Managing our broadleaf resource to produce quality hardwood timber

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COFORD
NATIONAL COUNCIL FOR FOREST RESEARCH & DEVELOPMENT

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Edited by John Fennessy[1] and Lauren MacLennan[2]

[1] COFORD Research Programme Manager (Tree Improvement and Non-wood Forest Products). Email: john.fennessy@coford.ie
[2] COFORD Technology Transfer Co-ordinator. Email: lauren.maclennan@coford.ie

COFORD, National Council for Forest Research and Development
Agriculture Building
Belfield, Dublin 4
Ireland
Tel: + 353 1 7167700
Fax: + 353 1 7161180

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Foreword

Since 1982, when state grants for forestry began to attract private growers, close on 40,000 ha (100,000 acres) of broadleaves have been planted. Current policy is to increase the proportion of broadleaf planting so that it will reach 30% by 2006. The primary policy objective places a strong emphasis on the production of quality hardwood timber, to support both industrial and craft level production.

There is no doubt that there is a strong market for hardwoods, as the prices that can be achieved for high quality oak and other species demonstrate. There are many users of home-grown hardwoods and there is are a ready market for any increase in production.

Stepping-up the production of home-grown hardwoods may take a long time. The COFORD forecast indicates that the potential production will remain largely static at about 30,000 cubic metres per annum over the decade. Nevertheless, there may be opportunities through the new Native Woodlands Scheme to regenerate and sustainably produce additional home-grown hardwood for the market.

The key issue to be addressed in growing broadleaves is wood quality. The difference in price between firewood and sawlog grade hardwood logs is ten-fold, sometimes more. As Padraic Joyce and his fellow authors point out in the COFORD publication *Growing Broadleaves* 'the objective of high quality timber emphasises the need to produce high-quality broadleaved stands. High-value timber is invariably linked to quality in the tree. This is much more in the case of broadleaves than in conifers'. The papers presented here augment this critical point and provide much practical advice on growing quality hardwood forests and on what the market needs in terms of wood quality.

Managing broadleaved stands for wood production requires skill and perseverance. It also requires public awareness that most trees, including broadleaves, are part of a sustainable production cycle and that they are primarily grown for wood production. Oak forests will not regenerate unless they are opened up to light by selective felling. Conservation is not preservation.

Many recent public outcries at tree felling have been in situations where the forest had reached maturity and needed to be felled from a commercial perspective. This point needs to be strongly and continuously made by the forest industry and by all those whose livelihood depends on wood processing. What can be more sustainable than the use of a renewable wood resource, derived from forests that are regenerated after felling? There need be no apologies from those involved in felling and regenerating forests in a sustainable way. Let us hear outcries instead about the continuing, high energy, non-renewable use of concrete, steel and aluminium

To all the authors, we say well done for their excellent and thoughtful presentations. Their work will continue to be promulgated through further COFORD seminars and workshops in the months and years ahead. There is a big task ahead in putting a high quality hardwood resource in place. We are confident that with the right policies and supports and with the obvious technical expertise and grower willingness that is demonstrated in this publication, this can be done.

Eugene Hendrick
Director

David Nevins
Chairman

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Background

John Fennessy[3]

As part of COFORD's commitment to the development of all aspects of the forest industry in Ireland, the successful establishment and management of broadleaves and the full utilisation of home-grown hardwoods has high priority. With this in mind, the seminar reported here was held with the following objectives:

- to bring growers and processors of hardwoods together so that each would have a better understanding of the others problems and requirements,
- to demonstrate effective management techniques for the production of high quality hardwood timber, and
- to further develop a wood culture in Ireland.

In recent years there has been an increasing trend towards planting of broadleaved species. It is estimated that 20,000 ha of broadleaves have been planted in Ireland in the last 12 years, with the majority being planted by farmers. This area is likely to increase substantially in the future as the Forest Service target for broadleaves, which was originally set at 20%, has recently been increased to 30% of the total annual afforestation programme.

Generally speaking, broadleaves require more intensive management than conifers to achieve optimum quality. While there is much information and expertise available in Ireland on the establishment and management of conifers, there is less practical experience of the early management of broadleaves. COFORD has been supporting research on early management to include formative shaping, tending and thinning of a range of species. Teagasc, supported by the EU Framework Programme and COFORD, has been working on the shaping of broadleaves since 1992 and has produced information on shaping protocols for ash and sycamore. More recently, a new COFORD programme, BroadForm, has been established with the objectives of determining the optimum regime to produce the best quality timber; to examine three separate interventions (shaping, tending and thinning) and the impact they have on crop quality; and to develop guidelines for the production of quality stems in every broadleaved plantation.

Limited volumes of hardwoods are presently available from Irish forests. Traditionally, Irish-grown hardwoods have found their way into lower value end uses but they have the potential for more lucrative markets. In recent years pioneering developments are emerging in the sector. These will result in higher returns for the grower.

The seminar brought together a group of specialists, all experts in their fields. It was the first in a series of two-day events, arranged by COFORD, on growing and managing broadleaved trees and utilising hardwood timber in Ireland.

The seminar was chaired by Ms Jan Alexander, President of CRANN, and Mr Pat Hunter-Blair, Director - Policy and Operations, Northern Ireland Forest Service. Field trips took place on both days. On the first day Shanballybawn property was visited to discuss management of pure ash stands, mixed broadleaf and oak stands. The field trip on the second day was to a young stand of quality oak in the Rooskey area. It concluded with a visit to the workshop of Breffni (Irl) Ltd. at Carrigallen, Co Leitrim.

This programme was organised by COFORD in co-operation with the Forest Service, Teagasc, Woodland Investment Ltd, Greenbelt, Breffni (Irl) Ltd. and forest owners. The co-operation of all these individuals and organisations is gratefully acknowledged.

[3] COFORD Research Programme Manager (Tree Improvement and Non-wood Forest Products). Email: john.fennessy@coford.ie

Introduction

Jan Alexander[4]

The fact that there are so many people from the forestry sector here today is an indication of how much this subject has come of age in the short time since Crann was formed just 16 years ago. I was presenting slide lectures around the country during the early 1980's and was often asked by foresters if I was talking about broadleaved trees or commercial forestry. At that time broadleaves were viewed by many foresters as being purely for amenity purposes.

The speakers at this seminar will be addressing the subject of making home-grown hardwood more commercial. Creating a home-grown hardwood resource will be a considerable challenge. We are really just in the infancy stage, although much work lies behind us to have even brought it this far.

So why has the subject of commercial home-grown hardwood met with such resistance? At a recent ITGA field trip to Jack Tenison's estate in Co Monaghan, we were looking at a site of poor regeneration of oak, despite much effort to encourage it. The question was put to Mike Bulfin "Well what do they do on the continent?" Mike replied that they just open the canopy. Here in Ireland, we first have to create the canopy, and that won't be done overnight.

Herein lies one of our main challenges. In the absence of an established and continual hardwood resource, and with our forestry premiums only reaching as far as 20 years, we have to somehow create a situation whereby our thinnings will fetch some form of commercial return, at least for the next 80 or so years until we have established permanent forests to draw our timber from. And that will only be achieved if we do our work well in these formative years. How do we fund the 60 to 100 years required to establish a resource that will then offer profitable and sustainable returns into the future?

In some parts of Europe, coniferous forests planted in monoculture have been successfully used as pioneers to bring back broadleaves using "Close to Nature" systems. With the establishment of a Pro Silva Group here in Ireland, perhaps this is another approach worthy of consideration.

The level of sustainable profitability that Ireland is able to achieve with regard to its hardwood resource will also depend on the establishment of locally based hardwood timber industries. These will be needed to fully utilize the resource, which in turn will help to reduce the flow of Irish cash to other grower countries. According to Just Forests *Good Wood Policy Guide*, Ireland imported €133 million worth of tropical timber and wood based (tropical) products in 2000. This figure is up 41% from the 1999 figure of €94 million – and that is just hardwood timber from tropical countries. I do not have the current figures on the overall imports of hardwoods into this country, but in the early 1990's just 10% of the hardwood timber we imported was from tropical countries.

There is no doubt about the hardwood requirements of Ireland, both presently and in the future. During the decade from 1980 to 1990 our requirements of tropical hardwoods increased by a staggering 64%. In conjunction with this increase, our furniture industry expanded to become the third largest producer in Europe.

So what does all this say? To me it points to some of our strengths. We have a strong and expanding furniture and joinery industry with a long history of using hardwood materials. We can and do market our products successfully from this small island to the UK and elsewhere. Presumably, as various timbers have become unavailable, we have been able to adapt to new and different timbers. This would indicate that we would also be able to adapt to home-grown hardwoods, should they become available. Our speakers tomorrow will be addressing this subject and will hopefully be pointing to some solutions.

I feel that the Irish timber traders could also be part of the solution in finding a way forward for home-grown hardwoods. Their expertise would be valuable in planning an integrated infrastructure to match home-grown material with the end user. In short, I feel that all strata of the timber industry will need to come on board if we are to succeed here: the State agencies; the growers; the processors; the manufacturers; timber traders; the various NGO's;

[4] CRANN, Crank House, Main Street, Banagher, Co Offaly. Email: jalex@gofree.indigo.ie

those with marketing skills, etc. It will be necessary to drop our differences and pull together on this one. I believe it will be well worth the effort and perhaps future generations will benefit in a very real, non Celtic Tiger type way, from our efforts.

Finally, this is not the first seminar on the subject at hand today. In November 1992, a full decade ago, a similar effort was made in the form of a seminar held at Trinity College Dublin, followed by workshops at Killykeen in Co Cavan. The aims were similar to those outlined at this event and many of the people who spoke or participated in that event 10 years ago are also here today. Although there have been many achievements since then, let us not allow the papers from this COFORD event gather dust for another decade. Let's build on our work of these two days and bring home-grown hardwoods another step.

The COFORD team is to be congratulated for having brought this important subject back onto the platform.

Broadleaves: What's out there?

Séamus Dunne[5]

Policy-makers require accurate and up-to-date information in order to make the best decisions. Forest policy, and indeed broadleaf policy, is no different. In this paper I hope to outline some aspects of our hardwood resource and the associated policy implications.

For any reasonable level of industry planning, a number of questions need to be addressed: What is the total area of broadleaves and how are they distributed around the country? What is their volume, their increment and what are the annual removals? What species are present? What is the age distribution and what is the quality like? Who owns it? How well organised are they? What are their management objectives (timber/conservation/amenity)? And, most importantly, how effectively will all this information, when gathered, be used to formulate policy.

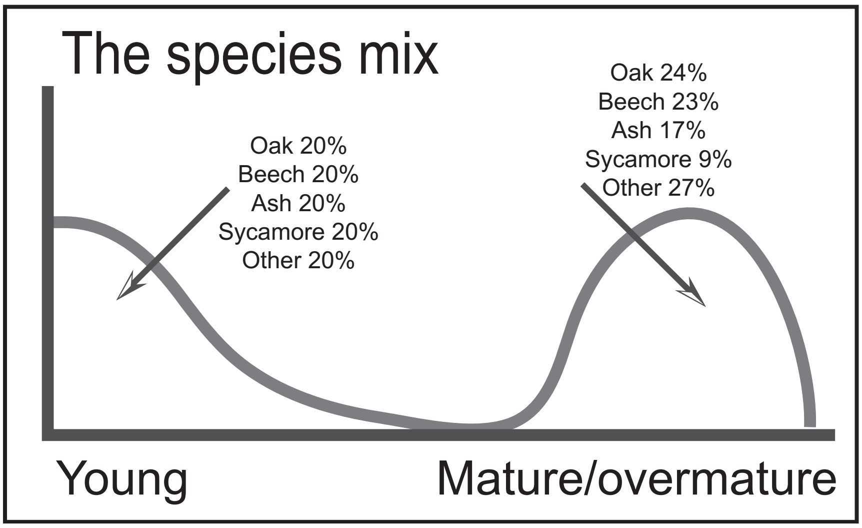
It is estimated that there were approximately 65,000 ha of pure broadleaves in Ireland in 1900. In the first two decades of the last century this fell to less than 40,000 ha. Indeed it was only in the last five or six years that total broadleaf area surpassed the 1900 level. The first policy implication for us to bear in mind is the age structure of our forests. There are quite clearly two distinct age groupings. Nearly 40% of our broadleaf area was planted in the last 10 years. Meanwhile, many of the older woodlands have been under-managed or neglected and are in need of rehabilitation. These two groupings have different policy considerations.

Unlike the conifer resource, the vast majority of our hardwood resource is in private hands. Of our 80,000 ha of broadleaves, 71,000 are privately owned, with the private sector continually increasing this gap.

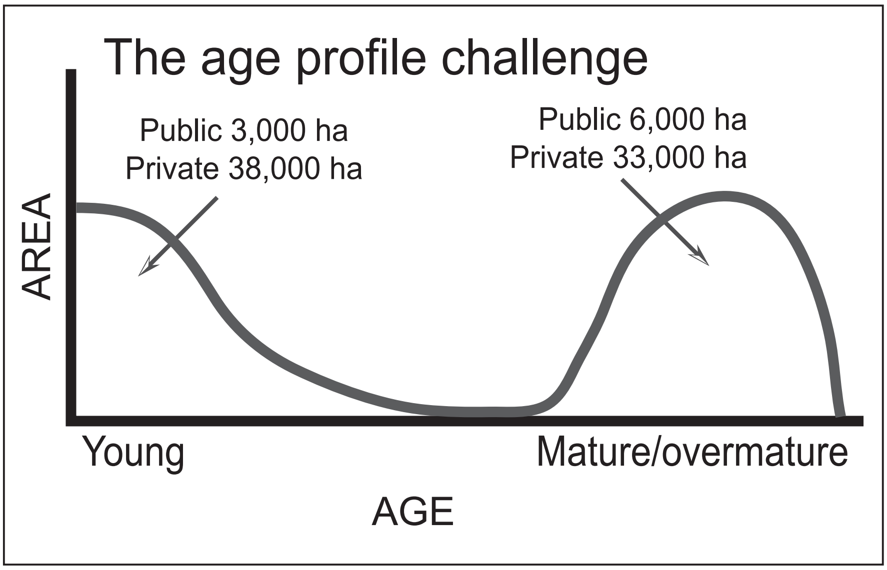
Young broadleaves

Our broadleaf estate is growing at a fast rate and likely to grow even faster with new planting targets set to rise to 6,000 ha per annum by 2006. A close look at the figures for planting over the last five years gives us an indication of where much of the future broadleaf estate will be concentrated. County figures vary enormously over the last five years, from a total of 14 ha in Co Louth from 1997 to 2001, to 1,302 ha in Co Tipperary for the same period. The four main species of oak, beech, ash and sycamore are planted equally, each with about 20% of the annual broadleaf planting figure.

Forest Service policy on broadleaves has been to grant aid the establishment of broadleaves to the highest of silvicultural standards with 100% of the costs paid for in the establishment grant. High initial stocking is a new characteristic of our silvicultural standards, with oak and beech planted pure at a stocking rate of 6,600 stems per ha. While first



[5] Forest Service, Dept Communications, Marine & Natural Resources, 29/31 Adelaide Rd, Dublin 2. Email: seamus.dunne@dcmnr.gov.ie



shaping of broadleaves is covered under the afforestation grant, a second shaping is grant aided by the Forest Service. Many of the broadleaves planted before the mid-1990s are now at a stage where they require to be tended and this is an area where the Forest Service is keen to assist and is currently considering an appropriate grant for this operation.

Mature/over-mature broadleaves

About half of our broadleaf woodlands are in the mature/over-mature age bracket. The species distribution of these varies a little from the species planted today, with almost 50% of them being oak or beech compared to about 40% today. Only 9% of the older woods are predominantly sycamore, compared to our current planting rate of about 20% sycamore.

The private sector owns most of the older broadleaf woodlands. It is estimated that these woodlands have a growing stock of about 4,000,000 m^3. The annual increment is about 80,000 m^3, some 45,000 m^3 more than the annual estimated removals.

To encourage the active management and conservation of these older woodlands, the Forest Service has for a long time had a Woodland Improvement Scheme, and has recently launched the Native Woodland Scheme. Both schemes should have the effect of increasing the production potential of the woods without compromising any of their social or environmental values.

Keeping the information up to date

To assist us in formulating forest policy it is necessary that we keep our information regarding the growing stock up to date. Many of you will know that we conducted a survey of Ireland's forests in 1997-1998 using satellite imagery and aerial photography. While this gave us very precise area and location data, volume and yield class data could not be assessed remotely. It is proposed that a sample survey of Irelands woods be carried out in 2003 to get an accurate picture from a national and county level of the species, volume and yield class data.

Looking forward, we can see opportunities in the near future where the information we gather in carrying out our day-to-day business (of granting felling licences, paying grants at year 1, receiving management plans at year 4 and year 10) will be inputted into an inventory database to further facilitate policy formulation and hardwood industry development.

Growing broadleaves – important issues for growers

Joe Barry[6]

I have been planting trees all my life in a small way. I decided to take the plunge and invest in trees in 1995 under the then forestry scheme, and planted about one third of my farm in Meath with broadleaves. I also purchased some land not far from here, in Leitrim, and planted this with a mix of conifers and broadleaves. I have put a lot of time and effort in to managing these plantations and I have no regrets for making this investment. I am convinced of the financial viability of well managed plantations and especially the potential of fast growing hardwoods, such as ash and sycamore, on suitable land.

This is where we always seem to get bogged down with the old disagreements about Sitka spruce and other conifers versus broadleaves, and the only result is that a lot of hot air has been produced. I am here to talk about facts as I see them and not theory.

Alder, for example, has moved from almost weed status to being accepted as a suitable tree for wetter areas and it is becoming increasingly popular as the timber of choice for fitted kitchens and other decorative uses. Like the majority of hardwoods we use, most of our alder is imported.

The slower maturing broadleaves, such as oak and beech, are a different matter, but in order to establish a national forest base, which in turn will provide the raw material for a potentially thriving rural industry, we simply must plant them. They are for our grandchildren and any farmer planting these trees is doing so to benefit others and is making a gift to the community at large. While that might leave him with a warm feeling and a rosy glow inside, it will not do much for his bank balance in his own lifetime. We badly need to address the problem of making the growing of these trees more attractive and I will discuss some ideas on this later on.

It is a pleasure to be able to talk about my favourite topic and at least, having planted a sizeable portion of my own land, I have put my money where my mouth is. So if I get it wrong it will hurt my own pocket first. Unlike a lot of forestry commentators, I have a vested interest in getting it right. And do not think I am anti-conifer. Larch, Scots pine, Norway spruce, Sitka spruce and Douglas fir and so on are all excellent and valuable trees. But we must match site to species and I have planted broadleaves where I feel reasonably sure that they will thrive. So far, with one notable exception in Meath where a 2 ha area of oak refused to prosper despite every attention, all the remaining trees are growing satisfactorily with the ash performing brilliantly. The problem area of oak has since been filled-in with that old reliable, alder and I have yet to see alder fail anywhere.

The level of premium paid for broadleaves is, of course, higher and the end value of the crop is potentially greater than that of conifers. We have the fifth largest furniture industry in Europe and yet we import most of the raw material used. This is a ridiculous situation and should not continue. My local sawmill supplies the furniture industry with ash, sycamore and beech and has great difficulty in obtaining suitable trees, often substituting with imported timber just to keep up continuity of supply.

Now, my brief here is to talk about the important issues for growers and as a farmer my number one issue is: Will it pay? This is where the difficulties lie. No-one in their right mind would suggest to a farmer that he should give up the use of a portion of his land without a financial return that will match competing land uses. Currently the uses for land that compete successfully with forestry are many - the Rural Environment Protection Scheme (REPS) and extensification are just two examples.

REPS is only paid on the first 40 ha of any holding, and as most Irish farms are less than 40 ha then it is obvious that this conflicts with forestry. Forestry, as I am sure you are aware, is not allowed within REPS - even the Native Woodland Scheme is outside the brief of REPS. This is rather strange when you consider that both schemes are supposed to enhance and protect the environment.

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[6] Private timber grower, Larch Hill Stud, Kilcock, Co Kildare. Email: joebarry@esatclear.ie

The cop-out at the moment is always, "Brussels will not allow it" Well, why are our Euro MPs and groups such as An Taisce, who are always moaning about Ireland's failure to implement environmental directives, not lobbying for a better deal for forestry and its inclusion in to REPS for those who wish to join.

Slow maturing broadleaves, such as oak and beech, simply cannot compete with the returns available from conifers. But if we are to develop a forest base that can deliver a sustainable supply of hardwood timber, which in turn will support rural crafts and industry, then we must make growing these trees attractive and financially viable.

So how is it to be done? Well for a start, why not allow land planted with broadleaves to be also eligible for REPS payments? This would enable farmers who are currently reluctant to reduce the area of their land that is eligible for REPS, to increase their income through inclusion in both schemes. I have heard critics of this concept say that the EC will not allow double payments on the same land. Nonsense! They already do so with tillage land so why not with forestry?

Fast growing conifers attract 20-year premiums and can be ready for harvest in 35/40 years. Oak also attracts 20-year premiums and can be ready for harvest in 120 years. Something is clearly askew here, yet we hear endless talk about why too few people are planting broadleaves. Just think about that one. It is blindingly clear that something needs to be done to make these slow maturing trees pay better and including such plantations in REPS would be a start. Perhaps paying longer-term premiums is the answer, with broadleaf plantations attracting maybe 40 or 50 year payments instead of the current 20. There must be many solutions - we need at least one, quickly. The Forest Service and Mr John Browne, who is now the Government minister responsible, must address the real fact that planting slow maturing broadleaves will not deliver a viable cash return to the farmer who plants them. That is why our planting targets for broadleaves are proving so difficult to achieve.

Take a farmer with say 80 acres. He has taken an off farm job and wishes to plant part of the farm to lighten his work load, but will only do so if it makes financial sense. If he plants, say, 40 acres with oak or beech he will get a higher premium for the following 20 years and then what does he do? The land that these trees are on is virtually unsaleable as the trees must be looked after for the next 100 years. If he has conifers he will have the sale of thinnings at around year 20 and has only to wait another 15 to 20 years for his investment to show a handsome profit. I am using this example simply to show how the current incentives for broadleaves are just not adequate until we have mature trees to harvest.

If my grandfather had planted hardwoods in the late 1800s, and if a percentage of my plantation consisted of high quality mature oak or beech, and if I was really lucky, the odd quality walnut, I could harvest a proportion of these every few years, and with the tax free income, pay for perhaps my children's education, a change of car or whatever. But like the majority of Irish landowners, I do not have any quality mature trees because no one planted them 120 years ago. So by planting some now, I am starting the ball rolling but I am aware that my son or daughter will not benefit nor will their sons or daughters. So I am naturally slow to give over land for this use. At least two generations of farmers must be supported while they grow hardwoods for the future benefit of our nation. You plant oak, get the premiums for 20 years, and then manage the plantation for another 100 years before getting a return. Why should a farmer or a forestry company, both of whom have a responsibility to support their families and or workers, plant a large percentage of land with something that will prove a liability in their lifetime? I am painting a rather stark and gloomy picture here but it is the only way I know to get the message across that we absolutely must improve the incentives for growing broadleaves now. Once we have established a forest base with mature trees providing an income, then the whole process will become self-sustaining. We must invest now in order to provide for the future.

We need firm assurances from the Government that premiums will be kept in line with inflation, and then establish a system of adequately rewarding landowners for giving up land which could continually earn money in other ways. Those of us who planted ash and sycamore in the early or mid-1990s are now faced with the need to thin these plantations, otherwise we will have large areas of woodland producing nothing other than firewood. If something is not done about the menace of the grey squirrel then our sycamore will be only fit for firewood anyway.

I have already thinned 8 ha of ash and hope to have a marketable crop available for sale as hurley ash in 10 to 12 years time. Thinning broadleaves is an expensive operation for, unlike thinning conifers, there is no method as yet of doing this mechanically and there is currently no market for these thinnings. I am told by foresters throughout Ireland that farmers cannot afford to thin their plantations and will not do so without some form of financial encouragement, and yet the Forest Service are dragging their feet on this issue. Originally we received assurances that thinning and the slow and costly task of high pruning would be grant aided this year but so far nothing has happened. Again this is short sighted and Ireland will be the loser if the huge amount of money already invested in ash is allowed to go to waste.

Quality timber can provide quality rural based jobs but, like anything else, to produce a quality article takes knowledge, time and work. If the time and work are not put in then we will end up with thousands of acres of valueless trees and scrub which farmers will remove at the first opportunity. In Germany, for example, you have farmers who have a tradition of forest management in addition to commercial farming. Because they are fortunate to have a forest base, these farmers can harvest trees annually while maintaining their acreage under timber. We are a full century away from that point here in Ireland and that is why we must subsidise the establishment of broadleaf woodland until we reach the happy point where the whole thing is self-sustaining.

Until this is achieved and the correct inducements are in place, few people are going to commit large acreages to trees such as oak. There are, of course, people out there who shout and scream that planting broadleaves should be made compulsory. Do this and farmers will plant nothing.

Small plantations are a different matter and they have a place on every farm. The non-timber benefits are many especially for anyone involved in farm tourism and with grants available to cover the cost of planting as little as a quarter of an acre with broadleaves, there can hardly be a farm anywhere in the country that would not benefit from partaking in the current scheme. Small woodlands, linked by hedgerows acting as wildlife corridors, are of huge benefit to wildlife and the landscape. We need lots of them.

People who like and admire trees are often classed as a little soft in the head. Well, there are two classes of people that are about as hard nosed and steely hearted as it can get, and these are bank managers and auctioneers. Well, you know what I mean, these are not people to pass up a money making opportunity. Bank managers love trees. They love them because their clients who have planted have a regular, 20 year tax-free income, which can be used to boost a pension, pay the mortgage on an investment property or just pay off an existing loan. Auctioneers love them because a properly landscaped property sells twice as fast as a bare bleak treeless farm. If you don't believe me just ask one. Well-planned woods, spaced out within a farm add value.

So, to keep on a positive note, let us look at the other benefits of trees in general. On a farm, woodland, by breaking the force of the wind actually increases the air temperature and this in turn raises the temperature of the soil. Livestock and crops then benefit. Have you ever seen the sorry sight of a cow or bullock standing with its backside to an electric fence, trying to shelter in an April hailstorm? A plantation acting as a shelterbelt would keep them warm, thriving and earning money.

Instead of the constant whingeing about poor prices for our produce, we also need to use a little imagination. Some people are not prepared to accept the going price for milk so they make cheese. A small number of grain growers, rather than looking at ever decreasing grain cheques, are starting to investigate biomass and the possibility of producing willow chip as fuel. It is already being done on the continent, why not here? I know COFORD have made a beginning but there is no reason why farmers cannot speed up the process instead of waiting for it to be handed to them on a plate.

The same applies to our timber and the value added prospects for hardwoods could be better than those for softwoods. But we need to show some initiative and make it happen. The uses of home-grown timber on a farm are endless and with the easy availability of Woodmizers, the mobile band saws, it is no longer necessary to transport timber to a sawmill. It can all be done at home. And when you cut one, plant at least two and the next person will have timber also. My father always warned me that we do not own land, we simply have a loan of it for our lifetime and it is a point worth remembering. We must pass it on at in at least as good condition as we found it. Growing trees is fun, it's nice, it can make money for us all, it's good for the environment and wildlife. It adds value to property. The current scheme will not be around forever.

We all know what needs to be done to make the current good scheme into a great one. Farmers, the Forest Service, the timber growers, environmentalists and the IFA should all join forces to lobby for the changes needed. We must make growing slow maturing hardwoods a financially viable activity for the people who look after them in their early years. If we get it right, everyone will benefit.

Growing quality broadleaves — the British experience

Dr Peter Savill[7]

Introduction

Historically, the most important forest management objective for the majority of forests in Europe has been the production of timber, though this is now tending to change with environmental and social issues gaining more prominence. Against the background of increasing pressures on European forest resources, this paper outlines the procedures for growing high quality timber from broadleaved trees in Great Britain.

In countries like Great Britain and Ireland, where most of the emphasis in the recent past has been devoted to growing conifers, a culture change has been needed to grow broadleaves well. The traditional conifers tend to grow on a wide range of sites without experiencing too many problems. They generally have good apical dominance and rather fine branching habits. Saleable produce, usually for the lower end of the quality range (pulpwood, particle board, structural timber), can be produced without too much difficulty. Broadleaves, by contrast, can either fill the bottom of the quality range (fuel wood) or, if grown well, the very top with such products as joinery and carpentry timbers and veneers, which fetch very high prices. However, it is much more difficult to grow high quality broadleaves than conifers.

In Britain 42% of the total forest area of 2.71 million ha is broadleaved. Of the 1.13 million ha of broadleaves, two thirds are in England; Scotland and Wales have much smaller areas. A large proportion of broadleaved woodlands, possibly about one third, is unmanaged. These are mostly small woods on farms. Overall, 91% of the British broadleaved area is in private ownership, meaning that there is, and always has been, considerable scope for variation in approaches to growing broadleaves. There is much less standardisation than in the predominantly state- and large company-managed conifer forests. In terms of current (1999-2000) planting, the proportions reflect traditional levels well. 65% of planting in England is with broadleaves, 39% in Scotland and 23% in Wales, with an overall figure of 44% for Great Britain as a whole.

The total annual production of hardwoods is stated to be approximately 100,000 m^3 (Forestry Commission 2002) of which 33,000 m^3 are oaks and 20,000 m3 are beech, indicating that the recorded harvest is only a small proportion of the annual increment each year, which for 1.13 million ha, should be nearer to 4 million m^3 a year. The market is steady for British oak, but prices for beech have recently declined due to economic trends.

The technical and economic constraints on production of hardwood timber in Britain are:

- On average, lower timber revenues than conifers, due to poor quality;
- Higher cost of suitable land than that used for conifers;
- Costly management during establishment;
- Lack of expertise and training in broadleaved management;
- Marketing difficulties including lack of consistency in supply;
- Poor quality of the existing resource; and
- Lack of developed home markets.

Of the many factors involved in establishing and growing quality broadleaved trees, seven have been selected in this paper as deserving particular attention: species and provenance selection, achieving minimum stocking densities, weed control, protection from mammals, pruning and thinning. There are, of course, many other silvicultural aspects that could be considered, but none rate as highly as these in growing broadleaves for quality.

Match species to site correctly

An incorrect choice of species can result in poor health or growth, and even the loss of a crop. The species selected for planting should be those whose

[7] Oxford Forestry Institute, Dept Plant Sciences, University of Oxford, South Parks Road, Oxford OX1 3RB, England.
Email: peter.savill@plant-sciences.oxford.ac.uk

requirements throughout life are likely to be satisfied by the site and climate in question. They must also fulfil the objectives of the planting scheme. Broadleaved species, in general, tend to have much more specific site requirements than the common conifers such as Sitka spruce.

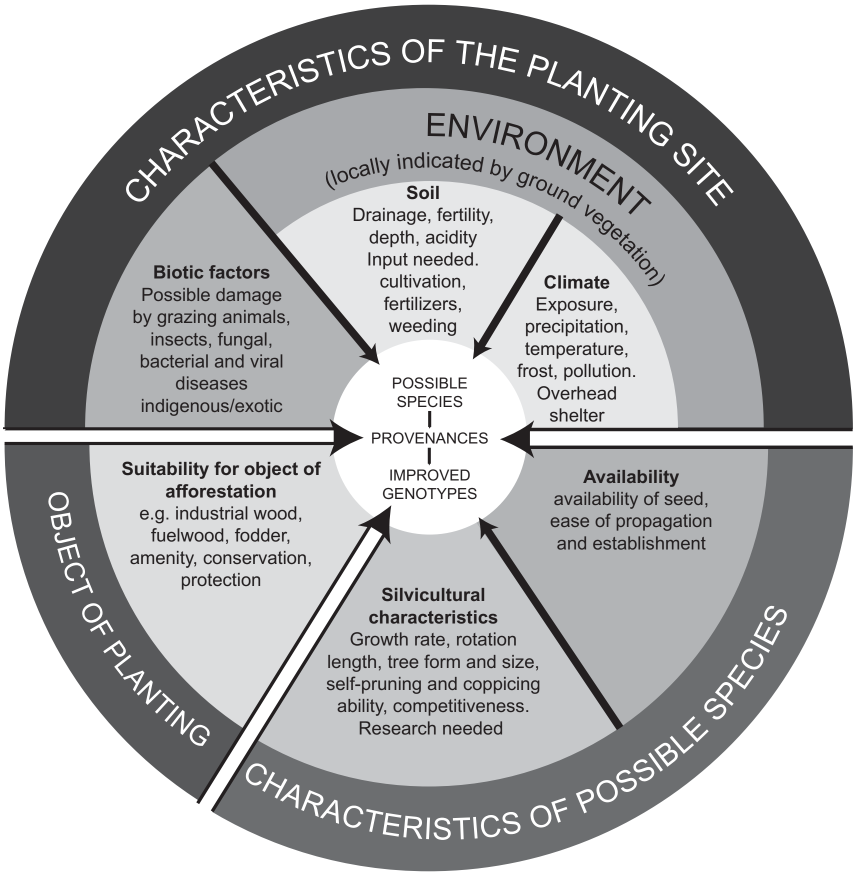
The process of species selection is done in three stages:

- Determining the characteristics of the planting site in terms of climate, soil, and other ecological factors;
- Deciding which species and provenances are likely to thrive in such conditions;
- Deciding which of one or more species, at the same time, satisfy the objectives of the planting scheme.

In many places there is considerable past experience of which species will grow and how they will perform, either from former crops of the same tree on the site or from nearby similar areas. Many publications have also been written to guide those who have to select species for planting in particular countries or regions, for example Savill (1991) for Great Britain. On regional scales, guides for selecting species based on soils alone have also proved useful. For example, Evans (1984) provided a method for selecting broadleaved species using the potential of different soils according to pH, texture, rooting depth, drainage, and fertility.

Exceptional climatic events can reveal inadequacies in species selection that may not be apparent in more normal periods. For example, the prolonged drought in western Europe during the summer of 1976 caused a great deal of mortality of beech that had been planted on unsuitable soils.

One of the features common to most broadleaved trees is that they are “site-demanding” (Miller 1984) in comparison with many commonly planted conifers. Though they do not require more nutrients to grow to a particular size than any other tree species, most require rather specific soil and nutritional conditions for optimum growth. Miller (1984) argued that they require their nutrients in specific and easily available forms, and tend therefore to be found only on soils that are considered “fertile”. These sites have mostly been converted over the centuries into arable or grazing land, so the ones available for broadleaves have been much reduced by



Considerations when selecting species

human activity. Walnut, ash, sycamore and cherry, in particular, have the reputations of being site-demanding.

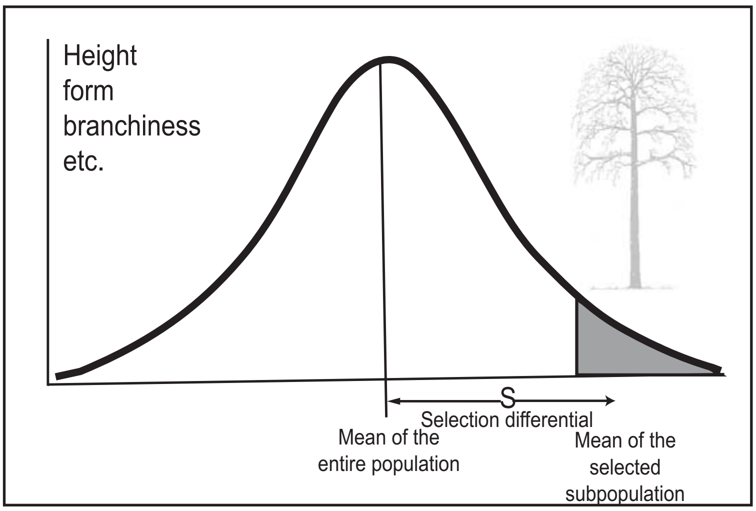
Oak may be an exception. It will produce economically valuable trees in a wide range of climatic conditions and on very varied soils, ranging from acid to alkaline, and from quite dry to wet. The range of sites suitable for most other hardwoods is much narrower. A glance at publications such as Pyatt *et al.* (2001), which list the suitability of sites for different species in terms of a range of climatic and soil factors, confirms this. Really suitable sites for some of the so-called noble hardwoods (such as ash and sycamore) are comparatively rare and small in extent. These two species usually grow in rather a scattered manner, in small clumps or groups, in mixed forests. Typically they make up less than 5% of the forest cover, being competitive only on comparatively rare suitable sites, where they can produce high-quality timber. In many areas, and especially in hilly country, a detailed consideration of local topography and soils may suggest a change of tree species quite frequently to take account of local conditions. This is in marked contrast to the extremely extensive planting of Sitka spruce and lodgepole pine, where most site variations can be ignored.

The use of indicator plants in the ground vegetation

The composition of natural or semi-natural ground vegetation is often used to indicate soil and climate within restricted geographic areas. It can be a valuable guide for species selection since changes in the natural vegetation reflect and integrate changes in the physical environment. Both tree growth and the composition of the lower vegetation are, to a large extent, determined by the same basic variables of temperature, light, water supply, soil aeration, and fertility. All of these are quite difficult to measure in practice. Where there is enough natural or semi-natural vegetation, it can be a remarkably sensitive indicator of site variability. Classifications based on vegetation are commonly used in Europe and elsewhere. For example the main types of ground vegetation in Britain have been widely used as indicators for species selection since the time of Anderson's (1961) work on the subject. The basis of all systems is that various indicator plants, or plant communities, are used to give a guide to the productive potential of the site, and other features of interest. The recently produced ecological site classification (Pyatt *et al*. 2001) provides another approach to species selection, and the National Vegetation Classification (Rodwell 1991) can be a considerable help in matching species to sites.

Obtain seed of a suitable provenance or origin

When dealing with both indigenous and exotic trees, it is not sufficient to decide simply which species to plant without considering the geographic source of the seed as well, i.e. the provenance. The forester has much to gain by using the best possible seed source for raising trees for plantations. The purchase of seemingly expensive but appropriate seed adds only a tiny fraction to establishment costs. It is a false economy to buy seed of an inappropriate provenance



The selection differential is indicated as the difference between the mean of the entire population and the mean of the selected population.

however cheap and readily available it may be. Often seed sources of native species that have been undisturbed are usually the best adapted for survival and reproduction in the local conditions.

There is also considerable variation within any natural population that cannot be attributed to differential selection along environmental gradients: this may often be greater than responses to environment. Experiments frequently show that within-provenance variations are larger than those that occur between provenances. The recognition of this type of between-tree variation is the basis of most tree breeding for increased productivity, improved stem form, disease resistance, and other attributes. Where economic analyses have been conducted, they suggest that investment in tree improvement as part of a plantation programme is well justified.

Though these principles are very well known, unfortunately progress with broadleaves has been insignificant so far. Little work has been done on provenances in Great Britain, and there is also an almost total lack of availability of genetically selected or improved material.

There are grounds for concern over the genetic quality of a significant proportion of broadleaves planted in Britain. Specific problems centre on the widespread use of stock imported into Great Britain from continental seed sources. Much of this appears to be of inappropriate provenance, especially when planted on upland sites. There is also a lack of useful information on choosing the best provenances and a general lack of planting stock of domestic provenances on the market.

These problems still exist because during the 1960-1980s British forestry concentrated almost solely on conifers, and as a result research and advice on broadleaved genetics have suffered from considerable under-provision. During the 1980s and early 1990s an attitude developed that broadleaved planting was mainly for amenity and conservation and that hardwoods were not capable of producing anything of economic value in their own right. This led to the attitude that the genetic quality of planting stock was not particularly important and as a result broadleaved genetics, particularly tree improvement, remained relatively under-resourced. Most seriously, it limits the potential for producing of high quality hardwood timber.

Reasons for supporting provenance and tree improvement are based in a belief that using broadleaved stock, which is capable of high quality timber production, has the following benefits:

- It helps the commercial viability of plantations whilst maintaining high amenity and conservation values;
- High quality hardwood timber has a record of being readily marketable;
- It leads in the future to a more diversified range of timber products in Britain;
- Confidence in the performance of broadleaved planting stock encourages a better standard of silviculture and will encourage further tree planting.

Such progress as there has been, has been made through the British and Irish Hardwood Improvement Programme (BIHIP). This is a collaborative association of landowners, research institutions, universities and professional foresters who are actively attempting to improve the quality and performance of broadleaved species, currently ash, cherry, oak, walnut, birch and sycamore. The general aim of BIHIP is to work in collaboration with all sectors of the forestry industry towards the selection and provision of superior broadleaved tree genotypes for timber production. The methodologies being applied include, mainly, the establishment of provenance trials, progeny trials and clonal field trials.

The use of good genetic material is important when growing high quality trees, but it is only part of the recipe. The other part is good silviculture.

Achieve a minimum initial stocking density

To grow quality broadleaves it is essential to achieve adequate initial densities by planting or natural regeneration. Too few stems will almost certainly result in poor quality timber, however good the genetic origins may be, with short lengths of stem wood, heavy branches, and often stems that are not straight, because of a lack of choice of good trees.

This is particularly the case in beech and oak. Both species are much more variable in terms of stem straightness than, for example, sycamore, cherry and ash. Hence, plenty of choice is needed so that badly formed trees can be removed in thinnings, leaving the good remaining ones at sufficiently high densities to provide mutual competition, so that they become tall, straight and branch-free for at least the first 5-6 m of stem. It has been amply demonstrated that oaks grown at very wide spacings are substantially (up to 40%) less tall than trees grown in dense, competitive high forest conditions (Savill and Spilsbury 1991). In addition, oak suffers badly from shake on many sites. It can be very advantageous to have enough choice to remove the shake-prone trees in early thinning operations. These can be recognized by the fact that they come into leaf in the spring somewhat later than the unsusceptible trees (Savill and Mather 1990).

Current recommendations for initial stocking densities in Britain are shown in Table 1. The differences between restocking and new planting recognize the likely presence of natural regeneration and coppice growth on restocked sites. Most foresters agree that the current recommendations represent a considerable advance on the very wide 3 x 3 m spacing (1100 stems per hectare) that was normally adopted for all broadleaves for a 10 year period from the mid 1980s. It will certainly result in a generation of appallingly formed trees.

Some owners plant at much higher densities than the minimum recommended. For example, one oak grower in Suffolk always plants at 10,000 trees per hectare (1 x 1 m).

Ensure efficient weed control for at least the first three years

During the early stages of establishment of a tree crop, whether it originates from planting or from natural regeneration, the availability of plenty of light, water, and nutrients can lead to a rapid development of herbaceous and woody vegetation. This can have very detrimental effects on planted crop trees by competing for moisture, nutrients, and causing physical damage. The most desirable strategy of weed control, and one that can eliminate or greatly reduce the need for additional measures, is to ensure rapid establishment by harnessing the competitive ability of the trees themselves. This involves planting at sufficiently high densities, using big enough plants.

However, even in countries as wet as Great Britain and Ireland, it has been amply demonstrated that one of the main causes of slow growth in the first three years after establishment years is competition for water with other vegetation. In areas that suffer from drought, or even mild deficits of summer water, weed control may be critical for the survival of young trees and it can certainly result in dramatic improvements to growth. Ash and cherry can grow 1 m in a year, and oak and beech 2.5 m if kept free of competition.

The main reason for this, as Kerr and Evans (1993) have explained, is that only small amounts of moisture evaporate from bare soil before a layer of dry soil forms a barrier to further losses. In contrast, deeper rooting vegetation transpires large amounts of water before availability limits further loss. Cutting or mowing vegetation, by perpetuating fresh regrowth, can increase the rate of loss.

It is ironical that until 1984, when R. J. Davies (reported in Evans 1984) carried out some research into the effects on tree growth of 1) cutting grass, 2) complete weed control with a herbicide, and 3) unmown grass, the most common method of weeding broadleaves was to cut or mow the grass (treatment 1) during the growing season. This was shown to be the method that results in the worst growth of all the three treatments because it causes more water loss from the soil than any other. First year growth of cherry, both in terms of height and diameter, was less than a quarter under the mown treatment than under the complete weed control. Adequate weed control involves keeping an area of 1 m2 clear round each tree until they are 2 m tall. It is most commonly achieved using the herbicide glyphosate applied as spots 1 m in diameter around each tree, or as 1 m

Table 1: Recommended minimum initial stocking densities in the United Kingdom.

Species	New planting stems ha^{-1} (square spacing in m)	Restocking stems ha^{-1} (square spacing in m)
Cherry	1100 (3.0)[a]	1100 (3.0)a
Ash, sweet chestnut, sycamore	2500 (2.0)[a]	1600 (2.5)a
Oak, beech	3100 (1.8)[a]	
	5000 (1.4)[b]	2500 (2.0)[a]

From: [a]Kerr and Evans (1993), [b]Savill and Spilsbury (1991).

wide bands along planting lines. Other methods such as mulching are also possible.

Protect trees from mammal damage – usually deer and grey squirrels

As Kerr and Evans (1993) have pointed out, the protection of broadleaved trees from damage by mammals is vital if high quality timber is to be grown. This must be part of the management strategy, and cost-effective methods of protection need to be in place. Numerous wild mammals can inflict serious damage to trees, including:

- Browsing damage (red, roe, sika, fallow and muntjac deer, rabbits and hares).
- Fraying, or removal of bark from the stems and branches of young trees (deer).
- Bark stripping damage (grey squirrels, rabbits, deer, voles, and the edible dormouse).

In addition, farm animals including sheep, cattle, goats and pigs, can all inflict serious damage to trees. They must be excluded.

In Britain, rabbits are at pre-myxomatosis levels in some areas, and fallow and roe deer present serious problems in the lowlands. Their numbers and ranges are continually increasing. The grey squirrel is not being effectively controlled over large areas.

Failure to protect vulnerable woodlands can result in complete failure in extreme cases, or degraded timber in the case of bark stripping damage. In the Chiltern woods of south east England for example, squirrel damage is now so serious that high quality beech can no longer be grown.

The two main methods of protection for broadleaved woodlands are:

- The use of fencing (usually on large areas) or individual tree guards (when the area to be regenerated is less than 1-2 ha), when trees are young. The fences must obviously be adequate for excluding the animals likely to cause the damage.
- Control of grey squirrels. This is done most effectively by the use of 0.02% warfarin on wheat or maize dispensed from hoppers that only squirrels can enter. The use of warfarin is prohibited in parts of Britain where the native red squirrels are still present. In these areas traps of various kinds are used, or shooting.

Details of how to recognize the different kinds of damage, and methods for control are given in Kerr and Evans (1993).

Prune when necessary

The aim of pruning is to produce a single straight stem of at least 5-6 m in height, which is free of knots and other defects. The first stage of pruning is when the trees are young, known as formative pruning, and the second stage, on bigger trees, is called high pruning.

Formative pruning

Formative pruning is carried out on young trees up to 3 m tall (Kerr 1992). It involves the removal of multiple leaders and unwanted large branches to promote their potential to achieve clear straight stems. When carried out correctly, formative pruning can be the most effective pruning that a tree can receive. It is not always essential but it will be necessary when the leader has been lost following damage by browsing, bird-perching, insects, frost and wind. Young trees are particularly susceptible to these hazards. The need for formative pruning can be significantly reduced by using close-spacings (greater than 2500 stems per hectare) and good genetic stock.

High pruning

Forest trees lose side branches naturally over time as higher branches heavily shade lower ones. However, because the process is so slow, both live and dead branches leave knots in the wood that reduce the value of timber. High pruning is undertaken to accelerate the process of branch death with the aim of promoting stems with valuable knot-free timber outside a knotty core of no more than 15 cm diameter. It is only worth pruning potentially high quality trees. Details of high pruning are given in Hemery *et al.* (2002).

Species differences

The need for pruning differs among species. Wild cherry, for example, generally has strong apical dominance but at low densities it will develop heavy branches that need removing. Beech, oak and sweet chestnut usually lack pronounced apical dominance and are more likely to require formative pruning. Ash and sycamore are frost-tender species and though their apical dominance is usually very good, they also quite often lose their leaders from frost. The arrangement of buds in these two species usually results in the production of two new leaders from the same point on the stem, one of which should be removed by pruning. Walnut is also particularly frost-sensitive and damage-prone. Most other species fare better when the terminal shoot is damaged because a single bud lower down the stem then sprouts to become the new leading shoot.

Thin according to silvicultural characteristics of species

Thinning is carried out to reduce the density of trees per unit area and hence to reduce competition, leaving the remaining trees more space to grow. It is also normally done to provide the owner with some revenue though, if this is not possible, as with some early thinnings, it is carried out in the expectation of greater returns later in the rotation. In broadleaved species the aim is usually to improve the quality of the final crop. This involves removing poorly formed and damaged trees. Kerr and Evans (1993), and Savill *et al*. (1997) describe the principles of thinning and how to approach it in detail.

Thinnings have to be carried out several times during the life of a stand, reducing the number of trees progressively from the 2500 or more that were planted per hectare, to fewer than 200 in the final crop. Although most broadleaves achieve their greatest value at about 60 cm dbh, and it is therefore tempting to thin heavily, this usually has serious adverse effects on the trees. For example, epicormic shoots will develop on oak, bark scorch may occur in beech, and all species will tend to develop low, heavy branches and uneven annual ring widths. The ideal regime for most broadleaves is to thin lightly and often (every 5 to 10 years) rather than heavily and infrequently. However, each species needs a different detailed approach, for example ash crowns must be kept completely free of competition to produce good timber—it is a species that recovers badly from delayed thinning. Oak will produce numerous epicormic shoots if thinned too heavily, which seriously degrade the value of the timber. It will also result in ring widths that are too wide for veneer.

Conclusions

Broadleaved trees can produce exceptionally valuable timber if they have been grown well. This involves producing straight, undamaged, stems that are circular in section, with fine horizontal branches and desirable wood properties, including a lack of knots. To achieve this, good genetic sources of seed must be used to grow the trees. They then require particular care during the vulnerable establishment years to ensure that the minimum stocking density is achieved, that they are weeded, protected from damaging animals, and formatively pruned. After this, high pruning and thinning at regular intervals are necessary.

Growing broadleaves successfully requires commitment and continuity of management. It is more difficult to produce good broadleaves than good conifers. However, both the financial and environmental rewards can be very much higher for a good grower of broadleaves.

One of the main problems in growing broadleaves today in Britain, and in many other countries, is the increasing divergence between economic and ecological interests in producing them (Schutz, 1999). There is a pressing need to find systems that can bring the two together

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Management of broadleaves : shaping, tending and thinning

Michael Bulfin[8]

The rate of broadleaved planting in Ireland has accelerated in the last 10 years. To date over 41,000 hectares of broadleaves have been planted and more are being planted each year (Dunne 2002).

From a commercial point of view the most important part of any tree - whether broadleaf of conifer - is the lower section of the stem. This is the portion of the tree, particularly in the case of broadleaves, which yields the greatest financial return. Balandier (1997) quotes French timber prices for pruned, straight, sound and knot free boles as being four times that of unpruned ones. Such price differentials do not yet exist in Ireland.

The form and quality of this lower stem is laid down in the very first years of growth. At this time should significant form defects arise they can quickly become intractable (e.g. a fork at 1 m above ground) and result in a reduction of lower stem quality. In the early growth stages of a young stem, tissues are soft and malleable and have not lignified. Lower stem defects unless corrected at the time of such malleable growth, are almost impossible to redress at a later stage.

In order to realise the full potential of Ireland's newly planted broadleaf plantations it is essential to develop management systems to promote quality. Formative shaping can offer an efficient way of ensuring that the most valuable lower portion of the tree will be straight, clean and of sufficient quality to be marketable as a high quality raw material for an expanding hardwood processing industry.

In the early 1990s the spacing of stems in a broadleaved plantation ranged from some 1.75 m spacing (3,300 stems/ha) to 2 m spacing (2,500 stems/ha). Currently ash and sycamore are planted at 3,300 per ha, while oak and beech are planted, with a nurse species, to a combined total density of some 5,500 plants. Even these spacings mean that each sapling is growing in its first few vital years at a spacing far less than in natural regeneration. There is little competition from neighbouring saplings for 4 to 7 years. Each plant grows in a free growth environment with little lateral competition.

Formative shaping is a silvicultural operation carried out in the very early years of a young broadleaf's development. Formative pruning is widely used in the literature but it covers a wide range of operations. Therefore, the term formative shaping is used in this study as a more precise definition of operations to improve stem form up to a height of 3 m.

The purpose of formative shaping is to ensure that (such widely planted) trees produce a straight defect-free stem with a single, straight, dominant leader. Formative shaping (often abbreviated to shaping) is concerned with assisting a single main shoot to achieve dominance. Shaping also seeks to counteract the tendency of young broadleaved saplings to produce defects, such as forks and disproportionately large branches lower down on their stems.

The objective of formative shaping in this study is, as outlined by both Hubert and Courraud (1987) and Bulfin and Radford (1998 a,b), to produce a straight cylindrical bole by (if necessary) removing forks, co-dominant leading shoots, side branches with an acute angle of insertion and disproportionately large side branches. The aim of this process is to produce a clean straight main stem to a height of at least 3 m. With standard hand pruning tools (i.e. secateurs and loppers) shaping up to 3 m is easy but above this height it becomes more difficult and more complex procedures and equipment are required (Barton 1993). This study conforms to the 3 m height convention employed by Bulfin and Radford (1998) and Ledgard and Giller (1999).

The available literature would suggest that the summer months of June and July are most suitable for this operation. Hubert and Courraud (1987) and

[8] Teagasc, Kinsealy Research Centre, Malahide Road, Dublin 17. Email: mbulfin@kinsealy.teagasc.ie

Balandier (1997) in France and Bulfin and Radford (1998) in Ireland all recommend that formative shaping is ideally commenced only after the rigours of winter and particularly late spring frosts and spring insect damage have passed. Early spring shaping is not recommended as it can result in much loss of sap, especially from sycamore. This type of timely shaping is also supported by Barton (1993) for New Zealand, who advocates early summer formative shaping to assist what he terms stem remodelling. Branch removal at this time will result in rapid occlusion of pruning wounds. Formative shaping carried out at this time of the year also allows the full growing season's growth to express itself entirely through the stem singled out as the main growing focus (Barton 1993).

There is some confusion arising from Lonsdale who recommends shaping at other times (Lonsdale 1987, 1991). However, Lonsdale was speaking in the context of arboriculture and the removal of large branches of 5 to 10 cm in diameter. This is entirely different to formative shaping, which confines itself to the removal of branches that are mostly less than 2 cm in diameter.

Methodology

The impact of formative shaping on a visual assessment of stem quality is the principal method of assessing the effectiveness of the formative shaping treatment. Formative shaping is directed towards two parts of the stem.

The first part is the leader shoot at the top of the stem, where any shoot that is likely to compete with the leader is removed. These unwanted, competing shoots are most likely to be an incipient fork in ash. Removal of these defects allows the stem to add (at least) the length of that year's leading shoot growth. In this way the defect height of the stem is increased by at least this amount.

The second part of the stem is the lower part where large branches likely to cause future deformation of the stem are removed. Such large branches could cause a bend or kink in the stem at their point of insertion into the main stem, or otherwise become so large that they distort the main stem. Such large branches low down on the stem reduce its timber value.

All the quality measurements in this study are based on a four-grade, quality categorisation of each tree. This grading system is a modification of the five-grade system originally employed by Bulfin and Radford (1998 a, b) and is based on assessing the dominance of the leading shoot, the straightness of the stem and the presence or absence of form defects along the main stem.

In this grading system a Quality Category 1 stem is a good quality well-formed sapling requiring no shaping. A Quality Category 4 stem has such a poor misshapen form that shaping is not worthwhile or would be too labour intensive to warrant the effort. Trees of intermediate quality categories (QC) are characterised by defects, which may be remedied by shaping or - more rarely - by natural processes over a period of time. Many, but not all, QC 2 trees can be brought to QC 1 by shaping. QC 3 trees may also be moved up to QC 2 but less frequently to QC 1. These standard Quality Categories are depicted in Figure 1 and their characteristics are listed in Table 1.

Both QC 1 and QC 2 are taken as good quality trees for the purposes of this paper. QC 1 trees by definition rarely require shaping, while QC 2 trees, in most cases, require very little shaping to be improved to the Grade 1 category.

The type of formative shaping practised by Bulfin and Radford (1998), Balandier (1997), Nicol (1820), Jennings and Hershey (1979) and Ledgard and Giller (1999) was an annual shaping, concentrated on those trees that were most likely to benefit from shaping. Whereas this approach of removing a little and often is very effective, it may not be the most cost-effective or efficient in practice.

In the results reported here a series of trials was devised to examine how long and in what way the effects of a single formative shaping would last. By extension, this was to assist with a decision on if, and when, a second shaping intervention would be appropriate.

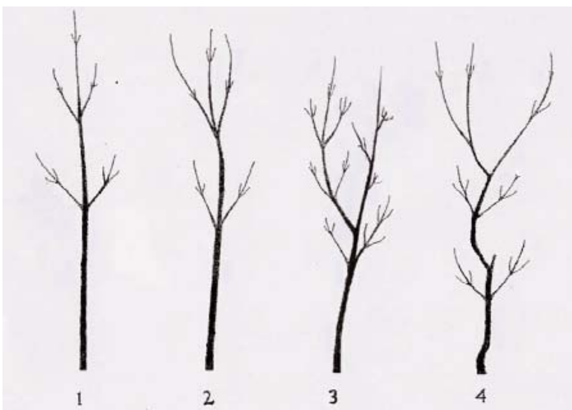

Figure 1: Standard quality categories for young broadleaved stems.

Table 1: Stem form for each quality category.

Quality Category	Description
1	Very good well balanced tree, straight stem, single dominant leader, no strong competing co–dominants, light branches.
2	Good quality tree, not full apical dominance or stem can be slightly wavy, no strong co–dominants, moderate stem straightness, not more than one disproportionately large branch or branch with acute angle of insertion.
3	Poor quality tree, poor apical dominance or poor stem straightness, One or more forks, whorls or strong co–dominants. One or more disproportionately large branches or a moderate kink could be present.
4	Very poor tree, poor apical dominance and very poor or competing stems. Crooked stems. Multiple heavy branching or forking. Severe kinks or bayonet relays.

Each trial consisted of 900 trees, with three blocks and three treatments per block. The treatments were control, light shaping and heavy shaping. There was no shaping in the control plots. In the shaping plots only those trees which required shaping were shaped. In the heavy shaping plots a large proportion of live branch and foliage tissue associated with defects (measured as a visual estimate of the percent of total foliage) was removed. In the heavy shaping treatment of the ash trial an average of 55% of total foliage was removed. The amount, on an individual tree basis, was generally in excess of 40% but in some cases as much as 80% of the foliage was removed. In addition to shaping for obvious forking or competing co-dominants defects, large branches were removed or had their outer one third removed (tipped). In contrast the light shaping treatment resulted in an average of 25.5% of the foliage being removed. Again some trees may have had considerably more foliage than the average removed.

Once the experiment was laid out - and in advance of any formative shaping work commencing - all trees were measured for height (to the top of the highest living branch), diameter at 20 cm above ground level and quality category (as illustrated in Figure 1 and described in Table 1). Where trees were shaped records were taken of the number and type of branch removed or tipped and of the percentage foliage removed.

In subsequent years measurements were carried out each year after leaf fall and before commencement of growth the following spring. The measurements taken were as already outlined for the first year. Trees were assigned to a Quality Category each year based on an assessment of their form in that year. In addition in the final set of measurements, collected at the end of 1999, where the tree quality was categorised as QC 2, 3 or 4, the height was measured from ground level to the point on the stem of the lowest defect affecting stem quality.

Results

This paper reports on the results for ash at Morninton, Co Westmeath. The ash was 3 years old at the time.

The ash was shaped early in 1997 and a full year's growth after shaping took place. The experiment continued for another two years and so measurements, of subsequent performance, for three years are available. As discussed, the amount of foliage removed was 24.4 in the light and 55.0 in the heavy treatments respectively.

Status of stems at time of shaping

Table 2 summarises the overall quality of the ash stems in the trial, and shows that the ash at Morninton had overall good quality, with almost half of the stems in QC 1 and QC 2 before shaping.

The difference in the amount of foliage removed for each of the different species, for the light and heavy treatments, is summarised in Table 3. Each

Table 2: Percent of stems before shaping of each species in each quality category.

	Ash Morninton	Ash Crookedwood
Quality Category	Year treatment applied	
	1996	1997
1	12.2	2.5
2	34.0	7.4
3	40.8	33.9
4	13.0	56.2

Table 3: Percent of foliage removed by treatment from each species during shaping.

Site and species	Ash M/ton	Ash C/wood	Sycamore C/wood	Sycamore Clare	Maple	Beech	Oak
			Year treatment applied				
Treatment	1996	1997	1996	1997	1997	1996	1997
				%			
L	24.4	32.9	37.3	26.0	27.8	26.0	33.6
H	55.0	60.9	63.7	50.3	63.9	50.3	75.0

species was treated individually and the definition of 'light' or 'heavy' was a matter of judgement as to what was sufficient to bring the stems of each individual species to the required level of quality. Based on this subjective visual criterion of 'light' or 'heavy' the average amount of foliage removed by species varied from 24 to 37% for light and 50 to 75% for heavy, depending on the species. In comparison with most other species ash required less foliage removal in each treatment, as shown in Table 3.

Effect on quality, height and diameter

Table 4 describes the effect of shaping on stem quality, and shows that both the 'heavy' and 'light' shaping treatments had a statistically significant effect on mean quality category score in 1997 after the shaping treatment had been applied. In 1998 only the 'light' treatment was significant but both treatments were again significant following the 1999 assessment.

Figure 2 shows the progress of the mean quality category score for the three treatments[9]. The mean quality category score for the control treatment increased steadily, indicating a decline in overall quality of the stems from a mean of 2.49 in 1996 to 2.86 in 1999. The effect of the shaping treatment is shown by the improvement caused to mean score (indicated by the reduction in the mean score) by shaping. The heavy treatment has a greater effect. In 1998 and 1999 the quality of the stems in the shaped treatments began to decline, as indicated by the increase in the mean scores. However, the shaped treatments still retained their improved status in relation to the unshaped treatment.

Table 5 indicates that formative shaping had no significant effect on height growth in the first two years after shaping. In the third year the control treatment was significantly taller (about 18 cm) than the shaped treatments.

The progress of height growth is shown in Figure 3, indicating a steady height increment of 50 to 55 cm each year. The height growth of the two shaped treatments is almost identical.

Table 6 shows the effect of formative shaping on diameter growth. The average diameter of trees in the light treatment plots differed significantly from the control and heavy treatments before the experiment started. This means that no statement of statistical significance can be attributed to the results for the light treatment. The average diameter of the control plot increased faster than both of the other treatments. Because diameter is influenced by foliage removal, the control plot diameters gradually surpassed the growth of the heavy and light treatment plots. This is shown in Figure 4 where diameter was increasing in all treatments, albeit at different rates.

Table 4: Effect of formative shaping on stem quality of ash at Morninton 1996 – 1999.

Treatment	Year 1996	1997	1998	1999
		cm		
Control	2.487	2.560	2.667	2.857
Light	2.573	2.377	2.540	2.640
Heavy	2.582	2.199	2.475	2.529
C v L	NS[10]	*[11]	*	*
C v H	NS	*	NS	*
H v L	NS	NS	NS	NS

Height Category

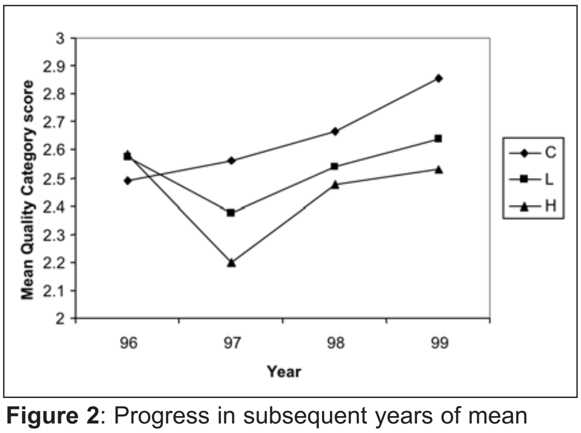

Figure 2: Progress in subsequent years of mean quality category score by treatment - ash Morninton 1996-99.

[9] As a QC 1 tree is the best, the lower the mean quality category score the better the quality of the stems in any particular treatment.
[10] NS : difference not statistically significant at the $p \leq 0.05$ level.
[11] * : difference statistically significant at the $p \leq 0.05$ level.

Table 5: Effect of formative shaping on height growth of ash at Morninton, 1996-99.

Treatment	Year			
	1996	1997	1998	1999
		cm		
Control	112.0	165.7	236.0	301.2
Light	118.0	163.3	226.3	283.0
Heavy	112.3	165.7	228.4	282.7
C v H	NS[12]	NS	NS	*[13]
C v L	NS	NS	NS	*
H v L	NS	NS	NS	NS

Table 6: Effect of formative shaping on diameter growth of ash at Morninton, 1996-99.

Treatment	Year			
	1996	1997	1998	1999
		mm		
Control	19.503	22.857	34.260	45.763
Light	20.863	23.097	31.853	41.493
Heavy	18.805	20.970	29.576	38.976
C v L	NS[12]	NS	*[13]	*
C v H	NS	*	*	*
H v L	*	*	*	NS

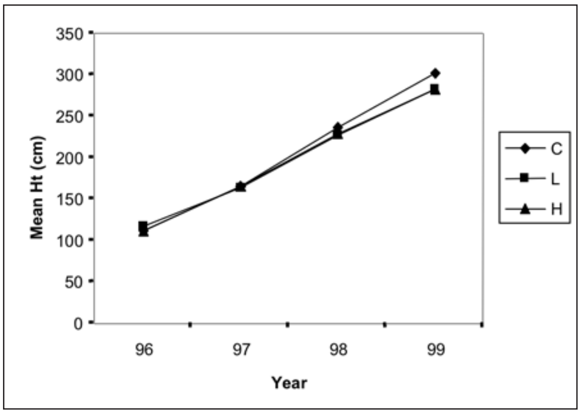

Figure 3: Effect of formative shaping on mean height growth – ash, Morninton, 1996–99.

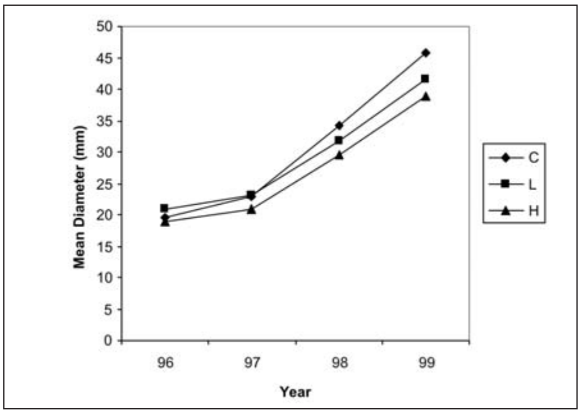

Figure 4: Effect of formative shaping on diameter growth – ash, Morninton, 1996–99.

To facilitate further analyses the stems in the three treatments were divided into height categories based on their height before the treatments were first applied. The categories were at 25 cm intervals, with the exception of the smallest category, which contained stems in the 20-50 cm range. The height intervals chosen were purely arbitrary and were solely to facilitate analysis – equally, 30, 40, or 50 cm intervals could have been chosen. The Height Categories allowed a more detailed analysis of the progress of height growth among the population of stems to be made. It also provided a mechanism whereby the effect of other analyses – such as defect height - could be examined in more detail.

Dividing stems according to the height which they had attained after three year's growth gives some indication of their genetic height growth potential. Following the progress of each category over the subsequent three years allowed an insight to be obtained into the dynamics of growth in such a variable population of unimproved seed origin. A population of trees at plantation espacement face a different challenge compared with natural regeneration. Natural competition from other seedlings a few centimetres away is not present to force a seedling to grow straight upwards in order to compete for light. Seedlings are also growing in an environment which is more sheltered than that encountered in an open field.

It was possible to divide the ash stems into eight height categories based on their height at the end of the 1996 growing season. Categories ranged from one below 50 cm to one of over 200 cm. The most important categories were in the middle of the range where the largest number of the stems was found.

The first aspect of height growth which was examined was the distribution of the initial population of stems within each category. The number of categories varied depending on the species and the number of years since planting. Slower growing species have fewer categories for any given age than faster growing species. The ash at Morninton was divided into height categories after the third year from planting.

The distribution of stems by category, expressed as the percentage of stems in each category in 1996 by treatment, is shown in Figure 5. It shows that the greatest number of stems was located in the middle categories and that the distribution of stems follows a normal distribution pattern with a skew towards the

12 NS : difference not statistically significant at the $p \leq 0.05$ level.
13 * : difference statistically significant at the $p \leq 0.05$ level.

taller stems. The pattern is more or less similar for all treatments.

The progress of height growth by category for the control and shaped treatments (all stems from both treatments combined) is shown in Figures 6 and 7. The most vital information to be gained from these is that the growth pattern is the same for each category. The trend line for each category runs parallel to the others. Small stems do not tend to catch up with larger stems, nor do the larger stems tend to lose momentum or to pull away. In later years it is likely that the smaller stems will not enter or compete in the upper canopy.

The results indicate that stems, which start at one particular rate of growth, continue to grow at the same rate. However, it would seem that the very smallest stems (those in the 20 – 50 cm category) are beginning to fall behind the tallest.

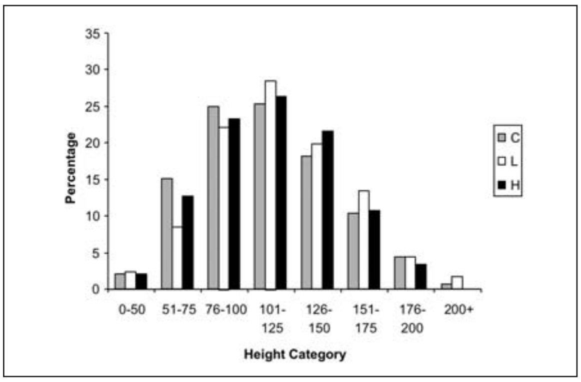

Figure 5: Distribution of stems by height category (percentage of stems in each height category in 1996 by treatment) – ash, Morninton.

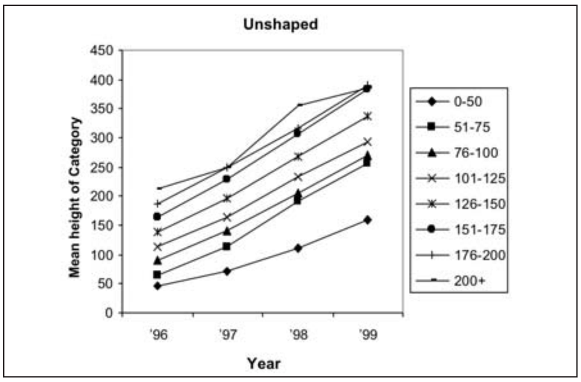

Figure 6: Progress of height growth in unshaped treatment by height category – ash, Morninton, 1996-99.

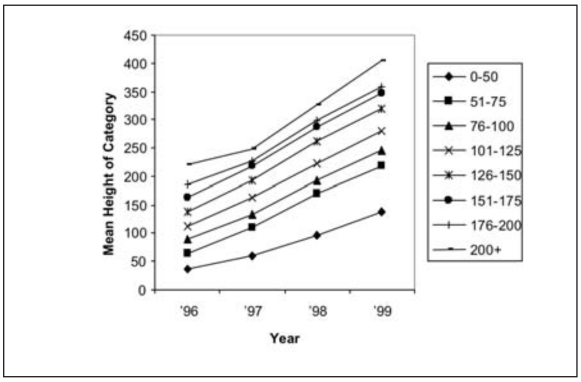

Figure 7: Progress of height growth in shaped treatments (combined) by height category – ash, Morninton 1996–99.

Defect Height

As pointed out earlier shaping affects two parts of the stem: first by promoting and giving protection to the growing point of the leading shoot, and then by improving the quality of the lower stem. In this section the effect of formative shaping on the lower stem is examined by assessing the height to the first stem defect. This gives a useful insight into the effectiveness of shaping as a method of improving stem quality. Both the light and heavy treatments added an additional length of defect-free stem in comparison to the control treatment. Table 7 indicates that both shaping treatments had a significant improving effect on the length of clean stem.

Defect height is examined by category in Figure 8, which shows the mean defect height by height category and treatment. It shows that the height to the first defect was greater in the taller height categories (with the exception of the 200+ height category). For instance the stems, which were in the 76 – 100 cm category in 1996 when first measured, had defect heights of around 150 cm in 1999. Stems, which started in the 176 – 200 cm height category in 1996, had defect-free heights of around 300 cm in 1999. In most categories the defect-free height in the control treatments was lower than in the shaping treatments.

Defect height can also be expressed as a percentage of total height thus giving another measure of differences between treatments. Figure 9 shows the height to the first defect as a percentage of the total height reached at the end of the 1999

Table 7: Mean height to first defect by treatment – ash, Morninton, 1999.

Treatment	Height
Control	186.5
L	211.3
H	221.0
C v L	*[15]
C v H	*
H v L	NS[14]

14 NS : difference not statistically significant at the p ≤ 0.05 level.
15 * : difference statistically significant at the p ≤ 0.05 level.

growing season for each treatment. The stems are also divided into 25 cm height categories. It shows that the defect height as a percentage of the mean height in each individual height category in the control plots was less than the defect height in either of the treated plots, (with the single exception of the light treatment in the 200+ cm height category). The defect height percentage also increases with increasing height category for each treatment – again with the exception of the 200+ cm category. Defect height, as a percentage of total height, is also much less in the control plots in the smaller than in the taller height categories.

The mean defect height for each treatment was also examined by quality category. Such an analysis confirmed the effect of defect height on quality ranking. The results for the ash at Morninton are given in Figure 10.

In the top two quality categories, the control plots had the greater defect height. This is anomalous. A partial explanation, however, is that the mean heights of the stems in QC 1 and QC 2 were taller than the stems in the treated plots. There were also fewer stems in the control plots in the top two quality categories and these stems tended to be defect-free. There was a decline in mean defect height in each quality category. There was a rapid fall in mean defect height between QC 2 and 3 where mean height was almost halved from around 300 cm for each treatment to around 150 cm. QC 4 had the lowest mean defect height.

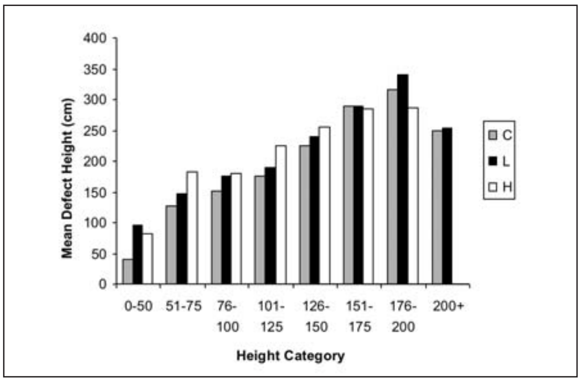

Figure 8: Mean defect height by height category and treatment – ash, Morninton, 1999.

Note: there were no stems in the heavy plot in the over 200 cm Height Category.

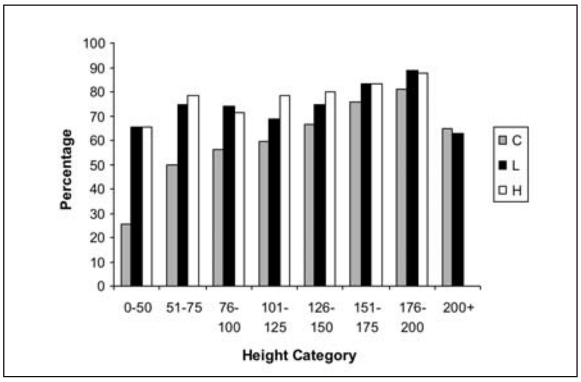

Figure 9: Defect Height as a percentage of total height in 1999 – ash, Morninton.

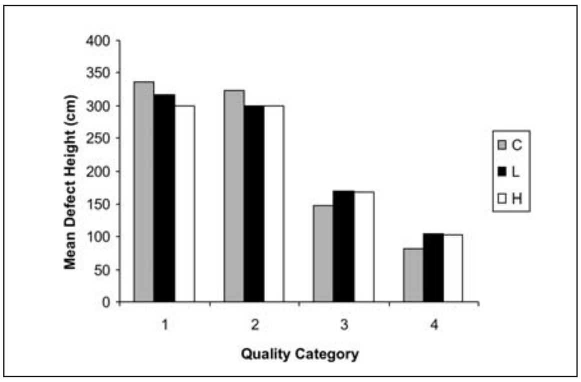

Figure 10: Mean defect height by quality category and treatment – ash, Morninton, 1999.

Foliage Removal

The amount of foliage removed was estimated visually and is shown in Figure 11. There was a small increase in the amount of foliage removed with increase in the original height category with the clear exception of the tallest category. There are only 5 stems in this category. Because the light and heavy treatments were combined, the range of foliage removal for all height categories, except the tallest, was from 35 to 45%.

Each stem was assigned to a foliage removed category as follows: (1) 0 to 25%, (2) 26 – 50%, (3) 51 – 75% and (4) over 76% foliage removed.

The effect of different levels of foliage removal on stem quality is shown in Figure 12. The control treatment shows a steady decline in quality (shown by the slow increase in mean quality category score). Where foliage has been removed there is an improvement in mean quality category score for all levels of foliage removal with the greatest effect showing in foliage removed category 4 - the category with the greatest amount of foliage removed.

The effect of foliage removed on diameter growth is shown in Figure 13. Diameter growth, in the experiment is regarded as good and (as shown in Table 6) the effect of shaping is statistically significant. The control treatment has the largest diameter while the other treatments have a somewhat smaller diameter. (Note diameter was measured at 20 cm above ground). There is very little difference between the other foliage removed categories, despite having had increasing amounts of foliage removed.

The effect of foliage removed by foliage removed category on height is shown in Figure 14. There is little difference between any of the categories and the control. Foliage removal has little effect on height growth.

Tending

Many consider that the sole requirement of tending is the management of the canopy during canopy closure. However, the operations to be considered in conjunction with tending include vegetation control, rack cutting, brashing, pruning, fertilisation, protection and fire prevention (Hart 1991).

In broadleaves, the process of formative shaping can be equated to brashing and pruning in conifers. Because most broadleaved plantations are located on enclosed agricultural land, the risk of fire is limited. However, care needs to be taken in the early spring when, in dry weather, there is a considerable amount of flammable, dead vegetation.

Once a plantation has been successfully shaped it requires just routine attention to protection from animals. Broadleaves in Ireland lack attention to maintaining easy access to the plantation. While heavy vegetation such as grass and weeds merely impede progress, briar infestation can make a plantation virtually inaccessible. Judicious herbicide application or the use of an off-road vehicle can maintain sufficient access. Access will be needed to the plantation for the removal of stems during tending operations to manage canopy closure. It is a moot point whether this operation should be considered to be tending or thinning.

Joyce (1998) defines tending as: "The removal of wolves and trees of defective stem form, which would adversely affect the growth and quality of the crop. This is usually done at a top height of 5 – 8 metres".

A tending following this prescription was applied to an ash plantation at Shanballybawn, Co Roscommon, to accompany the workshop. The plantation itself was not typical in that it had a very high stocking rate with approximately 6,500 stems per ha. It had not been shaped or tended. Tending was also applied to the plantation at a late stage as the mean height was 9.2 m. It could be considered as both

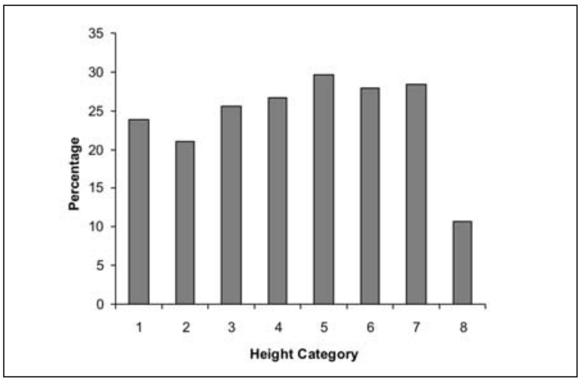

Figure 11: Percentage of foliage removed from each height category – ash, Morninton, 1996.

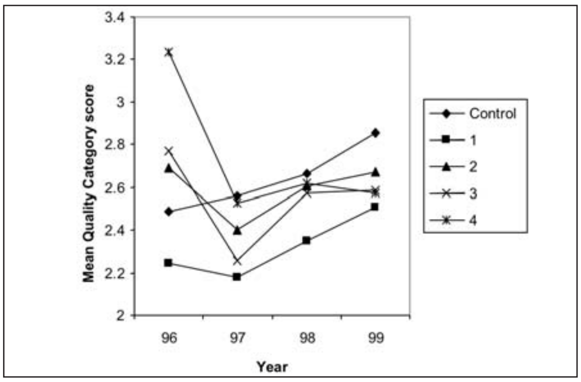

Figure 12: Progress of mean quality category score within each foliage category and the control treatment - ash, 1996-99.

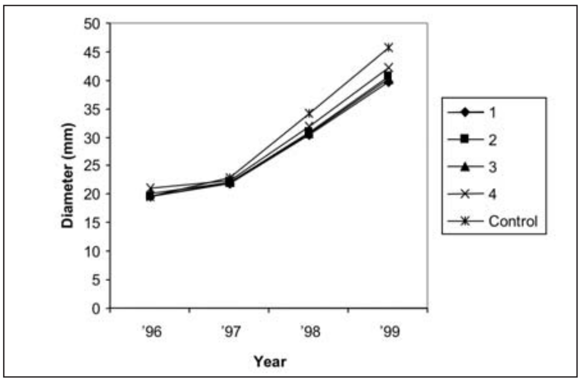

Figure 13: Progress of diameter within each foliage removed category - ash, 1996-99.

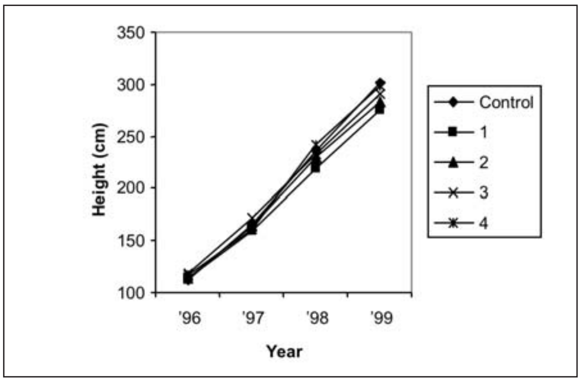

Figure 14: Progress of height growth within each foliage removed category - ash, 1996-99.

a tending and thinning operation, with a little shaping and pruning to the selected stems. Measurements were taken before and after the treatments were applied (Table 8).

Table 8 shows that it was necessary to remove almost 1400 stems per ha in order to remove wolves and to free up the crowns of an estimated 664 stems per ha, which were being favoured as potential final crop trees. Because the plantation had not received any formative shaping the defect height was low. Also because many large branches or forks causing defects were well developed it was not possible to recover the situation by removing them. Thus, while the small amount of pruning that was done succeeded in raising the defect height, this was limited to an average of 0.5 m.

Table 8: Effect of tending treatment on stand quality – ash, Shanballybawn, 2002.

Item	Before treatment	After treatment
Age	12	12
Stems per hectare	6,500	5114
Mean Height (m)	9.2	
Average diameter (cm)	5.1	8.3
Defect height	4.6	5.1
Quality category	2.6	2.4
No. potential final crop trees		664
Stems removed		1386

Discussion

There were three years of annual measurements for ash following shaping in early 1997. This gives sufficient time for an assessment of the short-term (3 years) effects of formative shaping. Over this period the stems in the experiment grew an average of 2 m. Formative shaping improved quality relative to the control treatment for all shaping treatments and for most years. However, even in the shaped treatments quality declined in each subsequent year as damage occurred to good trees. By the end of 1999 only the heavy treatment has held the mean quality category score below the level it held immediately after shaping. There is a clear indication that ash would need at least two shaping treatments to produce sufficient stems (for long-term crop development) with clean boles over 3 m.

Height growth was regarded as moderately good, with an average height growth per annum for all treatments of 58 cm. The stems in the control treatment have gradually outgrown those in the shaping treatments and the difference is significant in the third year. This may be because the foliage that remained on the control trees gave them added vigour in the shorter term. However, over a longer period - if sufficient stems maintain one single leader - then the height growth of the shaped trees should be better, as found by Bulfin and Radford in earlier work (Bulfin and Radford 1998 a,b).

Diameter growth was reduced by formative shaping, with the heavy treatment causing the greatest decrease. This effect is attributed to the extra foliage on the unshaped trees allowing them to develop thicker stems. The differential in diameter growth (measured at 20 cm above ground) is more likely to last, as the unshaped stems become very bushy - which contributes to diameter but not to quality. As pointed out above, all diameter measurements were taken at 20 cm above ground level. Many unshaped stems had already forked or developed whorls below 1.3 m, which is the standard height at which diameter is measured in forestry.

While the differences in defect height between control plots and the shaped plots are significant this analysis of the average defect height masks other important information. This information can be obtained from the more detailed analysis of the height categories.

When defect height was examined by height category a number of trends became obvious. The most important observation is that defect height increases with increasing height category. This is not obvious and is masked in the analyses of mean defect height by treatment. The reason for this trend is not difficult to see. If at the time of shaping all serious defects are removed from the lower stem then the taller that initial stem is, when it is shaped, the longer the length of defect free stem it will have after shaping.

Further valuable information can be obtained by examining the relationship between defect height and the total height of the stem. Figure 8 examines this relationship. There is a trend apparent in that defect height, as a percentage of total height, was higher in the taller height categories. Defect height, as a percentage of total height is also much less in the control plots in the smaller than in the taller height categories. These finding indicate that it may be more effective to concentrate shaping activity on the taller stems.

Figure 9 indicates that the better the quality of the stem the greater the defect height. There is an anomaly in that the control treatment had the highest defect height. This is because, while plots were assigned at random, the control plots contained some very tall QC 1 trees, which remained defect-free. These stems, therefore, brought up the average defect height in the control treatment.

The amount of foliage removed tends to increase with increasing height category. Less foliage will be removed from a small poorly furnished stem than from a larger stem.

Foliage removal had little effect on height growth but did affect diameter growth. The amount of foliage removed had little effect on mean quality category score except in the heaviest removal category where the score improved perceptibly in the first year. However, this is not to say that very heavy foliage removal is to be recommended. Removal of up to 50-55% of foliage on some stems at the formative shaping stage is regarded as acceptable. Following shaping, the quality tends to decline slowly as some stems sustain damage.

The tending operation on the ash at Shanballybawn was delayed too long. The time of tending is not determined by years but by top height. Had the plantation been shaped when it was between 1 and 2 m in height a number of serious defects (that were too lignified and set into the stem) would have been removed. This would have increased to the final defect height and would have gone towards achieving the target set by Evans (1984) of 6 m of clean stem.

The information contained in this paper has implications for the choice of stems to be shaped in a young ash plantation. There is a clear indication that where good quality tall trees occur that most shaping attention should be given to these valuable stems. A rule of thumb would be to confine shaping to stems of average or above average height.

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An overview of hardwood use in Ireland

Gordon Knaggs[16]

Definition of a Hardwood

The term hardwood, confusingly, does not refer to the hardness or softness of a wood, but is a botanical division to differentiate broadleaved trees from conifers, which supply softwoods. In world terms, hardwoods range from ultra-light species such as balsa, with a density as low as 150 kg/m^3, to species such as greenheart that can be heavier than water. Irish-grown hardwoods range from moderately light species, such as alder or poplar, to moderately heavy species, such as oak or beech.

Historical

Before trade in timber developed significantly, Ireland was dependent on native sources, with softwoods being effectively absent from around the first millennium AD or perhaps even earlier. From records, and from surviving examples, oak appears to have been the dominant species, with some early buildings surviving, such as the Royal Hospital, Kilmainham (1684), where all structural elements in floors and roof were of this species. Artefacts recovered from King John's Castle, Limerick, show also that oak was the main species in the mine works dating from the siege of 1642, with alder, birch and some ash also present. Scots pine and elm present on the site were probably early imports. Even at this early period, Irish oak was regarded as particularly durable and eminently suitable for shipbuilding. Later, Irish oak was used in the reconstruction of the Great Hall at Westminster in 1912, with the original construction in 1399 reputed to also be of Irish oak.

Due to overexploitation of the forests, and to changes in fashion in furniture making, importation of other species slowly started. Oak was imported from Europe, and tropical timbers such as mahogany appearing from Cuba and the West Indies. This supply of mahogany was soon exhausted, and sources of supply changed to Africa and the Far East with species such as African mahogany and teak. More recently increasing supplies have come from North and South America.

Consumption

Today, we import a very wide range of hardwood species from many countries across the globe. Unfortunately, trade statistics are very unreliable. Estimates of consumption of sawn hardwoods range from a high of 150,000 m^3 (FAO), through 104,000 m^3 (Eurostats) to some trade estimates of 70-90,000 m^3. Some Central Statistics Office figures even suggest that we are major exporters of tropical hardwoods! These statistical difficulties are not confined to Ireland, with the International Tropical Timber Organisation (ITTO) also citing the lack of accurate statistics. However, it is probably fair to assume a consumption of around 100,000 m^3, of which 65% is of tropical origin and 35% temperate species. This includes a significant proportion of machined timber, principally North American and European species for flooring. Iroko from West Africa is still the biggest single species, with oak from America, Europe and Ireland the next most common. A wide range of other species is imported from North and South America, Africa and Europe. Asian species are now seen less frequently as sawn timber, with most imports from that region now in the form of mouldings or furniture. Malaysia alone sends some €7-million in furniture to Ireland from an annual production of over €1-billion, much from renewably managed rubberwood.

To put these figures into context, the total Irish production of hardwood logs is probably under 10,000 m^3.

The Irish Resource

Oak probably represents half of the Irish hardwood lumber usage, with beech, ash and smaller quantities of a number of species making up the remainder. Much of the present resource is over-mature, particularly the shorter-lived species such as beech, and the quality is variable. As far as I am aware, there has been no accurate inventory of Irish hardwoods classified by timber quality, so that the true value of the resource remains largely unknown. Recent plantings, even of the faster growing species such as

[16] Gordon Knaggs and Associates, The Gables, Baldoyle Road, Sutton, Dublin 13. Email: gordonknaggs@eircom.net

sycamore, will take a considerable time to produce saleable timber.

Available information, limited though it is, indicates that the properties of Irish-grown hardwoods are not greatly different than the same species grown abroad and, if of the appropriate quality or grade, are perfectly suitable for the same applications as the imported material. In the case of ring-porous species such as oak or ash, they may even be somewhat stronger due to their faster rate of growth.

Past and present plantings give us species that are mainly pale in colour, but with a range of strengths and textures. Oak, and to a lesser extent Spanish chestnut, are medium brown, while cherry is the only reddish wood. We do not have the range of dark woods typical of tropical species. At present, the fashion is for pale woods and finishes but this may change, and consideration should be given to identifying species with potential for reasonable growth rates in Irish conditions which could fill this area. It is likely that the availability of many tropical species will diminish markedly in the long term, either through over-exploitation or due to increased demand and processing capacity in the countries of origin, as has already happened in the case of Malaysia.

At present, the capacity of specialist hardwood sawmills in Ireland is small compared to that for softwoods, but is probably in line with the supply. Not all these mills have kiln-drying capacity, although this is compensated for in some measure by the Coillte drying facility at Dundrum, Co Tipperary. Considerable kiln-drying capacity also exists in the imported sector, mainly drying African species such as iroko and sapele.

Uses

It is extremely difficult to give a concise overview of the uses for hardwoods, as virtually every manufactured product has at some stage in history has incorporated wood. Traditional uses in transport (shipbuilding, vehicles) have largely disappeared, but many applications are still seen. Obvious categories include construction where hardwoods have largely been supplanted by softwoods on the grounds of cost in structural applications. In joinery and furniture hardwood is still the preferred choice ofmany, despite the advent of plastics and other materials, and there is a significant number of high quality bespoke furniture makers using Irish species.

One area where the use of hardwoods has increased considerably in recent years is in flooring, supplanting carpet and vinyl, not only on aesthetic grounds but also because of perceived health benefits. All the indications are that this trend will continue into the future, with temperate species being especially favoured.

Much garden furniture is also made from hardwood, but in this case much is of tropical species which are naturally durable.

Other uses that could be listed include crafts and woodturning, tool handles, hurleys from ash, toys, fencing, decking and charcoal making.

For the owners of newly established plantations, an area of concern is the present lack of viable uses and outlets for hardwood thinnings. Such material in not at present favoured by the board mills and presents difficulties in sawing. While some work on this material has been carried out at the University of Limerick, there is an urgent need to develop further and more profitable uses for this material.

Sustainability

Considerable public and media attention is given to the depletion of timber, particularly tropical hardwoods, worldwide. While this is a very complex subject and one where the timber industry is often unfairly blamed, some generalisations can be made. Temperate hardwoods, as imported into Ireland from Europe and North America, can be regarded as being sustainably managed, with growth increment being considerably in excess of fellings and standing volumes increasing.

There is considerably more pressure on tropical hardwoods, principally due to clearance for agriculture, although timber exploitation is a major factor in some regions. Many countries in the tropics have forest management policies in place, with Malaysia being perhaps the best example, and Ghana leading the way in Africa. However, the enforcement of such policies can be difficult due to pressure on land resources. There is potential for a great increase in the output of sawn timber without increasing depletion of the forests by the adoption of modern sawmilling techniques and especially by the banning of chain sawn timber.

Irish-grown timber, coming from newly established plantations, can be perceived as environmentally friendly and may in time even fetch a premium on this account.

Experiences in the processing of our native hardwoods

Seamus Heaney[17]

Introduction

Dundrum sawmill was originally established to process softwoods. However, more recently, a programme for processing hardwoods in Coillte was developed at Dundrum.

The commencement of this programme necessitated a new learning process about the handling and management of home-grown hardwoods for all staff. Managers and operators needed to learn how to handle logs of different species and of variable quality. Not having had an established hardwood culture at the mill, the process had to start at the very beginning. The mill also needed to be upgraded and adapted to process hardwoods in a new and competitive environment.

New facilities were installed at a cost of almost €1 million. Coillte would like to acknowledge the generous funding and support received from the Forest Service and Enterprise Ireland. The facilities included new sawing facilities. Drying facilities were added, and correct drying schedules were developed for the different species. Operators were required to learn the correct handling procedures, as well as the grading and correct storage of the processed material.

The hardwood resource

As well as establishing the processing facility, it was important to quantify the available Coillte hardwood resource. Where the resource was not available from the Coillte estate, other sources had to be identified. As broadleaves were always classified as a minor component in past forest inventories, it was difficult to establish the exact volume, quality and availability by species, and location. Another important issue was log grading and where they fitted in national and international log grading systems? Other issues that had to be addressed were log length and sizes demanded by the market place; regulatory issues such as felling licences to harvest the resource; what was the lead-in time to get the whole process established? The lack of a hardwood culture meant that the practical aspects of harvesting hardwoods needed to be learned.

Processing of hardwoods

When processing hardwoods, the importance of winter felling can never be overstated. The seasonality of broadleaf tree growth and the effect that sap has on log quality is of critical importance. Sap in trees causes the log to split much more easily on felling and it can cause discolouration of the timber, as in sycamore. The felling process is an important skill that needs to be learned by the feller, as incorrect felling of mature broadleaves can cause

17 Coillte Wood Products, Dundrum Sawmill, Dundrum, Co Tipperary. Email: heaney_s@coillte.ie

considerable degradation, especially splitting of the stem. This can be most serious in ash but affects all broadleaves. Damage is minimised by ensuring full severance from the stump before the tree begins to fall and by directing felling so that a tree does not impact directly on a large protruding branch or hit an irregularity such as a gully, rock or another log.

Once the log is felled, proper handling is important, for example a simple treatment such as end sealing to prevent the log cracking. Some species – especially sycamore - have a short time frame from felling to sawing if degrade is to be avoided. For birch and alder it is a little longer than for sycamore, while for Spanish chestnut it is longer still. Oak has one of the longest time frames allowable. Another issue relating to processing of the log into planks is certification (traceability).

Once the material is felled, and transported to the mill yard, the next issue facing the mill manager is the question of sawing and processing. The questions for the mill manager are how the wood should be dried, what is the required moisture content and how this can be achieved and maintained if the planks are to be stored? Can satisfactory moisture levels be achieved by air drying and how effective is air drying in Irish conditions? What is the ideal length of time for air drying or is it dependant on species, or the year that drying takes place (some years are very wet, others tend to have less rainfall and lower humidity levels)? Other important issues are how the different species behave while being air dried, and what are the correct stacking procedures. Is air drying adequate or is kiln drying necessary? In all drying, but especially kiln drying, the correct stacking of the wood is important. Degrade can occur at this stage, such as staining of Spanish chestnut, discolouration in sycamore and sticker marks in other species.

The next important issue after drying is correct storage. If there are no storage facilities available, what can be done to maintain moisture content at the required level? It is vitally important to have correct storage conditions for kiln dried material.

Processing of native hardwoods has been a major learning process for all at Dundrum mill: getting to know the behaviour of all of the different species, the ways of handling the timbers correctly and presentation of the timber of each species as a saleable product.

Grading of sawn kiln dried material

The establishment of recognised grades is important for presentation of Irish hardwood material. Irish joiners are accustomed to international grades for hardwoods – white oak from America comes in specific established grades, but in Ireland we do not have national grade standards. We need to establish a grading system so that all material is identifiable at these grades for customers, specifiers and other hardwood timber users. There is also a need to define standards such as lengths and widths of planks, because at present many of the small mills have several different sizes. At Dundrum, we have established grading standards for the different species. For example in oak we have six different grades: prime oak, rustic oak, quarter-sawn oak, pippy oak, burr oak and beam grade oak. We have also done this for all other species.

Grading of kiln dried material is very important as it gives the end user a specification of what the material will be like when he orders it and, more importantly, the end user can get the same grade of timber on repeat orders.

Selling the Irish hardwood material

In Ireland there may be a perception that Irish hardwoods are of inferior quality. This is not the case. In fact, Irish material, when properly processed, is of similar if not better quality to imported material and it can have better and more diverse colour and

texture. We have traditionally used European and American products because these products have been strongly promoted and because there was so little Irish product available. It could almost be said that for many consumers, Irish hardwoods are new products, which require proper presentation, branding and promotion. As stated, new quality standards for trading Irish hardwoods must be adopted and brought into common use. All this information must be circulated to end users and material specifiers. Irish material must be shown and promoted. This will lead to the development of new trading relationships. Product supply must be guaranteed and products must be widely available at competitive prices when compared with similar imported European and American products. A good product mix must also be available. Only in this way will it be possible to develop markets for Irish hardwoods.

Developments in the future

There is an onus on growers, processors and millers to continue to work together with promotional agencies to build confidence in Irish hardwoods. Specific promotions will be needed in order to encourage the use of the product and so increase the demand, while new products must be developed and marketed. New research projects are needed to investigate uses for smaller diameter and lower quality material. Continuity of supply must be guaranteed and stronger working relationships must be forged between growers, processors, manufacturers and the buying public. The special, unique qualities of Irish hardwoods must also be promoted. In the longer term, the possibility of creating export markets for Irish material must be explored.

The joinery sector - its material requirements

John Kenny[18]

Introduction

Today most of the material requirements for the Irish joinery/furniture manufacturing sector are supplied from Europe and America. There are many reasons for this but the principal one is the lack of availability of Irish material of a similar quality and quantity at a competitive price.

What are the reasons for this? Ireland has an ideal climate for growing trees, with lack of extremes and a wide variety of broadleaf species that grow well here, many of them indigenous to the country as well as several naturalised, introduced species. Why then has Ireland not got a thriving home-grown hardwood industry? It has a relatively large forest estate with an adequate supply of raw materials and has some of the best foresters, engineers, and craftsmen in the world, yet its hardwood resource is completely undeveloped.

Hardwood material used in Ireland

Much of the material used at present is imported from Europe and the United States, while our growers complain about lack of demand and very low prices for broadleaf material. It is commonly accepted that wood is a relatively low value product and is bulky and expensive to transport, yet Ireland is flooded with imported hardwoods from all around the world. At the same time we hear complaints from the hardwood processors that many of the best logs grown here are being exported to the United Kingdom and Continental Europe and that Irish sawmillers don't get a chance to bid for them. This suggests a breakdown in the way our hardwood industry is organised and working and therefore needs major restructuring and overhaul. It is about time that we started to develop our hardwood resource. Home-grown wood should be readily available throughout the country. To achieve this goal, a major review of the present system and how it functions is needed. Problems and bottlenecks need to be identified and the problem areas need to be addressed. COFORD should take a leading role in driving this change.

If these actions were to be undertaken, home-grown hardwood material would become readily available in local hardware shops in the very near future, as in most other European countries. So why can't we do it in Ireland? If, for example, a person in Carrick-On-Shannon wants a piece of oak skirting or sycamore shelf they should be able to buy it in Reynolds, the local hardware store. This must happen if all the broadleaves planted in the recent past are to be utilised to their maximum value.

Quality of product

Attention to quality is necessary in all areas in hardwood production but it is especially important in the following areas:

Stand establishment: In the areas of planting/pruning/thinning, a quality product starts at the very beginning with establishment and growing of the young seedling. After the tree is established it needs tending and pruning. Finally, thinning and removal of the poorer trees allows the best to fully develop. It is my view that standards are not always maintained in these areas.

Selection and harvesting: This is an area that needs much organisation. An extensive inventory of available material is urgently needed and I understand that the Forest Service has plans for an extensive new forest inventory. This inventory is most welcome and should provide a lot of useful information. Once this information is collated there is a requirement to develop some mechanism, possibly some form of a co-operative, to manage (select and harvest) and sell this timber. May I also remind tree owners that a lot of harm and wastage can occur at harvesting and drying, carried out by unqualified people.

Marketing: A proper national hardwood timber marketing group is urgently needed. Timber has to be available to joinery shops and compete in size and quality with the imported woods. Here it is necessary

[18] Breffni (Irl) Ltd, Meilton, Carrigallen, Co Leitrim. Email: breffniirl@eircom.net

to make better use of available wood, which must be sold on quality, such as home-grown walnut, quarter-sawn oak and sycamore. Where opportunities exist to promote home-grown wood, these should be availed of. For example where the Office of Public Works and other public bodies are specifying for furniture and joinery, they should specify "Irish wood or equivalent". The whole area of marketing needs special attention and examination by an expert group who should be charged with the development of a set of recommendations for this sector after an extensive examination.

Niche marketing - flooring

With the present housing boom and the fashion of wooden flooring, a clear opportunity exists for greater development of this particular sector, which may require special individual attention.

Conclusion

Most woodworkers and joiners like myself would prefer to use Irish hardwoods as we find them richer in colour and with finer character than imported material. However, we don't have the choice available at present. Most of us use Irish material when we can but the supply is limited and erratic while the imported material is readily available in whatever quantity is required, within twenty four hours. The use of quarter sawn oak native oak by Breffni (Irl) Ltd. can be viewed in the new altar and ambo in St. Mary's Parish Church, Maynooth, and the internal ten panel double sided doors in Castletown House, Celbridge, Co Kildare. Recently Irish hardwood material is becoming more available through Coillte and its Dundrum mill. However, much work still remains to be done in order to promote the Irish hardwoods sector throughout the island.

Finally, my wish is that Irish wood becomes readily available, and I hope that a major project of mine in the near future could be completed using the best of Irish home-grown hardwood, i.e. quarter-sawn oak, elm, sycamore or chestnut.

The location, selection, procurement, grading, drying and preservation of home-grown hardwoods for the small scale furniture and craft industry in Ireland

Stella Xenopoulou[19]

Background

The COFORD project on *The location, selection, procurement, grading, drying and preservation of home-grown hardwoods for the small scale furniture and craft industry in Ireland* commenced in 1997. Preliminary results have shown that the majority of wood users would transfer from using imported to home-grown material, assuming that the quality and price of the home-grown hardwoods are competitive.

There is an ever-growing demand and use of hardwoods in both domestic and non-domestic construction, from flooring and cladding, through to furniture and to other applications. At the same time the government is committed to increasing the proportion of broadleaves planted so that they comprise 30% of the area supported under grant-aided afforestation. The recently launched Native Woodlands Scheme, while primarily focused on woodland conservation, has a wood production component that should result in an increase in hardwood supply in the immediate future.

Objectives

The objectives of this project are to:

- help the development of the overall market for Irish hardwoods as well as develop further the added value use of those hardwoods by producing a database of the users of home-grown hardwoods in Ireland;
- contribute towards the establishment of a "common language", between the users of Irish hardwoods, on the grading, drying, finishing and working qualities of Irish hardwoods. This will be achieved by providing up-to-date information to growers, processors and specifiers on the utilisation of Irish hardwoods, including grading, drying and finishing.

Results

The project was approached by asking the following questions:

- Who is in the market and in what type of business is he/she operating (what market segments)?
- How much timber of each species is used and for what end use?
- How is timber cut, dried, graded, sawed, drilled, or finished?

Who is in the market and in what type of business is he/she operating (what market segments)?

Ninety organisations were contacted and asked for names of users of native-hardwoods in Ireland. Twenty-six follow up interviews provided information about market segmentation grades.

A database with over 1000 names was created out of which 252 people were operating full-time businesses using home-grown hardwoods. These businesses were in the following market segments:

- Conversion of roundwood (mobile saw or/and sawmill)
- Drying of sawn timber
- Joinery
- Furniture framing
- Flooring production
- Craft wood turning
- Industrial wood turning
- Craft cabinet making
- Industrial cabinet making (or production cabinet making)Toy making
- Wood sculpture
- Boat building
- Hurley manufacture
- Wood curving
- Fencing

[19] Wood and Furniture Industry Consultant, 35 Larchfield Road, Goatstown, Dublin 14. Email: stxenop@attglobal.net

- Pile manufacture
- Musical instrument manufacture
- Fretwork
- Trailer manufacture
- Other (moulding manufacture, coffin manufacture, gun-stock manufacture etc.)

The largest activity was sawmilling, followed by craft cabinet manufacture and drying of sawn timber.

Almost half of the users of home-grown hardwood were also involved in sourcing and converting roundwood, because they could not find the quality and quantity of wood they required. The majority of sawmillers were also involved in drying. More than one third of users dried their own timber, mainly because they could not find it elsewhere at the moisture content they required. About half of the users were involved in both primary and secondary processing, i.e. sawmilling and furniture manufacture. Almost all the users were involved in more than one activity, more than half (57%) of the users were in the craft sector, while 14% were in the furniture sector.

How much timber of each species is used and for what end use?

Table 1 lists the species that are used by 56 businesses.

How is timber cut, dried, graded, sawed, drilled, finished?

The following properties per grade of each species were rated by 56 users as excellent, satisfactory or poor:

- Machining
- Nailing
- Splitting in screwing
- Gluing
- Sanding
- Turning

The grades given in Table 2 are the trade grades that users of home-grown hardwoods use daily.

Table 3 shows how the 56 users of home-grown hardwoods rate the six properties of all the species and grades.

Table 1: Species usage.

Group	Species	% respondents using the species	Number of users
I	Ash	>= 50	30
II	Beech	>= 40<50	26
	Oak		24
	Elm		23
III	Yew[20]	>= 20<40	19
	Sycamore		16
IV	Cherry	>= 10<20	10
	Walnut		8
	Spanish, Sweet chestnut		8
	Horse chestnut		3
	Holly		6
V	Alder	< 10	5
	Birch		4
	Willow		3
	Lime		2
	Laburnum		2
	Maple		1
	Poplar		1
	Hazel		1
	Whitethorn		1
	Blackthorn		1
TOTAL		**56**	

[20] Although not a hardwood, yew was included as it is a native species that is used extensively.

Conclusions

People from all sectors have responded to this project with great interest and enthusiasm. This project has already resulted in the establishment of the Irish Hardwood Council and is driving the development of the new grading standard for home-grown hardwoods.

Two publications are being prepared as a result of this work: one on the different hardwood species and their properties, and the other on the market of home-grown hardwoods, including a database of users and their products. It is anticipated that these COFORD publications will contribute towards the use of home-grown hardwoods, both in Ireland and in the export market.

Table 2: Grading system used for home-grown hardwoods.

Grade	Description
Veneer	The highest grade: minimum amount of defects, straight grain, minimum amount of pin knots, planks available in big sizes.
Select (or defect free)	Smaller sized planks than veneer quality, some small live knots present, straight grain.
Character grade A	Smaller sized planks than the select grade, mainly straight grain, big live knots that disturb the regularity of grain to a minor degree, pith excluded.
Character grade B	Any size of plank, irregular grain, large live and dead knots, pith can be included.
Pippy	Pieces with the cat's paw characteristic.
Beaming	Square or rectangular pieces over 300 x 300 mm and 6 m long of select grade or character grade A.
Burr	Wood coming from part of the trunk where burr grew on.
Fencing	Usually any size small logs or big branches cut in two, bark included. It is classified just above firewood and quality of timber character grade B.
Framing	Softwood like timber in terms of softness, and whiteness in colour that is used in framing of furniture (horse chestnut, beech).
Prime	Close to veneer quality and just above select.
Rustic	It is mainly used for oak. Branches of trees over 50 years or thinings give small pieces of oak with special character.
Spalted	Beech, in the initial stages of fungal attack, that shows wide variation in colour with fine black lines.
Fuelwood	

Table 3: Rating of six properties of home-grown timbers for all species and grades.

Rating	Machining	Nailing	Splitting in screwing	Gluing	Sanding	Turning
Excellent	53	14	27	54	62	35
Satisfactory	40	33	51	44	37	43
Poor	7	17	8	0	0	3