon Code – NEIRF

Financial appraisal

August 2023

Contents

Executive Summary ____ 3
Objectives ____ 5
Financial appraisal methodology ____ 5
Financial model assumptions ____ 6
Outputs of financial modelling and analysis ____ 10
Demand for Agroforestry Carbon Units ____ 18
Key findings ____ 19
Appendix 1: Assumptions tested ____ 21
Appendix 2: Pilot site cashflow profiles under baseline and agroforestry revenue scenarios ____ 24

Financial appraisal for an Agroforestry Carbon Code

Executive Summary

In June 2022, a consortium of organisations was awarded funding from the Natural Environment Investment Readiness Fund (NEIRF) to explore the feasibility of an Agroforestry Carbon Code. Finance Earth led the financial appraisal of the role of carbon income in supporting the commercial viability of agroforestry projects.

Cost and revenue data was gathered from five agroforestry pilot sites in order to model the potential to blend carbon income, grant funding and revenues from the sale of agroforestry produce (e.g. fruit and nuts). Finance Earth assessed the financial viability of each pilot site and the importance carbon unit revenues played in covering lifetime project costs, as well as the potential to attract repayable investment to accelerate delivery of agroforestry across the UK. The five pilot sites for which financial information was included were: Parkhill Farm, Wood Advent Farm, Spains Hall Estate, Riverford Dairy Farm and Ings Farm (RegenFarmCo). The analysis was based on specific agroforestry interventions across the pilots and did not consider the overall impact on the farm-level business model.

This report provides the results of the analysis and the outputs across the five agroforestry pilots. Key findings across four target questions are as follows:

1. **What role can carbon income play to support delivery of agroforestry projects based on the latest available science?**

    - There are significant variations relating to establishment and maintenance costs, stocking density, type of agroforestry system and ultimately the potential carbon sequestration rates achieved across different projects.
    - Carbon revenues generates 1%-5% of project lifetime costs (present value), confirming that carbon income is not a primary driver of project viability.
    - Carbon income could play a role in addressing key market barriers by supporting initial capital expenditure and provide an additional diversified income source to incentivise project delivery over the lifetime.

2. **What blend of carbon income, grant funding and agroforestry product revenues is needed to deliver financially viable agroforestry projects?**

    - The costs of agroforestry projects are not solely met by the combination of carbon income and public funding alone.
    - The primary driver of a project's financial viability is likely to be agroforestry product revenue, however revenues are only generated once the crop has matured after several years, resulting in an initial funding gap, which could be met through sales of Pending Issuance Units or upfront repayable investment.
    - In certain cases, the blended project revenues may be sufficient to cover costs and provide an investor return, but scale may be a limiting investment factor.

- Private finance is more likely to be suitable for relatively large-scale projects with higher stocking densities or will require aggregation of multiple smaller sites or delivery of interventions across a farm to reach a scale that delivers transaction cost efficiencies.
- Financing of agroforestry systems should be considered as part of its role in the wider farm business model rather than on a standalone basis.

3. Is there a commercial case for an Agroforestry Carbon Code?

- The limited carbon income generated through agroforestry suggests that a standalone Agroforestry Carbon Code is unlikely to be viable, given the associated running costs of an accreditation scheme and ongoing verification requirements.
- A preferred route forward would be for an agroforestry carbon methodology to be bolted onto an existing code, such as the Woodland Carbon Code or nascent Hedgerow Carbon Code.
- Agroforestry could also be included in wider nature frameworks, such as the BSI Nature Standard, to support market robustness and quality.
- A farm-level framework or aligned governance across codes may improve the viability of a whole farm carbon sales approach through delivering cost efficiencies.

4. Is there likely to be demand for Agroforestry Carbon Units (ACUs)?

- Market evidence suggests that demand for carbon credits far exceeds the supply of credits available and there is strong demand for the development of high-integrity nature-based projects in the UK which deliver additional co-benefits beyond carbon.
- Agroforestry schemes can deliver a broad range of environmental co-benefits, including improved soil structure, resilience to climate change, water quality improvements, and creating biodiversity corridors, with wider community benefit opportunities through volunteer engagement in project delivery and management.
- However, agroforestry projects present some potential market integrity risks, including the permanence of the carbon sequestered in shorter duration schemes and the uncertainty of additionality of carbon income, which may reduce buyer demand or pricing for ACUs.
- The agroforestry carbon methodology could be well-suited to supporting supply chain carbon measurement approaches and insetting strategies, as an alternative to the carbon offsetting market. Alignment to a carbon verification standard and approved methodology would support a robust insetting approach.

Objectives

This report aims to provides a financial appraisal of the role that an Agroforestry Carbon Code in the UK could play in providing carbon income to support the commercial viability of agroforestry projects. It aims to answer four key questions:

1. What role can carbon income play to support delivery of agroforestry projects based on the latest available science?
2. What **blend of carbon income, grant funding and agroforestry product revenues** is needed to deliver financially viable agroforestry projects?
3. Is there a **commercial case for an Agroforestry Carbon Code**?
4. Is there likely to be **demand** for Agroforestry Carbon Units (ACUs)?

Financial appraisal methodology

Financial data was gathered from five agroforestry pilot sites on lifetime costs and private and public revenue streams. A bespoke financial model was created for each pilot site to understand the cashflow profiles for a variety of agroforestry systems with in-field trees in different regions. An assessment of the financial viability of pilot projects and potential carbon funding opportunities was carried out by modelling revenues generated from the sale of carbon credits to the UK voluntary carbon market. The optimal blend of funding streams across carbon income, grant funding and agroforestry product sales income was tested, providing an indication of commercial considerations around the implementation of an Agroforestry Carbon Code. The analysis was based on specific agroforestry interventions across the pilots and did not consider the overall impact on the farm-level business model.

Engagement with potential carbon credit buyers was carried out throughout the project to test market demand for UK carbon credits. Engagement focused on understanding the demand for both broader nature-based carbon credits (such as peatland and woodland carbon) and new markets (e.g., agroforestry), given the limited availability of scientific data on carbon sequestration from agroforestry systems and the early stage of scoping for an Agroforestry Carbon Code.

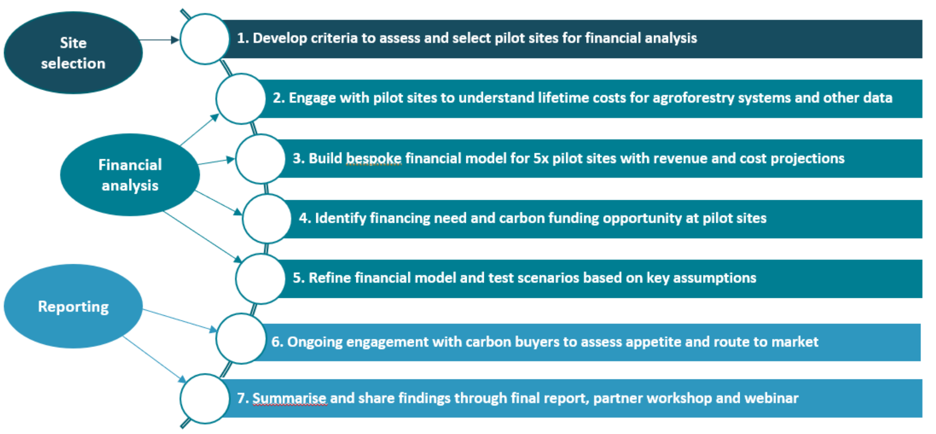

Figure 1. Financial appraisal methodology and process

Financial model assumptions

Multiple data sources were used to identify assumptions and test sensitivities within the financial models. Primary data was drawn from field data collected across five pilot sites. To account for variations in data availability and completeness, published literature on agroforestry systems in the UK and Europe was used alongside site inputs. Standards and guidance from the UK Woodland Carbon Code (WCC) were also used to inform assumptions and ensure alignment with existing frameworks. A range of assumptions covering low, mid and high cost and revenue scenarios were tested to explore how sensitive model outputs were to changing assumptions and this data is outlined in *Table 3*, Appendix 1. Given the wide range in variables, a mid-case was used where pilot site data was unavailable, seen in *Table 1*. Two scenarios were subsequently analysed to test key income variables and identify the blend of funding required to support overall project viability.

Table 1. Assumptions forming pilot site financial modelling inputs

Assumptions	Mid-case	Sources
Carbon revenues		
Carbon price (PIU) (£)	23	Finance Earth: Average UK voluntary carbon transaction prices for woodland and peatland carbon within the WCC
Verification premium (%)	30	Climate Change Committee (2022) price premium from PIU to WCU (verified units)[1]
Sequestration rate (tCO_2e/ha/year)	1.5	Organic Research Centre pilot site carbon modelled net sequestration rates; Cardinael et al. (2018)[2]
Buffer (%)	20	WCC (risk buffer)[3]; Gold Standard buffer level[4]
Stocking density (stems ha-1)	200	Stocking density used to scale available grant payment rates across the devolved administrations[5,6,7]
Other revenues		
Capital grant		

[1] Climate Change Committee (2022) Voluntary Carbon Markets and Offsetting URL
[2] Cardinael, R., Umulisa, V., Toudert, A., Olivier, A., Bockel, L., Bernoux, M. (2018) Revisiting IPCC Tier 1 coefficients for soil organic and biomass carbon storage in agroforestry systems Environmental Research Letters, 13 (12), art. no. 124020. URL
[3] Woodland Carbon Code. Management of risks and permanence -Contributing to the buffer. URL
[4] Gold Standard (2021) How do you ensure that Gold Standard Emission Reductions from sequestration (Land Use) represent permanent carbon reductions? For example, what happens if a forest burns down? URL
[5] Public funding payment rates for agroforestry available in Wales
[6] Public funding payment rates for agroforestry available in Scotland. Payment rates incorporated within this analysis are as of 2020. The availability of grant funding for agroforestry in Scotland has since been updated and stipulated on a £/tree basis, as of July 2023, but these rates have not been incorporated within this analysis.
[7] Public funding payment rates for agroforestry in Northern Ireland

Scotland sites (£/tree)	9	Scotland agroforestry public funding rates[6]
England sites (£/tree)	6	EWCO (England Woodland Creation Offer) payments[8]
Maintenance grant		
Scotland sites (£/tree – across 5 years)	0.23	Scotland agroforestry public funding rates[6]
England sites (£/ha/year – across 10 years)	175	Future payments for agroforestry to be published under the ELM Sustainable Farming Incentive scheme: "Revenue payments will depend on tree density £50 to £300 per ha"[9] Assumption in line with existing payments relevant to agroforestry, under the existing Countryside Stewardship offer[10]
Agroforestry product sales (£/ha/year)	600	Expert opinion across the project steering group
Costs		
Inflation rate (%)	2.5	Long term RPI inflation
Verification costs (£)	1,500	Soil Association: verification costs under the Woodland Carbon Code, assuming a discounted rate for multiple smaller projects aggregated together[10]
Maintenance costs (£/ha/year)	400	Pilot site data – scaled according to site stocking density
Cost of sales (£/unit)	1.50	Example broker rates on voluntary carbon markets
Costs contingencies buffer (%)	10	Sensitivity analysis

[8] Forestry Commission (2023) Payment rates available under EWCO– i.e., a total of per tree payment rates for individual capital items such as “Supply and plant of trees”, “Supplement for use of individual tree shelters” and “Mulch mats”. URL
[9] UK Government (2023) ELM payment rates update -as of February 2023. URL
[10] Woodland Carbon Code. Verification - Ongoing check of carbon sequestered – How much does verification cost? URL

Revenues

Carbon pricing

An average starting transaction price of £23/Pending Issuance Unit (PIU) was used based on quoted and transacted prices Finance Earth has seen across the UK voluntary carbon markets, primarily projects validated under the UK WCC. The price point for agroforestry carbon was further validated based on data from the Acorn initiative for Carbon Removal Units (CRUs) from agroforestry projects, incorporating the current CRU price (31 EUR) and price floor (20 EUR).[11] To ensure alignment with the operating codes (e.g, WCC), 20% of credits generated were assumed to contribute to a credit buffer pool, which cannot be sold and will be called upon if there are any future losses of carbon from a project.

Carbon sales strategy

To consider market integrity of carbon revenues generated, revenue scenarios were modelled for both PIU) (£23/PIU in Year 1) and verified ACUs (£31/unit assuming a 30% price premium when sold post-verification), with verification occurring in Year 5 and subsequently every 10 years under both scenarios. A PIU strategy has been modelled for each pilot in order to clearly visualise where carbon income could play a role in addressing the upfront funding gap for project implementation and illustrate the overall proportion of carbon income that could be generated. A verified unit sales approach was also considered to assess the impact of potential price growth and premiums on project cashflows and investibility.

Carbon sequestration

Modelled net carbon sequestration data from Organic Research Centre was generated for all five of the financial appraisal pilots. To validate assumptions, published literature on carbon sequestration (tCO_2e) potential of agroforestry systems in the UK and Europe was considered. While sequestration rates vary depending on the specific agroforestry system (higher sequestration rates are observed within silvopastoral systems), the assumptions do not distinguish between these systems, given three of the five pilot sites adopt a combination of both silvopastoral and silvoarable systems. Assumptions for sequestration rates account for low tree stocking density across the pilot sites, in line with relatively low tree stocking densities observed within the UK.

Public funding

Payment rates for agroforestry activities under the EWCO and Countryside Stewardship were determined through discussions with Defra. An agroforestry standard for England under the Sustainable Farming Incentive is expected to be published in 2024, providing detailed payment rates for agroforestry systems in England. The latest available payment rates across the devolved administrations were also taken into account, adjusting to a £ per tree measurement. Grant funding for agroforestry in Scotland was revised as of July 2023,[12] but this update has not been reflected within the financial analysis. Payment rates included in this analysis for Scotland are based on data as of 2020.[13]

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[11] Plan Vivo (2022) How does Acorn work? All characteristics of CRUs. URL

[12] Scottish Government (2023) Rural Payments and Servies – Agroforestry [July 2023]. URL

[13] Public funding payment rates for agroforestry available in Scotland. URL

Stocking densities were used to calculate available grant funding and maintenance cost assumptions based on the number of stems in a system. Primary stocking density data was received for Parkhill Farm (111 stems/ha) and Wood Advent Farm (30 stems/ha). For other sites, an average of 200 stems/ha was assumed, in line with stocking densities used to determine payment rates available across the devolved administrations.

Agroforestry product sales income

Agroforestry systems present an opportunity for generating product revenue, varying depending on the agroforestry system. Revenue from the sale of agroforestry produce (fruit, nuts, timber, etc.) was included based on the data received across one pilot site. At Parkhill Farm, revenue of £559/ha/year was modelled across Years 3-25, accounting for the contribution of productive apple trees grown on the site towards revenue generated from its cider business. Harvesting costs were also factored into the cashflow profile. For pilots which did not provide projected revenue forecasts, an average of £600/ha/year was used to forecast the net income from the sale of agroforestry produce, factoring in harvesting costs.

Costs

Restoration and maintenance costs

Cost data was received across all five pilot sites for the financial appraisal, covering capital costs for restoration and annual maintenance costs. Upfront capital costs encompass development costs including legal and staff costs and potential project developer fees. Implementation/restoration phase costs include tree saplings, planting labour, tree protection and soil preparation. Maintenance costs (to which a 10% contingency buffer was applied) encompass activities such as pruning, fencing, and ongoing tree protection, considering only the agroforestry trees and not the whole field. To account for variations in timeframes used and availability of data provided, an average mid case of £400/ha/year was used for pilot sites with no data for long-term maintenance costs. Land acquisition and lease payment costs were excluded from the financial model, as all pilot sites were already owned by the project developer.

Validation and verification costs

Soil Association validation and verification costs were used, assuming cost savings from grouping a number of (15+) small projects together. The assumed verification frequency (initially in Year 5 and every 10 years thereafter) aligns with that under the WCC.

Inflation

A cost inflation rate of 2.5% is included based on the long-term target Real Price Index (RPI) inflation rate. This was factored into all costs to account for the requirements on carbon projects to manage and cover costs over a long-term project lifetime, and account for inflation risks if carbon sales are made upfront.

Outputs of financial modelling and analysis

Pilot site key costs and timelines

Financial data collected for the pilot sites indicate variations in costs across sites, primarily due to planting and harvesting periods, stocking density and tree types. **Figure 2** shows the cost profiles across pilot sites.[14] High initial costs lead to a financing need towards the beginning of the projects, highlighting a potential role for carbon income in filling this funding gap. Implementation timelines also differ across projects, with one-year implementation phases at Wood Advent Farm, Riverford Dairy Farm, and Parkhill Farm, and five-year phases at Ings Farm (RegenFarmCo) and Spains Hall Estate.

Maintenance costs are included for agroforestry trees only and not the entire field. Costs are expected to decrease over time as trees mature, with an assumed phased decrease. Inflation is included across the modelled costs, creating a perceived increase in costs year on year within maintenance phases when compared to present value.

Smaller sites may incur proportionately higher costs, when costs are based on fixed fees e.g. verification or transaction costs. For example, for the smallest pilot site - Parkhill Farm (7ha) – third party verification costs far outstripped projected carbon income. In the case of all other pilot sites, carbon costs (for validation, verification and indicative cost of sales) are lower than the overall carbon income generated on these sites with proportions of carbon costs to income ranging from 5-55% (depending on factors such as site size and number of ACUs generated).

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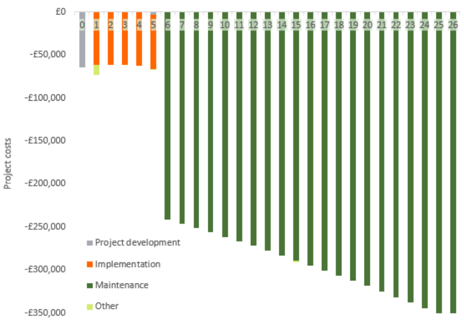
[14] See the NEIRF pilot site report produced by the Woodland Trust for further information on full pilot site characteristics.

Location: Fife, Scotland
Area: 7 ha
Baseline habitat: Arable Field
Type of agroforestry: Silvoarable x750 trees (apple)
Timeline: 35 years
Project costs (total): £110k (£16k/ha)
Project costs (NPV, 3.5%): £64k (£9.6K/ha)

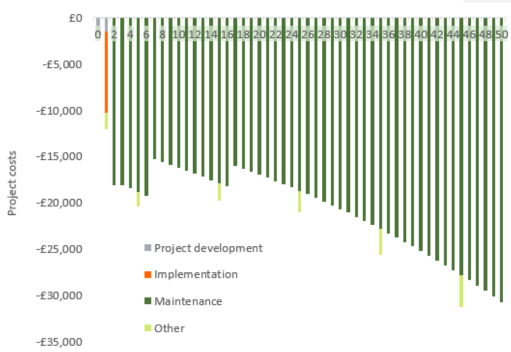
Spains Hall Estate



Location: Essex, England
Area: 300 ha
Baseline habitat: Arable cropland
Type of agroforestry: Silvopasture - nut trees and timber
Timeline: 26 years
Project costs: £6.6m (£22k/ha)
Project costs (NPV, 3.5%): £3.8m (£12.7k/ha)

Location: Somerset, England
Area: 29 ha
Baseline habitat: Arable and permanent pasture
Type of agroforestry: Silvoarable and Silvopastoral x878 trees (60 chestnuts, 200 hazelnuts, 618 walnuts)
Timeline: 50 years
Project costs: £1.1m (£37k/ha)
Project costs (NPV, 3.5%): £466k (£16.1k/ha)

Riverford Dairy Farm



Location: Devon, England
Area: 29 ha
Baseline habitat: Permanent pasture and leys
Type of agroforestry: Silvopastoral and silvoarable
Timeline: 51 years
Project costs: £1.1m (£37k/ha)
Project costs (NPV, 3.5%): £442k (£15k/ha)

Ings Farm (RegenFarmCo)

Location: North Yorkshire, England
Area: 37ha
Baseline habitat: Sheep grazing
Type of agroforestry: Complex stacked alley cropping agroforestry system
Timeline: 25 years
Project costs: £720k (£19k/ha)
Project costs (NPV, 3.5%): £521k (£14.1k/ha)

Figure 2. Pilot site summaries and cost profiles

Cashflow outputs for pilot sites

A financial model was created for each pilot site to forecast the cashflows generated over the project lifetime, based on the above assumptions for revenues and costs (Table 1, Figure 2). Outputs were discounted to Net Present Value (NPV) using a discount rate of 3.5% to match the Green Book guidance.[15]

For the five pilots, two scenarios were modelled across each site to assess the impact of carbon income on project financial viability, using site data and consistent assumptions in each case:

1. Baseline scenario: carbon revenues (upfront PIU sales) modelled based on carbon sequestration rates at pilot sites, project costs, and public grants received for agroforestry schemes. Assumed revenues from the sale of agroforestry produce were excluded.
2. Agroforestry revenue scenario: cashflow from the baseline scenario with the inclusion of income from the sale of agroforestry produce. The analysis also considered the impact of the inclusion of and removal of the carbon income under this scenario to assess the project viability without carbon income.

[15] UK Government (2022) Green Book supplementary guidance: discounting. URL

A viable agroforestry project needs to generate sufficient revenues to cover lifetime costs and could potentially be investible if it also meets the minimum risk-return requirements of investors. Considering the baseline scenario (in which only carbon income and public grants are available), the analysis shows that none of the pilot sites included in the financial appraisal are viable, as the revenues are insufficient to cover project costs over the lifetime. However, when carbon income is considered alongside modelled revenues from the sale of agroforestry produce (e.g. fruit and nuts), certain projects demonstrate viability, alongside the ability to generate a modest rate of return which may be attractive to an investor. The relatively small-scale nature of agroforestry projects means that aggregation of multiple projects is likely to be needed to meet scale requirements for private investors.

The cashflow outputs across each project are provided in the Table 2 below.

Table 2. Key financial outputs across agroforestry pilot site projects

Pilot site data	Parkhill Farm	Wood Advent Farm	Spains Hall Estate	Riverford Dairy Farm	Ings Farm RegenFarmCo
Site size (ha)	7	29	300	29	37
Project lifetime (years)	35	50	26	51	25
Total carbon sequestered over project life (tCO_2e/ha/yr)	0.08	0.79	1.02	0.80	1.35
Total costs (£)	-64,362	-466,879	-3,807,443	-442,225	-521,969
Potential carbon income (£)	333	20,291	140,931	20,959	22,120
Grant income (£)	7,288	29,083	844,213	50,230	89,669
Baseline scenario outputs (excluding agroforestry product revenue)					
Net operating cashflow/ funding gap (£)	-56,742	-412,622	-2,787,066	-365,796	-404,650
Per ha					
Total costs (£/ha)	-9,592	-16,099	-12,691	-15,249	-14,107
Potential carbon income (£/ha)	50	700	470	723	598
Grant income (£/ha)	1,086	1,003	2,814	1,732	2,423
Funding gap (£/ha)	-8,456	-14,397	-9,408	-12,817	-11,086
Agroforestry revenue scenario outputs					
Potential private agroforestry income over project lifetime (£)	64,170	495,694	2,880,175	503,199	379,795
% carbon income of total costs (%)	1	4	4	5	4
Net operating cashflow/ funding gap (including carbon income) (£)	7,428	78,189	57,876	131,516	-30,385
Net operating cashflow/ (excluding carbon income) (£) *	16,865	69,050	-75,416	121,709	-45,643

Net operating cashflow/funding gap (assuming verified carbon) (£)	7,611	88,398	118,090	141,849	-19,519
Investment need (minimum cash position + buffer) (£)	20,000	90,000	80,000	50,000	220,000
Investor IRR (assuming verified carbon) (%)	6.1	5.8	10.3	9.6	2.3

*All outputs in NPV, discounted to a rate of 3.5%. *Operating cashflow without carbon income assumes no verification costs or cost of sales*

Blended funding and sales strategies

Based on an upfront PIU sales approach, the pilot site cashflow profiles indicate that carbon revenues have the potential to cover 1-5% of project costs, illustrated in Figure 3. This is a result of the low site level net sequestration rates modelled at the pilot sites included in the financial appraisal (0.08-1.35 tCO_2e/ha/yr). These sequestration rates are lower than seen in published literature due to the reduced stocking density in UK agroforestry projects. The limited carbon quantum suggests that the financial contribution of carbon revenues to determining financial viability is relatively limited. As such, it is unlikely agroforestry carbon projects would meet financial additionality requirements of other similar carbon standards, such as the Peatland Code for instance, where carbon finance is required to make up at least 15% of the project's restoration and maintenance costs over its duration.

However, the appraisal of cashflows across each project also highlights that the timing of potential carbon revenue may be important in supporting the financial viability of a project. Carbon income early in the project lifetime may have a role to play in covering capital costs for some of the pilot sites, before agroforestry systems become productive and alternative revenue streams are available. Agroforestry projects require increased revenues from product sales and/or higher grant levels to address existing funding gaps and achieve financial viability.

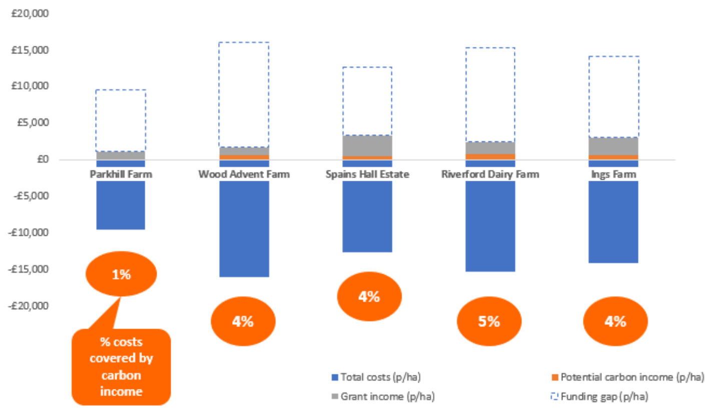


Figure 3. Funding need across agroforestry pilot site projects

Sales strategy

A predominantly PIU sales approach would be best aligned to the net cashflow profiles of agroforestry projects. Upfront PIU sales could be attractive to cover some of the initial capital costs (purchasing trees, tree guards, labour, fencing, etc.) before agricultural revenues are generated after the first few years of establishment, with a portion of units retained to be sold once verified to support ongoing verification costs. However, low overall carbon sequestration rates translate to limited carbon income overall, reducing the feasibility of covering costs of sales and verification costs overtime, and a high proportionate cost of sales may limit the desirability of selling verified units. An example of a purely ex-post sales strategy can be referred to in Figure 4, *'Verified carbon scenario'*. Such an approach better upholds market integrity, whilst also illustrating the potential opportunity for upfront investment to meet the funding gap.

Role of public funding

Public funding plays a role in supporting initial capital costs and stabilising ongoing cashflows, given that maintenance costs are high and often underestimated by farmers. Public funding can be blended alongside carbon income to support overall project viability, which is evidenced in the woodland and peatland carbon market. However, in the absence of agroforestry product sales and based on expectations of public funding and carbon income, project cashflows remain negative. Grant funding should increase to further incentivise the uptake of agroforestry projects in the UK. Considering the commercial potential of agroforestry projects, public funding streams should be designed to effectively blend with private markets.

Other income streams

While not considered a direct market revenue, it is important to acknowledge the potential co-benefits and additional income stream that may arise from implementing agroforestry practices. This can include an increase in productivity of the wider farm resulting from the presence of agroforestry systems. Although there is limited data around such changes in productivity (whether in gains or losses), these changes are more pronounced within silvopastoral systems. As a result, it is important to extend consideration to silvoarable systems as well.

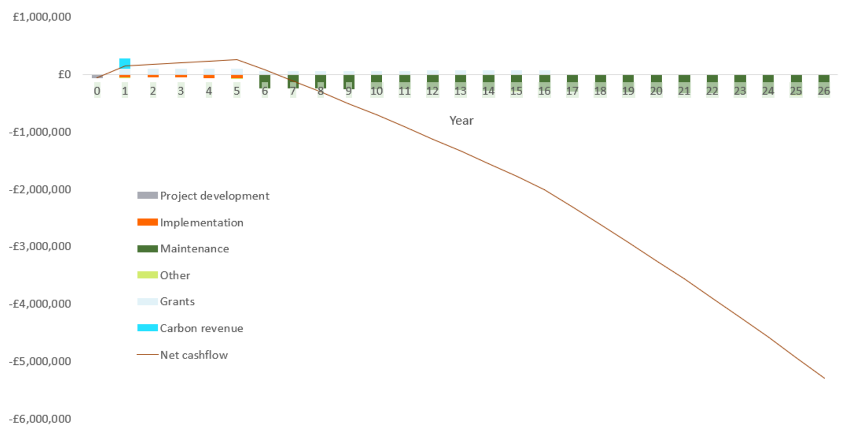
Pilot site example: Spains Hall Estate

An illustration of the outputs from the financial analysis for the Spains Hall Estate pilot is provided below. The cashflow outputs for the other pilots are included in Appendix 2, given that the overall findings across each pilot are similar, despite the variations certain assumptions and outputs.

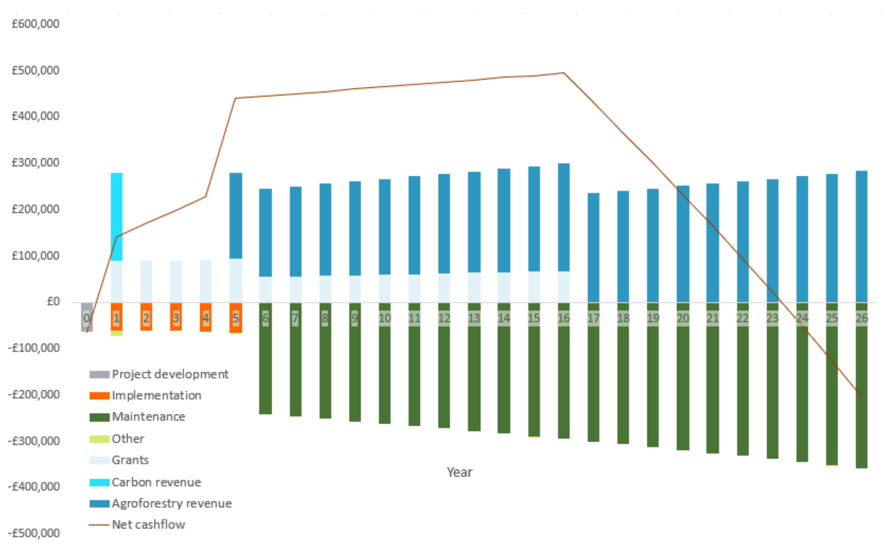
For Spains Hall Estate, the baseline scenario (excluding modelled nut revenues) demonstrates that carbon income may be important to cover the implementation costs of the agroforestry project from Year 1 to Year 5. However, the project remains unviable over its lifetime as net cashflows cease to be positive once grant funding expires, with negative net cashflow occurring beyond Year 6.

Under the agroforestry revenue scenario, revenue from the sale of walnuts and hazelnuts is modelled, supporting high ongoing maintenance costs. This scenario indicates that the project's financial viability in the long term would require a dependence on public grants, extending beyond the current 10-year period covered by grant contracts.

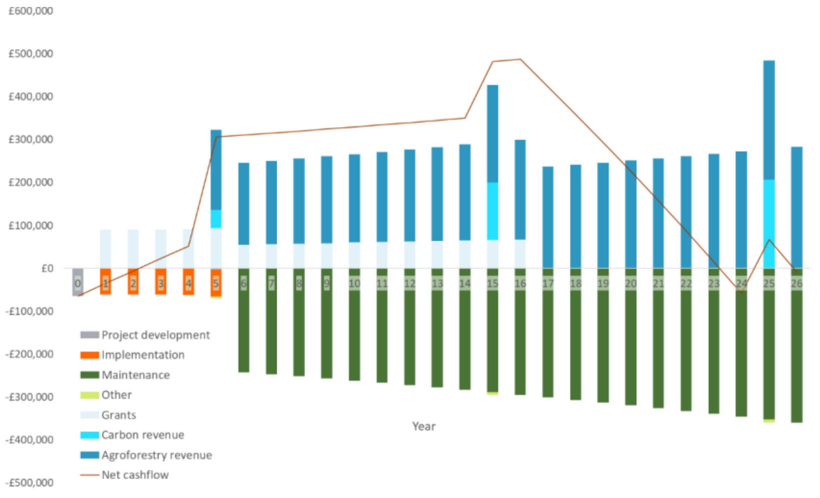
An additional 'verified carbon' carbon scenario was modelled to analyse the impact of sales of verified carbon overtime. There is an initial upfront funding gap of c.£80,000 to cover costs before sufficient revenues are generated over time to repay the investment. The sale of verified carbon generates income across the project timeline. However, based on current assumptions, the project cashflows indicate a slightly negative trend towards the later stages of the project, before the final carbon sales point in Y25. This may hinder the project's attractiveness for investment or necessitate an additional cash injection. The cashflow profile outputs of the three scenarios are provided in the graphs below.



Baseline scenario: Modelled project cashflow using site-level carbon sequestration rate (1 tCO2e/ha/yr) to determine potential carbon revenues alongside project costs and grant income. Agroforestry product revenues excluded from cashflow.



Agroforestry revenue scenario: Baseline project cashflow with the addition of income from the sale of agroforestry produce.



***Verified carbon scenario**: Income from the sale of verified carbon units, agroforestry produce and public grants.*

Figure 4. Illustrative financial model outputs at Spains Hall – cashflow profiles across three modelled scenarios

The financial viability assessment across the other four pilot sites followed the same baseline and agroforestry revenue scenario approaches. The financial outputs show significant variation between the delivery costs per hectare and the carbon sequestration rates for the pilots. However, across the pilots, a consistent conclusion is that carbon income alone will not support financially viable projects and agroforestry product income is the primary driver. For detailed analysis of cashflow profiles across the five pilot sites, refer to Appendix 2.

Repayable investment analysis

Repayable investment may be required to bridge an initial funding gap before revenues are generated over time. This could be needed in the case of selling a low proportion of PIUs and an adoption of an ex-post carbon sales strategy, with additional revenues generated over time through the sale of agroforestry produce.

If only verified carbon units are sold, the projects will have an initial funding gap to fill, with the potential ability to repay required upfront investment through carbon and agroforestry income generated overtime. Favourably, an ex-post sales strategy supports market integrity through ensuring the carbon benefits are delivered before credits are sold and enables the project developer to benefit from projected growth in carbon prices.

The internal rate of return (IRR) is a common metric used in financial analysis to estimate the profitability of potential investments and reflects the discount rate at which the NPV of all cashflows equal zero in a Discounted Cashflow (DCF) analysis. Investors generally compare a potential investee project's IRR against their internal cost of capital to assess whether a project is investible. Return expectations will depend on investor preferences and their risk-return profile, but a level of 10% is typically sought by equity investors, as a minimum IRR for investment.

The potential investment need for each project was identified based on the minimum cash balance over the first 10 years in the project. The revenues generated assume that only verified carbon units are sold overtime, with additional grant funding and agroforestry product revenues. The investor IRR for each project has been calculated on the assumption that disbursals to an investor are not made until revenues are sufficient to cover the following year's costs. Excess cash is then disbursed to repay the investor with a return. This generates the IRRs over the project lifetime for each pilot site, included in Table 2. Projects with a positive IRR may be sufficient to attract repayable investment dependent on investor appetite and time horizons for repayment and returns, given revenues are generated over long timescales. The projects will only be investable on the basis of assumed agroforestry product revenues.

Whilst a project may be deemed investible in terms of the IRR, the investment requirement (based on minimum cash balance) for most pilot sites (ranging from £11,000 - £220,000) may not be substantial enough to meet an institutional investor's minimum ticket size. Given the upfront need for capital is relatively low, this presents the case for project aggregation, as private finance is more suited to larger-scale projects with positive cashflows over the project lifetime. A need for the aggregation of projects might further incentivise farmers to engage in carbon revenues, considering the potential for cost efficiencies in verification processes, preparing documentation and engaging with advisors. Alternatively, farmers might opt to make their own individual equity investments in projects, as an individual business case.

Demand for Agroforestry Carbon Units

Demand for voluntary UK carbon credits is expected to surpass available supply, albeit several factors will be considered by buyers, influencing demand for purchasing credits. Buyers will conduct due diligence to determine strategic alignment of credits to their setting of science-based emission reduction targets and carbon claims made. As such, adherence to a robust, quality code, and the presence of both code endorsement such as the 'International Carbon Reduction and Offsetting Alliance', will instil buyer confidence. Established Measurement, Reporting and Verification frameworks will further ensure buyers are aligned with accepted guidance.

Additionally, buyers seek projects with positive social and community impacts, offering broader community benefit and UK projects that deliver local co-benefits have the potential to command premium pricing in the market. Flexibility and the absence of a minimum price are appealing attributes to most buyers and brokers and pricing confidence within existing carbon codes in the UK such as the Peatland Code, is increasingly being established. Importantly, given buyers will seek to diversify their portfolios, the demand for credits will vary depending on the nature of the buyer organisation. For example, corporate buyers prioritise meeting near-term demand and often seek verified units for Corporate Social Responsibility and carbon neutrality claims. Larger corporates or groups, with more resources and budget, may seek long-term supply through offtake agreements, while local SMEs will likely express interest in smaller volumes.

As an alternative to the carbon offsetting market, Agroforestry carbon schemes may be well-suited to address supply chain climate targets and insetting strategies. The credibility of insetting approaches would be supported through close alignment to a carbon verification standard and approved methodology.

Key findings

The findings relating to the four key questions for the financial appraisal of the five pilot sites are outlined below.

1. Role of carbon income in supporting agroforestry project delivery

The financial appraisal conducted across the five sites highlighted significant variations relating to establishment and maintenance costs, stocking density, type of agroforestry system and ultimately the potential carbon sequestration rates achieved. The primary driver of a project's financial viability was agroforestry product revenues, harvested and sold produce after the initial period of establishment and crop maturation (~5 years). The analysis showed that carbon revenues, modelled using a PIU approach would generate 1-5% of project lifetime costs and confirmed that carbon income was not a primary driver of project viability.

Carbon income could play a role in addressing key market barriers by supporting initial capital expenditure and provide an additional diversified income source to incentivise project delivery over the lifetime. Further engagement with land managers is required to test the attractiveness of the carbon revenue in incentivising agroforestry project delivery.

The conclusion from the pilot sites is that a blend of funding is needed to support projects as carbon income alone is not sufficient to determine financial viability irrespective of the variation in carbon sequestration rates across sites. Public funding and agroforestry product revenues are required to establish financially viable agroforestry projects and carbon income could act as an additional support mechanism to de-risk the financial viability.

2. Opportunity to deliver a financially viable agroforestry project through blended funding

A significant funding gap exists across the five project sites assessed, even with the inclusion of the anticipated public funding mechanisms alongside the carbon income. The combination of carbon income and public funding alone are unlikely to cover long-term costs and projects only become viable when revenues are included from the sale of agroforestry products. However, these revenues are only generated once the crop has matured after several years resulting in an initial funding gap.

The sale of carbon units could provide a partial solution to the initial funding gap if a portion of PIUs are sold and could provide an incentive for land managers to deliver schemes through lowering the capital required on implementation. However, the PIU sales approach leads to market integrity risks due to the limited agroforestry science/data on carbon sequestration, risk of project failure and cost inflation risk, and limits the potential for the land manager to benefit from future carbon price growth. Alternatively, the sale of verified ACUs could generate additional carbon income (up to 8% of the pilot project costs) to provide a long-term income stream to cover costs over the project and build market integrity. However, neither the PIU or ACU sales approach supports a financially viable agroforestry project based on carbon income alone, and blended funding is needed in all cases.

This analysis also assessed the opportunity to attract upfront private finance to deliver agroforestry projects based on sales of verified ACUs and agroforestry produce. In certain cases, the project revenues may be sufficient to cover costs and provide an investor return but scale may be a limiting investment factor. Private finance is more likely to be suitable for relatively large-scale projects with higher stocking densities or will require aggregation of multiple smaller sites or delivery of interventions across a farm to reach a scale that delivers transaction cost efficiencies.

While not specifically modelled, it is important to acknowledge the potential co-benefits and additional income or cost-savings that may arise from incorporating agroforestry trees into land management practices. Implementation of agroforestry systems can lead to an increase in productivity across the farm, which can provide additional incentives to incorporate agroforestry into wider land management. Financing of agroforestry systems should be considered as part of its role in the wider farm business model rather than as a separate intervention.

3. Commercial case for an Agroforestry Carbon Code

The limited carbon income generated through agroforestry suggests that a standalone Agroforestry Carbon Code is unlikely to be viable, given the associated running costs of an accreditation scheme and ongoing verification requirements. A preferred route forward would be for an agroforestry carbon methodology to be bolted onto an existing code, such as the Woodland Carbon Code or nascent Hedgerow Carbon Code. Agroforestry could also be included in wider nature frameworks, such as the BSI Nature Standard, to support market robustness and quality. The results suggest that there is a potential need to develop a whole-farm approach to carbon accreditation with agroforestry included within a portfolio of opportunities and accreditation delivered at the farm level. A farm-level framework or aligned governance across codes may improve the viability of a whole farm carbon sales approach through delivering cost efficiencies.

The measurement of carbon could also play a supporting role in delivery of agroforestry across the UK through alternative mechanisms outside of an Agroforestry Carbon Code. For example, the measurement of carbon could be used to justify higher premiums on agricultural and agroforestry produce or provide a route for supply chain insetting opportunity for the farmer.

4. Demand for Agroforestry Carbon Units

Market research and engagement with potential carbon credit buyers was carried out throughout the project to test market demand for UK voluntary carbon credits. Given the limited availability of scientific data on carbon sequestration from agroforestry systems and the early stage of the Agroforestry Carbon Code development, engagement focused on understanding the demand for broader nature-based carbon credits, such as peatland and woodland carbon, alongside new markets, including agroforestry.

Market evidence suggests that demand for carbon credits far exceeds the supply of credits available and there is strong demand for the development of high-integrity nature-based projects in the UK which deliver additional co-benefits beyond carbon. Agroforestry schemes can deliver a broad range of environmental co-benefits, including improved soil structure, resilience to climate change, water quality improvements, and creating biodiversity corridors, with wider community benefit opportunities through volunteer engagement in project delivery and management. However, agroforestry projects present some potential market integrity risks, including the permanence of the carbon sequestered in shorter duration schemes and the additionality of carbon income, which may reduce buyer demand or pricing for ACUs.

The agroforestry carbon methodology could be well-suited to supporting supply chain carbon measurement approaches and insetting strategies, as an alternative to the carbon offsetting market. Supply chain actors should be engaged to assess appetite for insetting through agroforestry and measurement requirements. Alignment to a carbon verification standard and approved methodology would support a robust insetting approach.

Appendix 1: Assumptions tested

Table 3. Low, mid and high assumptions were reviewed to test the model sensitivity to different input variables for the pilot site financial models. Due to the wide range in variables a mid case was chosen for the two scenarios.

Assumptions	Low	Mid	High	Sources
Carbon revenues				
Carbon price (PIU) (£)	17	23	40	**Low**: Plan Vivo Acorn agroforestry Carbon Removal Unit price floor[16] **Mid**: Finance Earth: Average UK voluntary carbon transaction prices for woodland and peatland carbon within the WCC **High**: Evidence of premium market prices
Verification premium (%)	-	30	-	Climate Change Committee (2022) price premium from PIU to WCU (verified units)[17]
Sequestration rate (tCO_2e/ha/year)	1	1.5	2.5	**Low**: Cardinael et al. (2018)[18] **Mid**: Organic Research Centre pilot site carbon modelling net sequestration rates; Cardinael et al. (2018)[17] **High**: WCC calculator average lifetime sequestration[19]; Cardinael et al. (2018)[17]
Buffer (%)	40	20	15	**Low**: Conservative assumption based on uncertainty in sequestration rates **Mid**: WCC (risk buffer)[20], Gold Standard buffer level[21] **High**: Plan Vivo international Agroforestry Carbon Removal Units projects buffer contribution level[22]

[16] Plan Vivo (2022) How does Acorn work? All characteristics of CRUs. URL
[17] Climate Change Committee (2022) Voluntary Carbon Markets and Offsetting. URL
[18] Cardinael, R., Umulisa, V., Toudert, A., Olivier, A., Bockel, L., Bernoux, M. (2018) Revisiting IPCC Tier 1 coefficients for soil organic and biomass carbon storage in agroforestry systems Environmental Research Letters, 13 (12), art. no. 124020. URL
[19] Woodland Carbon Code (2021) WCC Carbon Calculation Spreadsheet. URL
[20] Woodland Carbon Code. Management of risks and permanence -Contributing to the buffer. URL
[21] Gold Standard (2021) How do you ensure that Gold Standard Emission Reductions from sequestration (Land Use) represent permanent carbon reductions? For example, what happens if a forest burns down? URL
[22] Plan Vivo (2021) The Acorn Framework – Contribution to the buffer pool. URL

Stocking density (stems ha-1)	100	200	400	Stocking densities used to determine available grant payment rates across the devolved administrations[23,24,25]
Other revenues				
Capital grant				
Scotland sites (£/tree)	-	9	-	Scotland agroforestry public funding rates[23]
England sites (£/tree)	-	6	25	**Mid**: EWCO- (England Woodland Creation Offer) payments[26] **High**: ELM Test & Trial data
Maintenance grant				
Scotland sites (£/tree – across 5 years)	-	0.23	1.20	**Mid**: Scotland agroforestry public funding rates[23] **High**: ELM Test & Trail data
England sites (£/ha/year – across 10 years)	50	175	300	Future payments for agroforestry to be published under the ELM Sustainable Farming Incentive scheme: "Revenue payments will depend on tree density £50 to £300 per ha"[27] Assumption in line with existing payments relevant to agroforestry, under the existing Countryside Stewardship offer[26]
Agroforestry product sales (£/ha/year)	-	600	-	Expert opinion across the project steering group
Costs				
Inflation rate (%)	-	2.5	-	Long term RPI Inflation
Verification costs (£)	1,000	1,500	2,100	Soil Association: verification costs under the Woodland Carbon Code, assuming a discounted rate for multiple smaller projects aggregated together[28]

[23] Public funding payment rates for agroforestry available in Wales
[24] Public funding payment rates for agroforestry available in Scotland. Payment rates incorporated within this analysis are as of 2020. The availability of grant funding for agroforestry in Scotland has since been updated and stipulated on a £/tree basis, as of July 2023, but these rates have not been incorporated within this analysis.
[25] Public funding payment rates for agroforestry in Northern Ireland

[26] Forestry Commission (2023) Payment rates available under EWCO– i.e., a total of per tree payment rates for individual capital items such as "Supply and plant of trees", "Supplement for use of individual tree shelters" and "Mulch mats". URL
[27] UK Government (2023) ELM payment rates update -as of February 2023. URL
[28] Woodland Carbon Code. Verification - Ongoing check of carbon sequestered – How much does verification cost? URL

Maintenance costs (£/ha/year)	-	400	-	Pilot site data – scaled according to site stocking density
Cost of sales (£/unit)	-	1.50	-	Example broker rates on voluntary carbon markets
Costs contingencies buffer (%)	20	10	5	Sensitivity analysis

Appendix 2: Pilot site cashflow profiles under baseline and agroforestry revenue scenarios

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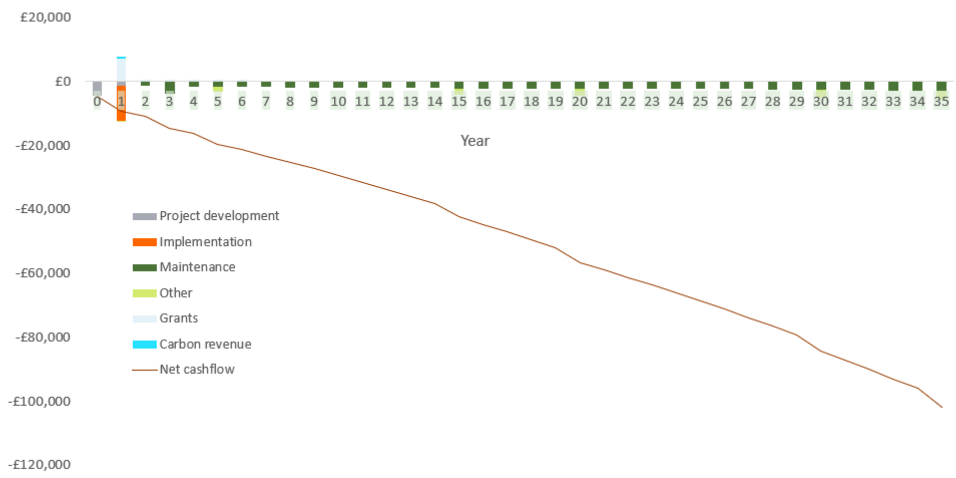
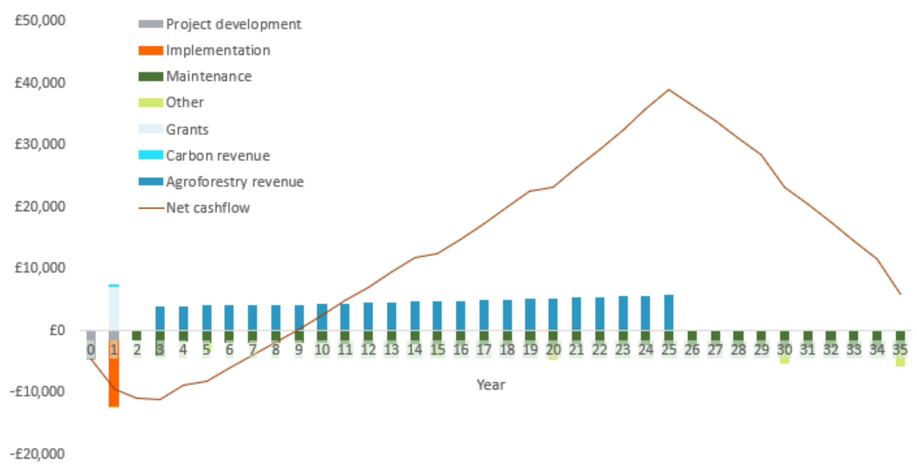
Parkhill Farm

Baseline scenario

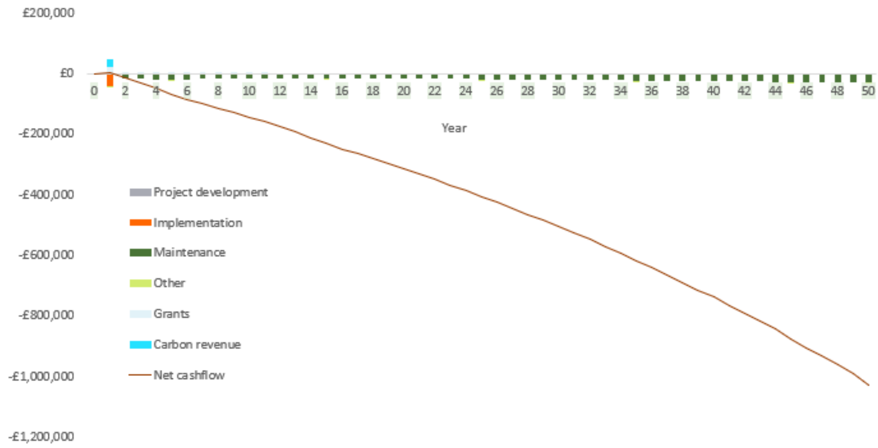


Agroforestry revenue scenario

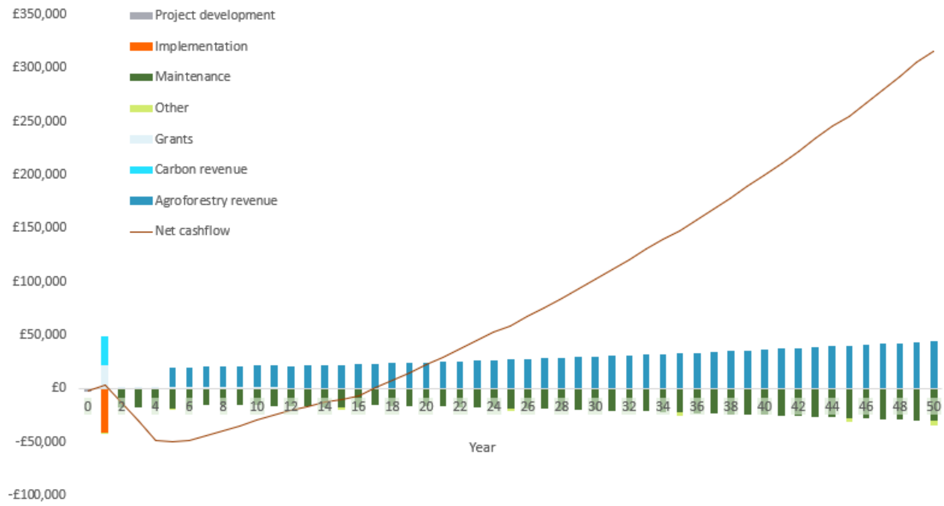


Wood Advent Farm

Baseline scenario

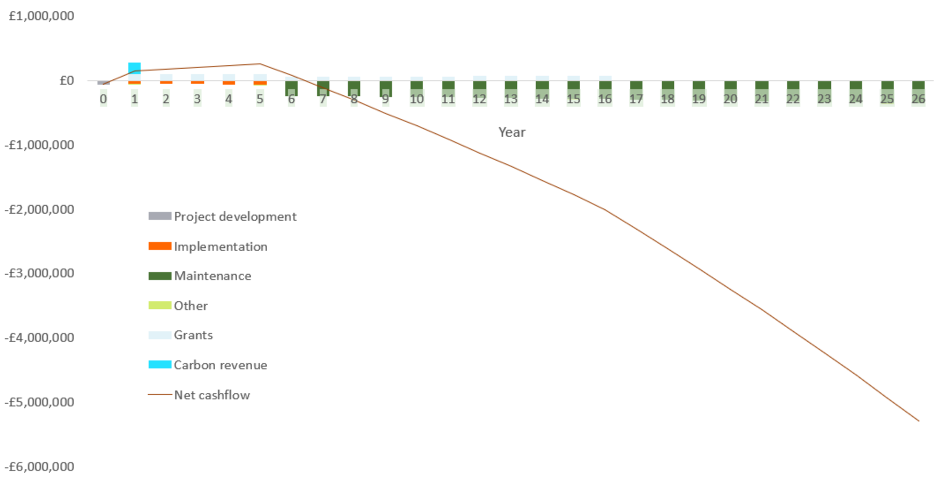


Agroforestry revenue scenario

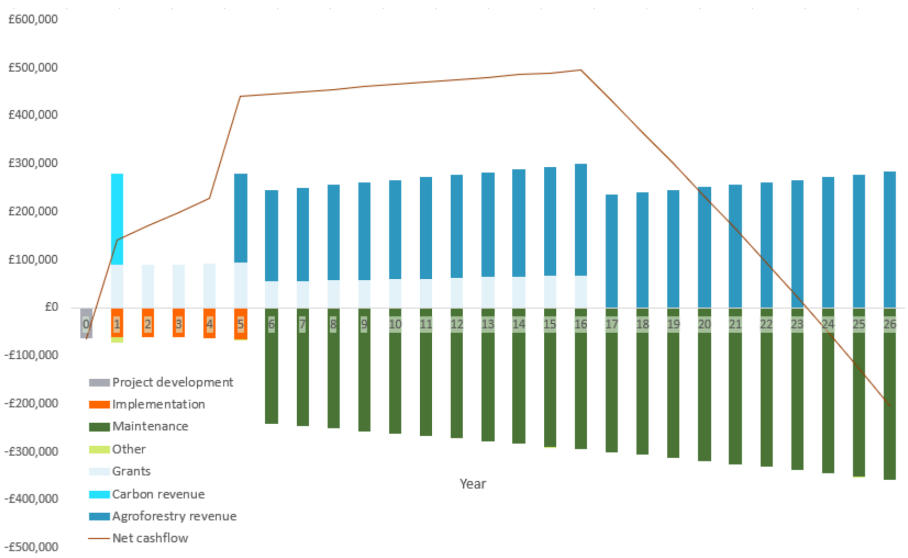


Spains Hall Estate

Baseline scenario

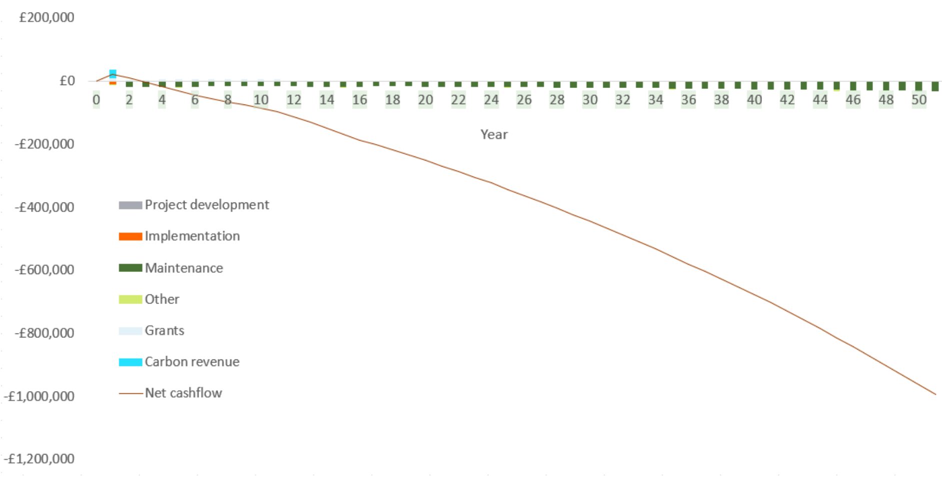


Agroforestry revenue scenario

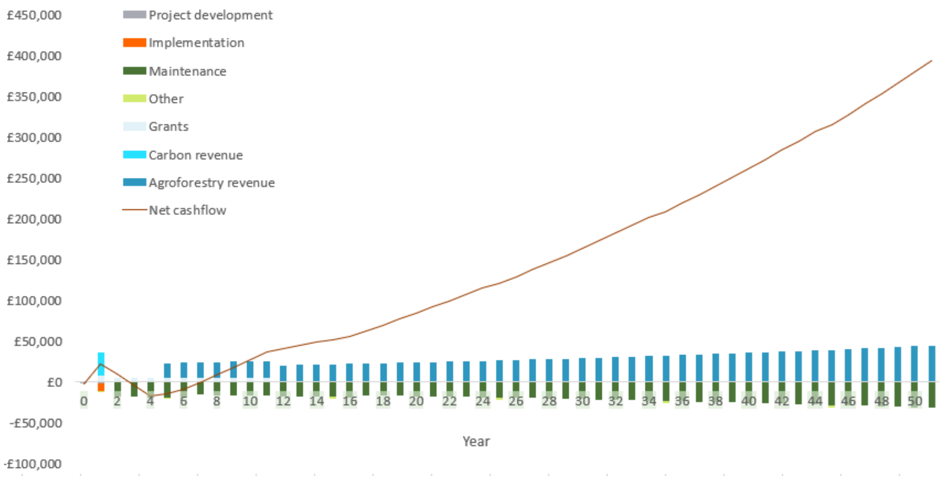


Riverford Dairy Farm

Baseline scenario

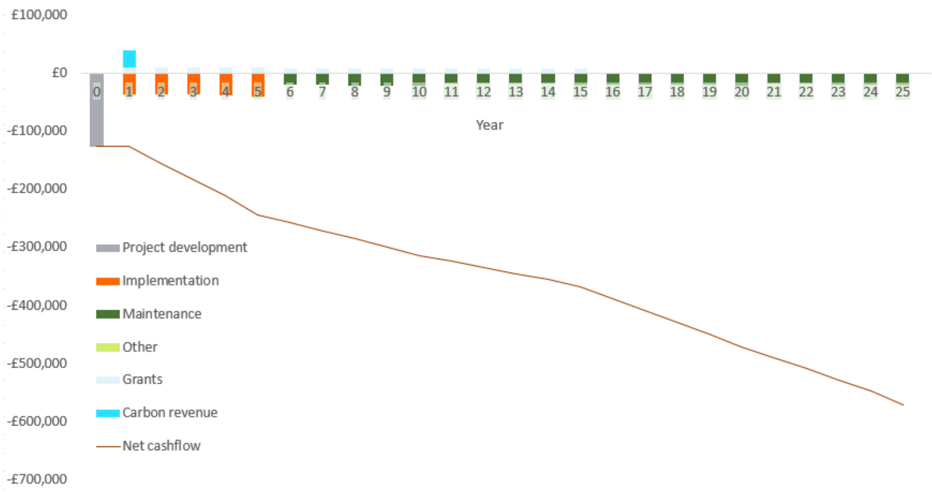


Agroforestry revenue scenario



Ings Farm (RegenFarmCo)

Baseline scenario



Agroforestry revenue scenario