

Investing in Continuous Cover Forestry

White Paper

Paul McMahon, SLM Partners
Darius Sarshar, SLM Partners
Paddy Purser, Purser Tarleton Russell Ltd

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Summary

This paper explains why Continuous Cover Forestry (CCF) applied to temperate commercial coniferous forest plantations provides an attractive investment opportunity for institutional investors. It uses the Irish forest sector as a case study, modelling the likely returns from the application of CCF management on acquired forests in Ireland.

Forestry investing today

Long-range data on historical returns for forestry investment in the USA and UK shows that it has delivered superior returns to many other asset classes. Forestry also offers portfolio benefits to investors as it provides diversification, an inflation hedge and current yield backed by real assets.

However, recent returns in developed markets have been driven by capital growth, as institutional investors chase a limited pool of assets and yields are driven down. Many observers believe that forestry assets are 'over-bought'. To ensure strong future returns, investors may need to invest in geographies that have been overlooked, or find more active ways to extract value from forest assets, for example through innovative management approaches. There is also increasing environmental pressure on commercial forestry, as societies insist that forests deliver a range of ecosystem services, leading to tighter restrictions on harvesting operations.

This paper focuses on the potential to apply CCF as an innovative and sustainable management approach in Ireland, a hitherto niche market for institutional investment in forestry.

The limitations of clearfell forestry

Conventional temperate conifer forestry is dominated by the management of non-native, single-specie, even-aged stands through a clearfell-replant system. Under this system, land is prepared and planted with trees; the plantation is thinned several times to remove smaller and lower quality stems; and all the trees are harvested on maturity. The land is then cleared and replanted.

This silvicultural system is relatively easy to plan and execute, and it produces predictable volumes

of wood to feed downstream processing. But it exposes investors to certain risks:

- Even-aged monocultures are more susceptible to pests, diseases and windthrow – risks that are likely to be exacerbated by climate change
- Clearfelling can cause negative environmental impacts (such as soil damage, water run-off, reduced biodiversity, low amenity value and release of forest carbon)
- Tightening government regulations and certification standards are constraining the ability to apply this system, especially in environmentally sensitive areas

Continuous Cover Forestry: an alternative

Continuous Cover Forestry (CCF), also known as 'close to nature' forestry, is an alternative silvicultural system that retains permanent forest cover. Under selection-based CCF management, trees are felled individually or in small groups throughout the entire woodland area. The increment in growth is removed as 'income' every few years, preserving the 'capital' of the standing forest. High quality trees are allowed to grow larger. The system relies on natural regeneration to develop a mixed-age stand. Species diversity is encouraged and naturally emerges across the full productive area of the forest, rather than being compartmentalised in plots. The overall objective is 'to maximise the commercial benefits from an area of woodland while letting natural processes do most of the work'.¹

CCF is widely practised in continental Europe. CCF is also gaining more attention in the British Isles, and in Ireland it is used on approximately 10,000 hectares of land.² It is possible to transform even-aged, single-species, conifer plantations into mixed-age, diverse forests managed according to CCF. However, CCF may not be suitable for all forests. It can be difficult to apply to already mature stands, or to stands on peat soils or in very exposed areas, as heavy or late thinning can reduce stability and lead to windthrow.

The environmental benefits of CCF are well-documented. It can increase soil quality, reduce

erosion and water run-off, enhance biodiversity and sequester more carbon. Forests managed under CCF have higher amenity and scenic value. They are also more resilient to climate change.

There are also 7 commercial reasons why CCF is an attractive proposition:

1. Transformation to CCF **brings forward cash flows** because of heavier thinning in early years
2. CCF **delivers a stable cash yield**, with less exposure to timber price fluctuations, as the entire forest area is partially harvested every few years – like ‘clipping the coupon’ on a bond
3. CCF **avoids the costs of replanting** by relying on natural regeneration to establish replacement trees
4. CCF **produces larger, more valuable trees** and a higher proportion of sawlogs, which achieve a higher price per m³
5. **Management and harvesting costs** are not prohibitive when the benefits of CCF are taken into account
6. CCF **grows and maintains the capital value** of the forest in perpetuity
7. CCF **reduces biophysical risks** as diverse, mixed-age stands are less vulnerable to pests, disease and windthrow events

An Irish case study

We have modelled the financial returns from investing in semi-mature forestry in Ireland using both conventional clearfell management and CCF management. This is based on standard forestry models, applied to a single hectare of typical Irish coniferous forest (Sitka Spruce, Yield Class 22) purchased 14 years after establishment.

The results show that CCF management produces a **net IRR of 6.0%** (in real terms, without inflation), compared to 5.5% for conventional management. The cash flow profiles are very different, with CCF producing earlier and more stable cash flows, whereas clearfell management delivers the bulk of cash flow at the time of clearfelling (every 31-32 years).

Conclusion

CCF can generate comparable, and potentially better, returns than conventional forestry with stronger and more stable cash yields, as well as more stable capital values. CCF also reduces the negative environmental impacts of conventional forestry and ensures forests are more robust and better able to resist the effects of climate change.

We believe that CCF will see greater uptake over the coming decades in commercial temperate forestry. Adopting CCF now will ensure that forest owners are at the forefront of sustainable forest management, rather than risk being left behind by a tightening of regulatory and certification standards.

About this paper

SLM Partners is an asset manager that acquires and manages rural land on behalf of institutional investors. Its mission is to scale up regenerative, ecological farming and forestry systems that deliver financial returns and environmental benefits. Founded in 2009, SLM Partners has offices in London, New York and Australia. Wherever it works, the firm partners with innovative local land managers to develop and execute investment opportunities.

SLM Partners manages the SLM Australia Livestock Fund, which owns and farms over 480,000 hectares of grazing land in Australia with a focus on grass-fed beef cattle production. The fund is applying a sustainable rotational grazing system – known as holistic planned grazing – that can restore degraded land, increase stocking rates and improve profitability.

SLM Partners is currently developing a fund that will invest in Irish forestry. The fund will take advantage of the attractive conditions for forestry investment that exist in Ireland today. Where

appropriate, it will apply an innovative and sustainable form of forest management known as Continuous Cover Forestry.

SLM Partners is working with Purser Tarleton Russell Ltd, an Irish forestry management and consulting firm that has considerable experience applying Continuous Cover Forestry management in Ireland.

This White Paper was written by Paul McMahon and Darius Sarshar of SLM Partners, and Paddy Purser of Purser Tarleton Russell Ltd. We would like to acknowledge comments provided by Phil Morgan during a review process.

The paper sets out the investment case for Continuous Cover Forestry, showing that it can be both profitable and environmentally beneficial. The paper draws on case studies and data from the commercial forestry sectors of Ireland, Britain and continental Europe.

Forestry investing today

Forestry: a growing asset class

An investment in forestry is an investment in a real asset, consisting of trees and the underlying land, which can produce a range of wood-based commodities. It is also an investment in a biological asset that will grow in value. This is one of the unique features of forestry; it is an appreciating, long-dated asset that requires minimal intervention from year to year.

Forestry investment can offer a number of desirable characteristics for investors that enable it to play a useful role in an investment portfolio. These include:

- A combination of cash yield from timber sales, plus capital gain attributable to biological growth and rising prices of timber and land;
- Superior risk-adjusted returns (above the capital market line);
- Capital preservation/inflation-hedging;
- Zero or low correlation with other asset classes such as bonds and equities;
- Favourable tax treatment in many jurisdictions;
- Suitability for long duration asset/liability matching.

Many sophisticated investors have sizeable allocations to forestry. Globally, there is an estimated \$90 billion of institutional and high net worth individual capital invested in forestry, with approximately \$30 billion invested in US-domiciled forestry Real Estate Investment Trusts (REITs), and \$60 billion with specialist managers (Timberland Investment Management Organisations or "TIMOs").

Long-range data on historical returns for forestry investment is available for the USA and the UK. In the USA, timberland investments yielded an annualised return of 12.07% before asset management fees between 1987 and 2015.³ This was superior to listed stocks, bonds and real estate, whilst also exhibiting lower volatility than US or global stock markets. As a result, long-term US timberland returns sit well above the capital market line, in large part reflecting the superior returns required to compensate investors for the

illiquidity of the asset class. An allocation to forestry can therefore substantially improve the risk/return profile (Sharpe Ratio) of an investment portfolio.

In the UK, the independent IPD UK Annual Forestry Index published by MSCI for the period to the end of 2015 showed 5-year annualised total returns were 19.0%, 10-year total returns were 18.4% and 23-year total returns were 9.0%. UK forestry delivered superior total returns to equities and gilts over all three periods and beat real estate in all except the 23-year timeframe, over which real estate posted a 9.5% annualised return, narrowly ahead of forestry.⁴



Commercial forestry in Ireland

Pressure on asset prices

Despite strong total returns, income returns from UK forestry were negative over all recorded periods, posting -1.0% over the ten years to the end of 2015; all UK forestry returns since the index was set up have therefore been derived solely from capital growth. Some of this can be attributed to the biological growth of forests and rising timber prices, but much is attributable to a repricing of assets. This illustrates a trend that has been evident across developed forestry markets for some time: a reduction of discount rates and an increase in capital values, as institutional investors chase a limited pool of assets and yields come down in other asset classes.

Some observers believe that forestry assets are 'over-bought', especially in developed markets such as the USA, Canada, Australia, New Zealand and the UK. There is a risk that future returns will not match historical performance because of inflated asset values.

This has propelled some investors to look to emerging markets, but this brings its own challenges. Emerging markets may involve a much higher level of risk associated with a more challenging and complex operating environment, lack of local forest management and contractor capacity, and foreign exchange risk, which can result in lower risk-adjusted returns compared to developed market forestry investment.

Another option is for investors to focus on niche developed regions that have been over-looked so far. Or they may need to find more active ways to extract value from forest assets, for example through innovative management approaches. This paper focuses on the potential to apply CCF as an innovative management approach in Ireland, a hitherto niche market for institutional investment in forestry.

Environmental pressures

There is also a growing awareness within society that forests are multi-functional and deliver a number of 'ecosystem services' apart from commercial timber harvests. These services include carbon sequestration, water regulation, biodiversity maintenance, soil health, erosion control, and tourism and recreational use.⁵ The concept of Multifunctional Forest Management has become mainstream.

This is especially the case in developed, temperate regions such as Europe and North America, where forests and human settlements are interspersed and where environmental lobbies are well-organised and influential. Environmentalists are often at loggerheads with the commercial forestry sector, insisting that the wider ecosystem services provided by forests are respected and maintained. In response, national forestry regulations are becoming stricter, balancing private exploitation of forests with long-term public goods. One famous example is the banning of logging in national forests in the US Pacific Northwest in the 1990s to protect an endangered species, the northern spotted owl.⁶ To preserve their social license, forestry investors must ensure that forests are managed sustainably and in ways that deliver multiple functions to society.

So far, most forestry investment has gone into even-aged, monoculture, clearfell-replant management systems, often using non-native species. In the next section, we will examine this system in more detail, pointing out some of its limitations and risks. We will then put forward an alternative forest management system, known as Continuous Cover Forestry, which, we believe, can mitigate these risks, deliver positive environmental impacts and generate financial returns that are comparable or superior.

The limitations of clearfell forestry

The silvicultural system

Conventional temperate conifer forestry is dominated by exotic single-species, even-aged stands which are managed on a clearfell-replant system. Land is prepared and planted with trees, often accompanied by the use of fertilisers and pesticides. The plantation is thinned several times to remove smaller and lower quality stems, and on maturity all the 'final crop' trees are harvested. The land is then cleared and replanted, starting the cycle once again.

With a large enough area, a 'normal' forest age structure can be established whereby planting is staggered such that at the end of the rotation an equal-sized area reaches maturity and is clearfelled and replanted each year, producing a predictable and steady wood flow in perpetuity. However, the opportunity costs of bringing forward or delaying final harvest, combined with regulatory requirements to replant within a restricted period, mean that establishing normal forests – with an even distribution of age classes – can be challenging.

This silvicultural system is relatively easy to plan and execute, it is quite effective at maximising the rate of wood production at a stand level, and it produces predictable volumes of wood of merchantable dimension on an annual basis to feed downstream processing. It also allows for the use of genetically-improved planting material on replanting.

Some limitations

The system does, however, have some well-documented limitations which means that it may not be the best silvicultural system to use in all circumstances:⁷

- Single species plantations are susceptible to pest and disease outbreaks, which are likely to become more frequent with climate change.
- Even-aged stands are susceptible to windthrow, and, if trees fall (particularly if they fall prematurely), there is a need for costly replanting, as there is no established natural regeneration to take its place.

- Conifers in single-species stands can cause acidification of soils and waterways.
- The extensive use of heavy machinery and clearing of vegetation at clearfell can result in soil compaction and erosion.
- Clearfelling can lead to flooding, leaching of nitrates and phosphorus and sediment loading of streams, which reduces water quality and damages aquatic life.
- The amenity and recreational value of these forests is low because of the visual impact of monoculture plantations and clearfelled landscapes.
- Fast-growing conifer monocultures can form dense stands which prevent under-storey growth and have limited biodiversity value. The flora and fauna that colonise the forest are then destroyed or dispersed by clearfelling and therefore subject to significant disturbance.
- Clearfelling can have a negative impact on the carbon cycle. It leads to emissions of carbon dioxide and methane because of the large-scale decomposition of harvest residues following a clearfell operation. Moreover, the carbon sequestration function of the forest is suspended until new trees grow back.⁸



Clearfell on Slievenamaddy, Co. Down, Northern Ireland

Over a longer timescale, this form of silviculture can also suffer from decreasing yields over successive rotations due to depletion of site nutrients, soil compaction and increasing vulnerability to windthrow and pests and disease.

For example, the experience of Germany in the 19th century showed that Norway spruce plantations began to perform poorly in the third and subsequent rotations. Heavy spruce trees with shallow roots, constantly swaying in the wind, compacted the soil, with each generation exhibiting more 'lazy' rooting. The loss of stability led to major windthrow events during storms.⁹

The limitations of conventional forestry therefore expose investors to three key risks to profitability:

1. **Increased vulnerability to pests/diseases and windthrow** – this will be exacerbated by a changing climate, as extreme weather events increase in frequency, and warming leads to plant stress and the spread of pests and disease.
2. **Degrading natural assets** because of soil acidification, compaction, erosion and nutrient run-off.

3. **Shifting regulation**, as governments seek to reduce carbon emissions from land use, and ensure forest management is better able to mitigate environmental externalities such as water pollution, loss of biodiversity and the negative impacts on amenity uses of forests.

These risks are set to intensify in the coming decades because of economic, environmental and political change. Investors will increasingly need to find ways to improve forestry performance without harming the environment. We believe that a good way to do this is by embracing Continuous Cover Forestry.

Continuous Cover Forestry: an alternative

CCF and its origins

Continuous Cover Forestry (CCF), also known as 'close to nature' forestry, is an alternative silvicultural system that retains permanent forest cover and results in diverse forests, with multiple cohorts of different ages and species growing together. CCF is not a single system but a "catch-all" term for non-clearfell systems. There are two broad types of CCF: selection systems (including single tree and group selection) and shelterwood systems, each developed for distinct site, species and management requirements. In this paper, to highlight the comparison of CCF with even-aged management, we focus on selection-based CCF systems (that deliver complex, multi-layered forests) and stands undergoing transformation to CCF from the even-aged, clearfell-replant system.

Under CCF management, trees are felled individually or in small groups throughout the entire woodland area. The increment in growth is removed as 'income', preserving the 'capital' of the standing forest. The basic premise is each removal of a tree should maximise the potential value of the trees that remain. High quality trees are allowed to grow larger, which produces higher value timber. The system relies on natural regeneration to develop a mixed-age stand, although some enrichment planting may be required where there are insufficient mother trees. Species diversity is encouraged and naturally emerges across the productive area of the forest rather than being absent altogether, or compartmentalised in blocks at the edge of the

commercially productive stand to satisfy environmental regulations. The overall objective is 'to maximise the commercial benefits from an area of woodland while letting natural processes do most of the work'.¹⁰

CCF is widely practised in continental Europe. Indeed, it is the only possible system in Switzerland, Slovenia and many German states, where clearfelling has been illegal for many years. In Germany, forest administrators integrated principles of Continuous Cover Forestry in silviculture after storms in 1990 blew down more than 60 million m³ of timber.¹¹ In Denmark it is now government policy that all state forests are managed using a 'close to nature' system. This new policy was instituted in 2002 because of the increasing incidence of serious wind damage in Danish plantation forests, coupled with greater public demand for more natural forests.¹²

With members in 24 countries, ProSilva is a European federation founded in 1989 to develop and promote CCF as an alternative to clearfelling in forestry. It has set up demonstration sites across Europe; it runs field days and training sessions for foresters; and it advocates for changes in government policy.¹³ For more details, see: <https://prosilvaeurope.wordpress.com/>.

Pro Silva also works closely with the Association Futaie Irrégulière (AFI), an international network of research stands established in 1990 to monitor and study the development of forests managed

Elements of a Continuous Cover Forest



Elements of a Close-to-Nature managed Continuous Cover Forest: young naturally regenerating trees in the under-story, mixed species, uneven forest stand structure, important dead 'nurse' logs

according to CCF principles. There are more than 80 research stands in France, Luxembourg, Belgium, the UK and Ireland, and these sites also provide a forum for research and training in CCF methods.

Since the 1990s, the CCF approach has also gained traction in the British Isles. In England, according to one expert, Continuous Cover Forestry is becoming the 'norm' in many lowland and mixed species woodlands and in most woods managed primarily for conservation and amenity objectives. Whilst there are still relatively few single-specie, commercial conifer plantations under continuous cover management after several decades of field trials (a recent study identified just 3% of British forests being actively managed under CCF), this situation appears to be changing. The same study quoted a figure of 20% of the public forest estate managed by the Forest Commission in which there were aspirations to transform to continuous cover management. Scotland and Wales, in particular, have set ambitious targets for adoption of alternative silvicultural systems in the national forest estate. These range from 20-25% in the case of Scotland to 40-50% in the case of Wales.¹⁴ CCF is also gaining more attention in Ireland, where it is currently used on approximately 10,000 hectares of forestry (2% of the forest area).¹⁵



Advanced natural regeneration in Sitka spruce, near Pitlochry, Scotland

Transformation to CCF

It is possible to transform even-aged, single-species, conifer plantations into mixed-age, diverse forests managed according to CCF. Transformation has to start early, however, at the pole or first thinning stage, in order to promote enhanced crown and root development, along with greater diameter increment before critical height is reached. This generates greater levels of individual stem stability than in conventionally-managed stands. Attempting to transform older forests to CCF can lead to high risk of windthrow.

The first thinning under CCF shares parallels with conventional forestry in thinning intensity, but it is more selective and focuses on the removal of poor quality stems of all sizes ('frame-tree thinning'), rather than on the systematic removal of smaller stems at even spacing ('low thinning'), in order to improve stand quality. Second and third thinnings generally continue the improvement of quality, regardless of tree size, with specific emphasis on ensuring high quality trees are favoured in order that they can grow optimally.

In subsequent thinnings, at which stage most trees of poor quality have already been removed, the focus shifts to selective harvesting of the largest and most valuable trees ('target diameter thinning' or 'crown thinning'), whilst the smaller trees are left to grow on. This selective harvesting, which is usually carried out at intensities greater than under conventional thinning, also serves to open up the canopy and to allow the right amount of light to enter for successful natural regeneration.¹⁶ Less complex CCF management systems with fewer forest strata, such as two-strata shelterwood systems, may be used for more light-demanding species such as Sitka spruce, where larger canopy gaps and lower basal areas are required to facilitate natural regeneration.

Environmental impacts

CCF can offer a number of environmental advantages over conventional forestry, linked to soils and water, biodiversity, amenity value and carbon stocks.

CCF offers the potential to significantly reduce levels of ground compaction associated with clearfelling, as it involves lower intensity

harvesting and the maintenance of permanent forest conditions. It also avoids the surface water run-off associated with clearfelling, which can cause flooding and loss of nutrients from the site, as well as eutrophication and sedimentation of water courses. Heterogeneous forests such as those produced by CCF management, with mixed species and ages, also support higher biodiversity and are considered by the public as more 'scenic' and having greater recreational value by avoiding the 'scars' on the landscape produced by clearfelling¹⁷. Forests under CCF management also accumulate more carbon than those managed to clearfell, and retain carbon permanently.



Young Sitka spruce stand after transformative 2nd thinning, Keshcarrigan, Co. Leitrim, Ireland

Forest carbon stocks and flows: comparing CCF and conventional forestry

Maximum carbon stocks achievable by temperate coniferous forests have been calculated to be around 200 tonnes C/ha¹⁸. These levels are found only in old-growth forest, with commercial plantations typically peaking at 100 tonnes C/ha at maturity.

Studies of CCF forests have shown that they tend to have intermediate levels of carbon stocks, with levels below those of old-growth forests but higher than in conventionally managed plantations. One Norwegian study¹⁹ found that transformation to CCF management leads to forests being able to store an additional 45-74 tonnes C/ha, representing an improvement of up to 75% over conventionally-managed plantations. A key feature of carbon storage in forests under CCF

management is that as permanent forest cover is maintained in perpetuity, carbon storage is also permanent. Under conventional management, the carbon sequestered and accumulated in woody biomass over the course of a rotation is largely harvested and extracted, leading to a lack of permanence that has plagued attempts to incorporate conventional forestry into climate change mitigation efforts such as the Clean Development Mechanism.

The rate of carbon sequestration and emissions from forests can also be affected by the management regime. The rate of carbon sequestration is linked largely to growth rates. Conventional forestry seeks to clearfell at the age at which mean annual wood increment is maximised, and under more commercial management this is further refined by timing harvest to maximise financial returns. If larger logs fetch premium prices, then growing a stand beyond the point at which maximum growth rate is achieved may make sense. Under CCF, some trees are retained beyond typical clearfell ages. Research by Poore and Kerr²⁰ has shown that under single-tree selection CCF systems, individual trees continue to grow at high rates well beyond the point at which the growth rate of even-aged stands peaks. Overall, the literature suggests growth rates are similar under the two management systems.

There are two further principal factors influencing forest carbon flows from managed forests. These are leaf litter and soil carbon decomposition rates. Under CCF, both rates are likely to be lower as levels of light, temperature and humidity are more stable under permanent canopy cover.

A recent study by Lundmark et al.²¹ in Sweden found little difference in carbon sequestration and emissions from running long range models of both CCF and conventionally-managed conifer forests. The study concludes that the indirect substitution effect of wood for non-renewable building materials such as concrete and steel, or for fossil fuel energy sources in the form of biomass energy, generated significant reductions in carbon emissions. This was more important than the amount of carbon sequestered in the standing forest. Therefore, the extent of carbon mitigation

was largely driven by the volume of timber harvested from the forests, which tended to be the same in CCF and conventionally-managed forests.

In conclusion, studies suggest that:

- 1) When considered over hundreds of years (multiple clearfell rotations), temperate and boreal conifer plantations sequester more carbon than they release, and sequestration or carbon ‘flows’ are at similar levels across management systems.
- 2) Timber from conifer plantations generates significant reductions in carbon emissions when used as substitutes for non-renewable building materials such as concrete and steel, and timber production levels are similar across management systems.
- 3) Forests under CCF management both accumulate more standing carbon (‘stocks’) than those managed to clearfell, and retain that carbon permanently, offering considerable advantages over conventional management.

CCF and climate change resilience

There is also a growing body of evidence that CCF management can help make forests more resilient to climate change – a significant risk faced by the forest industry especially in temperate regions given the long timeframes involved in growing trees to maturity. Forests managed under CCF will be better able to adapt to the changing climate

because of their diversified structure, greater stability and wider genetic diversity.²² For example, a report by the UK government’s Forest Research Division studied the usefulness of CCF to Scotland’s forests in terms of 5 primary risks and 9 secondary risks related to climate change. It found that CCF management could mitigate 3 of the primary risks and 3 of the secondary risks. As a result, the main finding of the report was that “CCF has the potential to help the forests in Scotland to adapt to some of the risks of future climate change”.²³

Windthrow is, however, part of the natural disturbance pattern of forests. Under CCF management, it can be reduced but not avoided altogether. Under a clearfell system, windthrow can be very value-destructive, as replanting can only take place once the windblown crop is harvested, which is often before the crop has matured to its full potential value. Under CCF management, windthrow can be used opportunistically to help develop the irregular structure and spacing within stands, and with strong natural regeneration there is nearly always an immediate replacement for any windthrown trees. Forests under CCF management have shown to have more rapid rates of recovery following windthrow events.

Summary of risks of climate change to Scottish forests and potential effects of CCF

Risk to forests in Scotland	Rating of potential impact*	Effect of CCF management (positive/neutral/ negative)	Evidence base for judgement**
Primary risks			
Increased incidence of strong storms	High	Neutral-Positive	Good
Increased incidence of heavy winter rainfall	Medium	Positive	Moderate
Changing growth rates due to increased CO ₂	Medium	Neutral	Good
Increased temperatures and incidence of drought	Medium	Unknown	Poor
Reduced incidence and changed timing of frosts	Low	Positive	Good
Secondary risks			
Attack by pests and diseases - general	High	Positive	Moderate
Pine weevil	High	Positive	Moderate
Green spruce aphid	High	Unknown	Moderate
<i>Heterobasidion annosum</i>	High	Neutral	Poor
Red band needle blight	High	Neutral	Poor
Implications for <i>in-situ</i> carbon storage	High	Positive	Moderate
Impact on biodiversity	High	Positive	Good
Changing tree species suitability	Medium	Negative	Moderate
Increased deer damage	Medium	Neutral	Poor
Changes in timber quality	Medium	Neutral	Moderate
Changes in weed competition	Medium	Unknown	Poor
Changing phenology of natural regeneration	Low	Unknown	Poor
Forest fires	Low	Negative	Moderate

Source: Forest Research, The evidence supporting the use of CCF in adapting Scotland’s forests to the risks of climate change (2009)

Some limitations

It may assist with tax planning, as profits will not be concentrated in particular years.

Despite its many advantages, there are limits to the application of CCF. On very wet sites, or sites which are exposed, the more open canopy structure under CCF should be avoided, and conventional clearfell-replant regimes may be more applicable. In addition, transformation to CCF may not be suitable for all forests. It can be difficult to apply to mature stands, or to stands on peat soils, as heavy or late thinning can reduce stability and lead to windthrow. A careful analysis of the suitability of a site must therefore be carried out before initiating transformation.

CCF is also a more complex management system and requires skilled foresters to implement. Trees are individually selected for felling by foresters (marked) before harvesting, which is different from standard practice in the UK and Ireland where contractors decide which trees to harvest. CCF is an adaptive system, rather than prescriptive, based on close monitoring of forest development. It should only be attempted where the forest

manager has the necessary capacity and resources to undertake it.



Target diameter felling at Bryn Arau Duon, Wales

Seven commercial reasons to consider CCF

The environmental and social benefits of Continuous Cover Forestry are well-established. However, this approach can also deliver a financial return that is comparable to or better than a conventional clearfell system, while being better suited to investors seeking strong and stable cash yields, stable asset values, and reduced biophysical risks.²⁴ There are seven reasons why we believe there is a compelling investment case for CCF in temperate commercial forestry.

1. Transformation to CCF brings forward cash flows

Transforming an even-aged coniferous plantation to CCF requires heavier repeated thinning in the early years, compared to conventional management. This is done to open up the canopy for natural regeneration and to increase the stability of the remaining trees. According to one study, transformation of a Sitka spruce stand produces 30% more timber in the first four thinnings than a conventional rotation.²⁵ It also produces a higher proportion of larger diameter trees during this period.²⁶ The average stem quality in CCF stands improves rapidly, so the number of quality breakouts is higher early on. As a result, a forest under transformation to CCF generates more cash flow earlier.



High quality spruce logs from target diameter thinning, Knockrath, Co. Wicklow, Ireland

2. CCF management delivers a more stable cash yield

Returns under a conventional clearfell system can be 'lumpy'. On any given hectare, there is limited cash flow for the first 30-40 years, and then a large

return in a single year at the time of clearfell, followed by a long period without any return as the forest regrows. In contrast, CCF management seeks to harvest the growth increment every few years across every hectare of forest, delivering a reliable, regular cash yield in perpetuity.

The consistent return profile will be more attractive to investors looking for a bond-like yield on their investment. In addition, CCF delivers an investment that is like a bond with a shorter duration, when compared to clearfell-replant, which has the characteristics of a bond with a longer duration since the bulk of cash flows come at "maturity" (i.e. time of clearfelling). Because of this, the net present value of cash flows from CCF is less sensitive to changes in interest rates (or discount rates) than a clearfell-replant system.

In addition, studies show that regular harvesting reduces exposure to timber price volatility. Under conventional management, the optimal time for clearfell may come during a period of cyclically low timber prices, thereby reducing the total return on the rotation. Under CCF management, smaller quantities of timber are sold into the market on a regular basis, which evens out the impacts of price fluctuations. As a result, CCF is a way of reducing market price risk and can reduce the volatility of investment returns.²⁷

3. CCF avoids most of the costs of replanting

Following a conventional clearfell harvest, the forest owner needs to replant the land – a legal obligation in many countries. This is a substantial cost: for example, in the Irish context it amounts to approximately 25% of the timber revenues generated at clearfell (and can be higher for premature harvest after a windblow event, as the timber crop has a lower value but restocking costs are fixed). In effect, a forest owner must keep back a substantial part of the income generated at clearfell and assume the full costs and risks of replanting.

CCF management relies on natural regeneration to establish new crops of trees. If completely

successful, there are no re-establishment costs. In many cases, enrichment planting is required, as well as some interventions to respace or prune young trees, but this comes at a lower cost than replanting after clearfell. The minimisation of replanting costs has a significant impact on the overall economic returns.

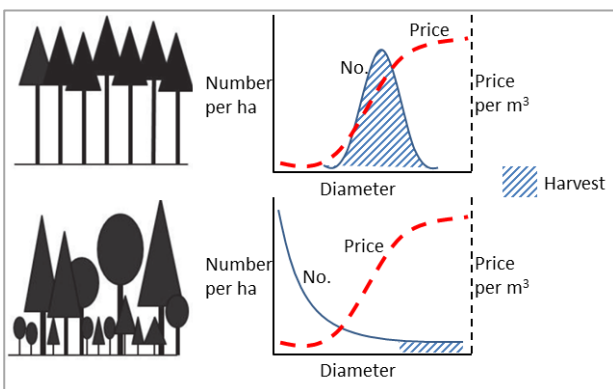


Sitka Spruce forest with natural regeneration at Clocaenog, Scotland

4. CCF produces larger, higher value trees

In a conventionally managed, even-aged plantation, clearfelling takes place when the stand has reached its optimal growth rate. A chart showing the number of trees in each diameter class has a bell curve shape. There are a large number of trees of average diameter, but there are also trees that are larger and smaller. The value per m³ will therefore vary, as large diameter trees are worth more than smaller ones.

Forest structure in clearfell vs CCF systems



In a Continuous Cover Forest at equilibrium, a chart showing the number of trees in each diameter class shows a distinct J-curve. There are large numbers of juvenile trees, moderate

numbers of medium-sized trees, and smaller numbers of large trees. But harvesting is focused on those larger trees at the right-hand end of the J-curve. In addition, trees are allowed to grow for longer under CCF management, thus reaching larger sizes. As a result, CCF produces a higher proportion of larger sawlogs. Assuming that sawmills are set up to take larger logs, this will translate into a higher average price per m³.

5. Management and harvesting costs are not prohibitive

As with conventionally managed forests, mechanised harvesting can be used under CCF, with machinery restricted to planned, permanent harvesting racks lined with brush (branches and small roundwood) to prevent soil compaction.

Under CCF, more timber is extracted per hectare during the thinning phase than under conventional management, which results in lower harvesting costs per m³ during this phase. This is confirmed by the table below (reproduced from Mason 2015), which shows harvesting costs on a Sitka spruce plantation in Wales. 'Frame tree thinning', as practised under CCF, had a cost of £11.40 per m³, whereas the 'low thinning' of a conventional clearfell system had a cost of £13.00 per m³.

By extension, CCF harvest costs are higher than the cost of a clearfell harvest, when the largest volumes of timber are extracted per hectare. But the difference is not great. The data from Wales shows that 'target diameter thinning', as practised under CCF in the later stage of transformation, had a cost of £10.00 per m³, compared to the clear felling cost of £9.70 per m³.²⁸



Harvesting of spruce thinnings in transformation to CCF of a private forest, Rathdrum, Co. Wicklow

Harvesting costs under different management systems

Treatment	Basal area before thinning (m ² ha ⁻¹)	Per cent basal area removed	Harvesting time (min m ⁻³)	Sawlog per cent	Cost (£m ⁻³)
Clear felling ⁱ	46.1	100	6.5	81.0	9.7
Low thinning ⁱ	44.9	20.5	10.5	73.0	13.0
Group felling	43.9	19.4	7.7	74.0	12.8
Frame tree thinning ⁱⁱ	42.8	19.6	8.0	81.5	11.4
Target diameter thinning ⁱⁱ	39.3	21.8	7.7	87.0	10.0

Comparative harvesting outputs, sawlog outturn, and costs of standard operations and different transformation thinnings in a 37-year old Sitka spruce stand in Wales.
ⁱ Conventional clearfell management; ⁱⁱ CCF management
 Source: Mason, W.L. (2015) *Implementing Continuous Cover Forestry in Planted Forests*

In addition, CCF produces larger trees and a higher proportion of sawlogs, which normally translates into a higher average price per m³ at harvest. Over a conventional rotation period, this should be enough to offset the lower harvesting costs obtainable under the clearfell system. The outcome is that harvesting under CCF generates similar, if not higher, “stumpage” (gross profit per hectare) than both thinning and clearfelling under conventional management.

Forest management costs are usually higher under CCF than clearfell because of the need for tree marking and more intensive management. This is an essential part of CCF management and should be seen as an investment in the future capital value of the crop. Poor selection in thinnings can reduce the capital value of a forest, and this is evident in many conventionally-managed stands in the UK and Ireland. Marking of thinnings by a professional forester also lowers harvesting costs, as the operator can spend more time on production and less time on selection.

6. CCF maintains the capital value of the forest

In a clearfell rotation, the capital value of the forest rises in line with the growth of the standing timber. But the majority of this capital is liquidated at clearfell. The value is reduced to the underlying value of the land, with the added liability of the costs of replanting. As a result, the capital value of a forest plot changes dramatically over the course of multiple rotations.

In contrast, CCF management increases and maintains the capital value of the forest in perpetuity. During the transformation to CCF, the rate of appreciation is greatest in the first 30-50 years of the forest, as the first coupes reach maturity. The rate then slows, but the forest should continue to appreciate in value as trees become older and larger, and slower-growing species reach maturity. This capital appreciation and preservation may be attractive to investors seeking the security of real assets.



Harvesting racks in place after 3rd transformative thinning, Keshcarrigan, Co. Leitrim, Ireland

Across Europe, privately-owned forest properties and directly-held institutional forestry property portfolios are generally small. In the UK and Ireland, they often have a narrow age class distribution, reflecting the age profile of private forests, much of which are new plantations

established with grant aid since the 1980s. For such properties, the opportunities to develop a 'normal forest' – forests with an equal area of plantation of all age classes, which can produce similar volumes of timber from clearfell on a perpetual basis – are very limited. Hence the attractiveness of CCF for institutional investors as it delivers a strong cash yield whilst also maintaining the capital value of the asset.



New infrastructure for sustainable access to stands, Bryn Arau Duon, Wales

7. CCF reduces biophysical risks

The most serious biophysical risks for forestry investment in temperate regions are windthrow, pests and disease. CCF management can help mitigate all of these. Diverse, mixed age stands have been shown to suffer less and recover more quickly from pest and disease outbreaks such as the large pine weevil (*Hylobius abietis* L.), which

causes serious damage to conifer seedlings planted to re-establish forests after clear felling.²⁹

There is also evidence that mixed-aged stands, after the transformation stage, are more stable and less vulnerable to storms as dominant trees in irregular stands are better adapted to withstand the forces of the wind. This is due to their having more favourable (lower) height-to-diameter ratios, greater root mass and stronger buttressing. Heavy early thinning can be used to develop stable dominants as part of the transformation process³⁰. And if trees are blown down in a forest managed under CCF, the impacts are likely to be less catastrophic, as younger trees will already be established and ready to fill the gaps. In an even-aged plantation, windthrow requires replanting, which sets the rotation back to the start.



Target diameter felling with developing regeneration, Bryn Arau Duon, Wales

Modelling the returns

All the factors explored in the previous section produce a financial return profile for CCF management that is very different from that of clearfell systems. We have modelled the expected costs, revenues, growth rates and capital values for both management systems in Ireland, applied to a single hectare of typical coniferous forest.

The clearfell model is based on the standard GROWFOR model used by the Irish forest industry and standard assumptions around management costs. The CCF model uses the methodology for transformation to a complex forest structure proposed in a major research project for the UK Forestry Commission, adapted to Irish conditions (i.e., with higher growth rates and different timber prices). A detailed explanation of this methodology can be found in the references.³¹

The results are set out in two charts below, which show the expected cash flows and capital values per hectare of forest. Our model uses the following assumptions:

- A Sitka spruce-dominated plantation (Yield Class 22) is purchased at Year 14 for a price of €8,500 per hectare.
- Productive forest accounts for 85% of the total area.
- Standard management, operational and marketing costs are included (including extra

costs for marking individual trees for harvest under CCF management).

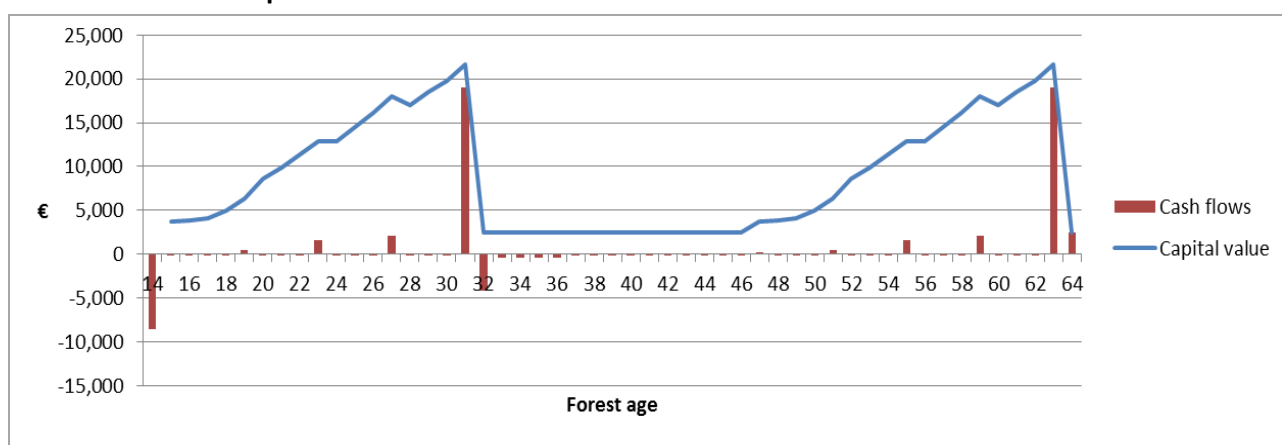
- Revenues are calculated using a price/size curve for standing timber that is based on an average of historic prices over the past 10 years, adjusted by the Wholesale Price Index to current values.
- All figures are in real terms, i.e. before inflation.

The first chart shows the expected cash flows and capital values under standard clearfell management. Thinnings are carried out in Years 15, 19, 23 and 27, before clearfelling in Year 31, which produces a net income of €19,000 per hectare. The land is then replanted and maintained, at a total cost of €5,500 over the next 5 years, before the rotation is repeated as before, with a second clearfell at Year 63.

Capital value – as measured by the value of standing timber and the underlying land – rises and falls according to the clearfell cycle. There is an assumed exit in Year 64 after the second clearfell that realises the underlying value of the land bare of trees (~€2,500 per hectare).

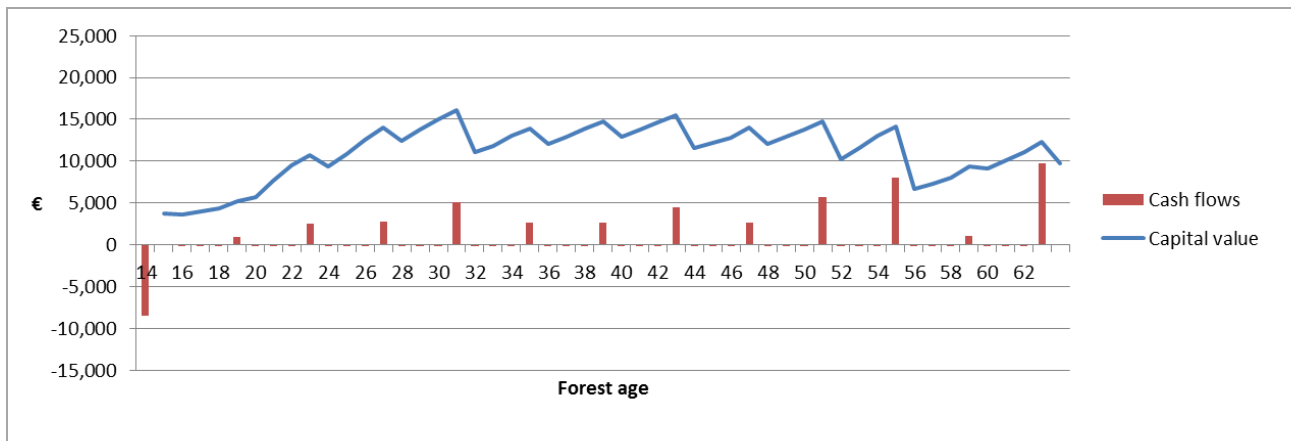
This produces an Internal Rate of Return (IRR) on the original investment of approximately 5.5% in real terms (i.e. before inflation).

Clearfell real returns per hectare



Note: Modelled using GROWFOR. Real returns, before inflation – nominal returns will be higher. Includes forest management costs. Capital value = value of standing timber + underlying land.

CCF real returns per hectare



Note: Based on methodology for modelling CCF set out in O. Davies & G. Kerr (2011) adapted to Irish conditions. 3 cohorts are assumed to coexist after regeneration and each cohort is modelled separately. Earlier cohorts are gradually felled to 'release' later cohorts. This is a simplified representation of a continuous cover forest – cash flows will be more even in reality. Shows real returns, before inflation – nominal returns will be higher. Includes forest management and insurance costs.

The second chart shows the expected cash flows and capital values under a transformation to CCF management, according to a methodology set out by Davies & Kerr (2011) and adapted to Irish conditions (for a higher Yield Class).³² Thinning takes place at the same time – in Years 15, 19, 23 and 27 – but net income across this period is 60% higher than in the clearfell scenario because more timber is removed. From Year 31 onwards, harvesting takes place at 4-year intervals, producing cash flows that average more than €4,500 per hectare each time.

The capital value of the forest rises quickly in the first 20 years as the initial cohort grows to maturity, and is maintained thereafter as the original cohort is gradually replaced by new cohorts through natural regeneration. There is an assumed exit in Year 64 that realises the value of the standing timber plus the value of the underlying land.

This produces an IRR on the original investment of approximately 6.0% in real terms (i.e. before inflation).

Conclusion

CCF can generate comparable, and potentially better, returns than conventional forestry with stronger, more stable cash yields, and more stable capital values. CCF also reduces the negative environmental impacts of conventional forestry and ensures forests are more robust and better able to resist the effects of climate change.

There is also a regulatory trend towards more sustainable forest management. National regulations in Europe and North America are limiting the size of clearfell plots and strengthening requirements for biodiversity in commercial forests. The European Commission will make its proposal on how to integrate emissions from land and forests (LULUCF) into the climate and energy package in 2016, which may lead to future limits on the application of traditional clearfell systems.

Forest certification programmes already encourage the shift to lower impact silvicultural systems, and the certification of timber from sustainably managed forests is becoming a prerequisite for sale of processed timber into many timber outlets, particularly in the UK. Both the PEFC and FSC standards for the UK and Ireland incorporate provisions to limit the extent of clearfell as a proportion of the total woodland area, and to ensure that even-aged woodlands are gradually restructured to allow a greater diversity of ages and habitats.³³

CCF is, however, quite knowledge-intensive and requires greater skill on the part of forest managers. Investors will therefore need to partner with teams that include local operational managers with expertise in CCF. The structure and terms of investments must also reflect the long-term nature of forestry and incentivise yield as well as capital appreciation.

We believe that CCF is a proven system that will see greater uptake over the coming decades with the rationalisation of Europe's private forest estate under institutional ownership. Adoption of CCF now will ensure that forest owners are at the forefront of sustainable forest management, rather than risk being left behind by a tightening of regulatory and certification standards.



Annex: Demystifying CCF

Below we address some common misconceptions about CCF.

CCF is unproven

CCF is widespread throughout Europe and the USA. It has been practiced as a matter of policy in countries like Slovenia for over 60 years. In many countries and states, clearfelling is not permitted, e.g. Slovenia, Lower Saxony and Switzerland. There is also a growing body of peer-reviewed literature on various aspects of CCF³⁴ and actual cashflows over 10-15 years of management (although the latter are often not publicly available). It is true that in the UK and Ireland, CCF practice is still in a development stage using non-native, light-demanding species such as Sitka spruce. However, CCF is often practiced in other countries using light-demanding species such as Norway spruce, Scots pine and oak. The AFI international network of Permanent Sample Plots, across a range of forest types, provides useful data and first-hand knowledge of both the silviculture and economics of CCF systems.

CCF increases the risk of windthrow especially in shallow-rooted conifers

Instability is a feature of even-aged plantations where crown and root development are generally limited. By implementing a more progressive early thinning regime, CCF encourages greater stem stability before critical height is reached and windthrow risk becomes an issue. However, windthrow risk cannot be fully eliminated and under CCF it is treated as part of the natural disturbance pattern. Windblown timber is harvested commercially as part of the regular harvest cycle, and wind events are used opportunistically to help develop the irregular structure and spacing within stands. By developing forests of diverse species and structure, CCF increases resilience to catastrophic windthrow, as there is always an immediate replacement for any blown trees. The professional selection of thinnings will also reduce windthrow risk, as stable trees are identified and retained in this process, while unstable trees are marked for removal.

However there are limits to the application of CCF, and it is best to avoid peat and peaty gley soils, for example. It is also only advisable to attempt transformation to CCF in juvenile plantations (generally around the time of 1st thinning).

Harvesting and roading costs are higher under CCF

As with conventional forestry, CCF management uses mechanised harvesting except for the removal of the largest diameter trees (or those with heavy buttressing or coarse branching) that are beyond the capacity of the typical harvester head, when motor-manual felling is used in combination with mechanical harvesting. The first thinning under CCF mimics conventional forestry in thinning intensity but is more selective. Second and third thinnings generally continue the improvement of quality, regardless of tree size. In subsequent thinnings, the focus shifts to selective harvesting of the largest and most valuable trees ('target diameter thinning' and 'crown thinning').³⁵

As a result of the more selective approach taken, thinning costs under CCF are often lower than thinning costs in conventionally-managed stands. Even the early thinnings in CCF produce larger logs and, as a result, are more profitable ("positive stumpage") than under conventional management. In the latter stages of transformation, individual stems are harvested at their optimum point for the market. Forest owners, therefore, do not incur the increased costs of harvesting sub-optimal tree sizes that arise in a clearfell at either end of the tree size distribution. Whilst CCF does not benefit from the lowest harvest costs obtainable from a clearfell operation under conventional management, these are offset by lower thinning costs and the fact that CCF management avoids the high restocking cost associated with clearfell.

Roading costs under CCF management are comparable to a clearfell system, as both require access on a regular cycle for thinning and/or harvesting. There may be some advantages under CCF as roads are continuously used and maintained, whereas, after a clearfell and replant, roads will be left alone for 15 years, by which time

they will require re-opening. Under CCF, roads require regular maintenance to service moderate flows of timber, whereas the impact of concentrated timber outputs from clearfells can cause damage to forest and to public road systems, especially in remote areas with limited infrastructure.

Management costs are higher under CCF

Yes, forest management costs are generally higher under CCF than clearfell because of the need for tree marking and more intensive management. However, higher management costs are offset by no restocking costs and higher early cash yield, and are not usually a significant factor influencing returns from forestry at the higher yield classes obtainable for spruce in Ireland. More intensive management should be seen as an investment in the future capital value of the forest.

CCF produces large logs which processors are no longer set up to handle

Growing bigger logs is only of value if the industry is set up to process them. Most modern sawmills are designed to process a relatively narrow range of sawlog dimensions available from conventionally-managed plantations. Outside of this range, logs will have little or no value if they cannot be processed. Under CCF, logs are harvested based on a target diameter set in response to market demands. Because of this, CCF produces a more consistent log size than under a clearfell system – at clearfell, there is always a wide distribution of tree sizes around a target average. Our experience indicates that there is demand in Ireland for larger logs, and the price-size curve continues to rise (meaning premium prices are obtainable) for larger logs above 0.5 m³. Where this situation exists, CCF management can continue to produce larger logs. Because CCF maintains a permanent growing stock it can adapt to changing market conditions and change target diameters very rapidly.

A forest can produce an annual cash yield without the need for CCF

With a large enough area, a 'normal' forest age structure can be established, whereby each year an equal-sized area reaches maturity and is

clearfelled and replanted, producing a predictable and steady wood flow similar to that obtainable under CCF. However, in the UK and Ireland, where the average size of privately-owned forestry properties reaching the market is relatively small, and age classes are clustered due to a peak in grant-aided planting in the 1990s, achieving a normal forest structure can be challenging. CCF ensures that a steady cash flow is obtained from every hectare of forest.

CCF cannot take advantage of improved genetics for replanting

Conventional clearfell management does enable a forest owner to use genetically-improved tree material on replanting, which over the long term can improve yields. The impact on returns is mitigated by the fact that these gains can take 30-50 years to materialise. Under CCF there is less scope for genetic improvement, although where natural regeneration is patchy and enrichment planting is necessary, some scope does exist. CCF also promotes phenotypic improvement of the forest stand much more than conventional management through its selective thinning approach that favours the best quality and fastest-growing stems. Natural regeneration in the more controlled environment of a CCF forest also provides better growing conditions for seedlings and saplings and should result in an early boost to yield for each new cohort.

CCF is not able to take advantage of cyclical highs in log markets

Under conventional management, the forest owner can in principle bring forward or delay clearfell in order to avoid or take advantage of the cyclical nature of log markets. However, there is a limit to this and it is not well-suited to institutional owners who depend on a regular cash yield from their investments. CCF management is less exposed to cyclical log prices, as smaller quantities of timber are sold into the market on a regular basis which evens out the impacts of price fluctuations – analogous to "dollar-cost averaging". As a result, CCF is a way of reducing market price risk and can reduce the volatility of investment returns.³⁶

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³⁰ Ibid.

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