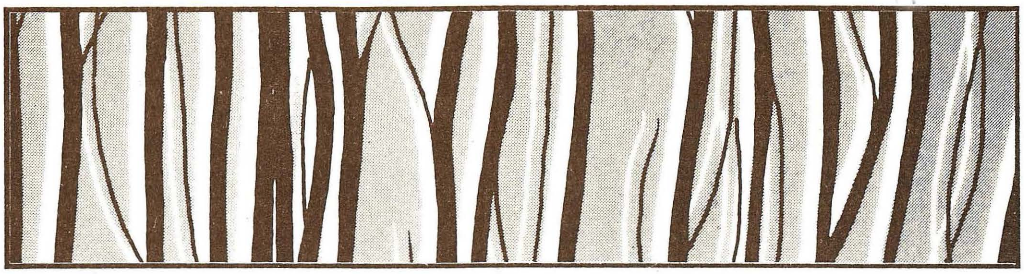

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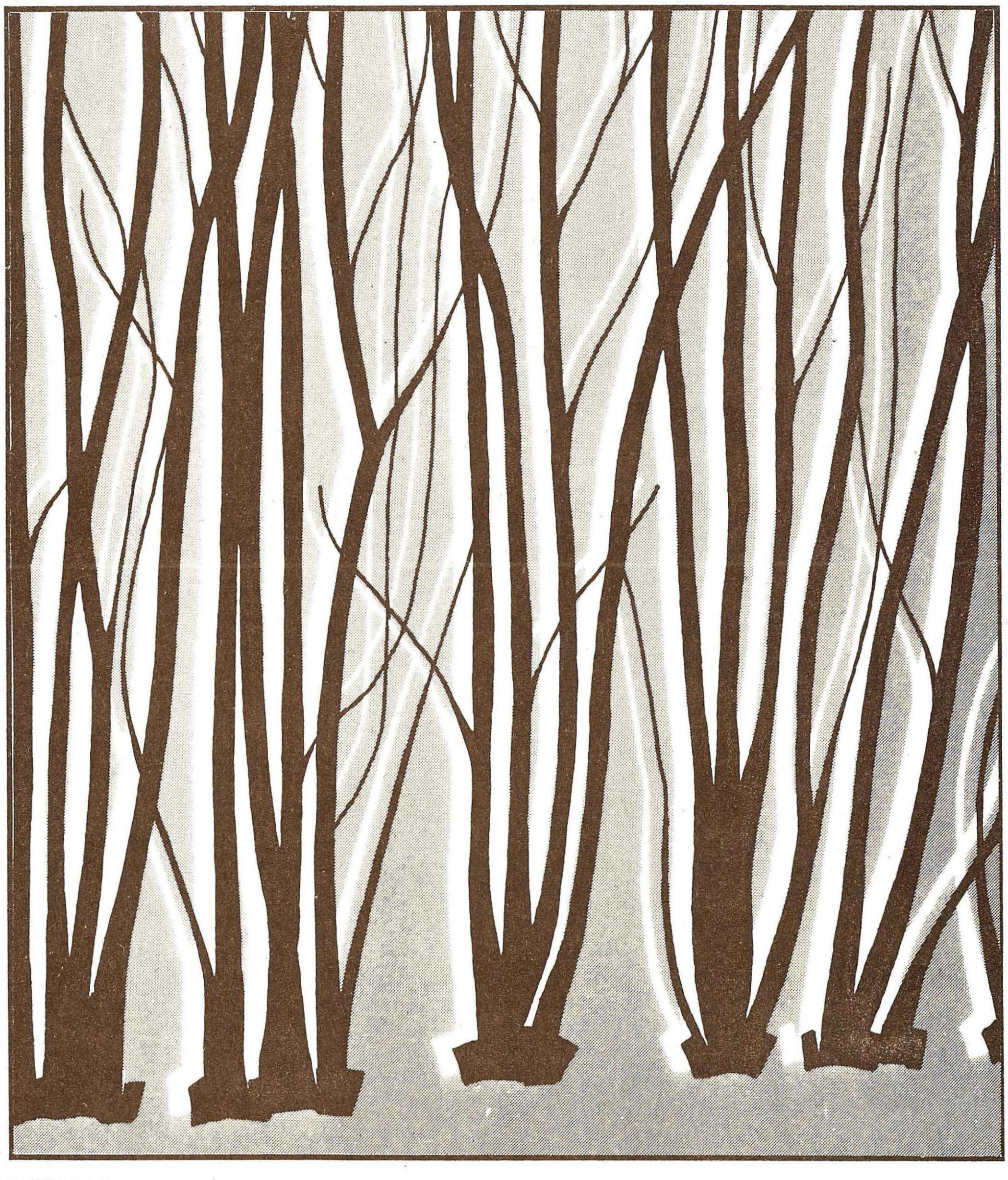

HORTICULTURE
and
Landscape

Department of Horticulture and Landscape, Lincoln University College, Canterbury

The Brandenburg Coppice

Bill Brandenburg

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FOREWORD BY

Professor R.N. Rowe

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Bill Brandenburg has a lifetime of experience with plants. Born in Holland, he worked as a gardener, studied and taught botany and horticulture, and worked as landscape designer for the Dutch Minister of Agriculture, Fisheries and Food dealing specifically with horticultural production areas. He came to New Zealand in 1952 where his subsequent horticultural career began in the Auckland Domain, and continued with the Department of Agriculture/Ministry of Agriculture and Fisheries. With them he rose to the position of National Specialist in Protected Vegetable Cropping, in a 30 year period of service.

Mr Brandenburg is a widely-respected member of the horticulture profession and Lincoln College has used his services as guest lecturer on many occasions. We also asked him to help develop a course in glasshouse technology for our horticultural students. He has always had an interest in sustainable methods of cropping and on retirement the Canterbury Growers' Society wished to make a presentation to mark his services to Canterbury vegetable production. Rather than a gift, Bill asked if they would put money towards the establishment of a coppice. This they were more than happy to do and we at Lincoln were able to provide a hectare of land at the Horticultural Research Area for this use.

The reasons for establishing a coppice and its potential value will become clear in the pages that follow. It is necessary here to point out the enormous effort that Bill Brandenburg and his wife Helen have put into the coppice. This was a retirement gift that demanded more of the recipient than it gave. The success of the Brandenburg Coppice will be mainly due to the work and dedication of Bill and Helen. This included planning and design, locating and planting of suitable material, and maintaining the plot.

More than that, Bill has lectured to students and other groups about the principles and practicality of coppice establishment and kept those that have helped in the establishment of the coppice of progress informed by a regular series of newsletters. This present publication is effectively a summary of available coppice literature plus experience to date on Lincoln's Brandenburg Coppice.

Finally I'm sure Bill would want me to thank the many other people who have helped in its establishment, they are too numerous to mention by name but include those who have donated trees and/or labour to the project. I would like to add my thanks to these people but most especially to the Brandenburgs for their efforts in developing this imaginative, and important project.

CHAPTER ONE

WHY A COPPICE?

Before discussing the rationale behind planting and managing a coppice, the term itself should be more closely defined.

In various locations and amongst various groups of English speaking people a "coppice" or "copse" may mean undergrowth in a forest or a small group of trees and shrubs but also trees that are to be used for coppicing.

The verb "to coppice" is however generally taken to mean the harvesting of trees by cutting them off near ground level and allowing them to regrow. In the context of this booklet I propose to attach this latter meaning to the words "coppice" and "coppicing".

This is not to exclude other functions such a coppice may have in the landscape or ecologically, as, for instance, provision of shelter, sanctuary for biological pest control organisms, supply of pollen and nectar for bees, beautification, etc.

There is a wide range of uses available for trees harvested by coppicing and amongst these are drought fodder for livestock, fuelwood, canes for basketry, poles for fencing and fruitgrowing trellises and, last but not least, high quality timber for artwork, furniture making, parts of implements including wheels and so on.

Some of the uses listed for coppicewood are also fulfilled by timber from various forms of plantation forestry. This tends to be carried out under commercial conditions favouring high outputs per unit area. To achieve this, accepting high establishment costs and - as a consequence of this - seeking high market returns quickly without much consideration for maintaining future production, is the rule. Purposes outside the immediate commercial target such as ecological or recreation ones are seldom considered.

This coppice

The coppicing management to be looked at in the "Brandenburg" coppice of Lincoln College is aimed at re-evaluating for New Zealand purposes the original characteristics of coppices in the older parts of the world. Some of these are:

1. The lowest possible establishment and maintenance costs.
2. To be, as far as possible, self sustaining without loss of soil fertility or structure.
3. Trying to make the coppice economically more viable at low returns by making full use of the extra functions it can supply besides wood production.

Basic data

The experience and data that can be obtained are largely anecdotal. Changes in the pattern of agriculture in most developed countries, especially those occuring after World War II, have led to an almost complete loss of interest in coppices and the removal of many of them. The pattern of observation has been broken and data have been lost. Improved modern measurement techniques can now, in many instances, only be applied to recently established examples. A revival of coppicing is now underway particularly in Europe and many attempts are being made there to recover the data sequence.

Fortunately some older data are available although assembled by much more basic means. Some, however, can take on a value comparable with proper scientific analysis from the fact that experience with them is very widely spread amongst many observers and has occurred over long periods of time, often stretching over centuries. One of the purposes of the Lincoln College project is to establish a data base, especially for New Zealand conditions.

Long-term maintenance of fertility

In England and Europe where - in spite of recent removals - there are coppices in existence that have been established for 500 years and over, no measurable loss of soil fertility has occurred. Even there, however, reliable observations are limited. It is hoped that local interest may be awakened so that some of the postulates made for this project and based on overseas experience, may eventually be verified by research here.

There are two immediately identifiable aspects to the maintenance of fertility in a coppice over the long term.

a) Elimination of methods of forestry that cause substantial loss of fertility.
b) Conservation and possibly increase of the existing fertility by the action of the trees the coppice exists of. The two most important processes here are <u>nitrogen fixing</u> by some tree species and <u>litter return</u>.

<u>Fertility loss</u>

a) Some data are available from research in commercial forestry on loss of fertility in terms of major soil elements as the result of methods used in establishment and post harvest replacement of plantation forests.

   The use of fire with or without prior windrowing causes very substantial loss of major elements. Data quoted by Shepherd 1986 (Plantation Silviculture) indicate that loss of nutrients by burning before re-establishment of coniferous forest is of the order of 72% of the prior available nitrogen, 27% of the phosphorus, 21% of the potassium and 16% of the magnesium. To this must be added the loss of almost all the humus.

   Non-return of the slash from subsequent pruning and thinning and loss of soil texture and stability through maintenance operations aggravate the situation and extend the immediate loss of fertility by inducing erosion or increased leaching in some situations. Operations such as deep ripping and chemical weed control, used to improve early development of the forest can also increase problems with long term fertility. Recovering of the status quo by management techniques is possible but adds to costs and may damage surrounding landscapes. Aerial topdressing and spraying are examples.

Management of the forest as a coppice is one way of overcoming many of these problems. Methods are available within the coppicing context to reduce problems. Some are:

* Planting into existing vegetation while controlling weeds only in a circle around the production trees.
* Using shading by nurse species trees to reduce the weed population. Rapidly establishing deciduous trees suitable for most sites are available.
* Nurse species with strong vertical roots can also be used to open up the subsoil and can reduce the need for deep ripping.
* Return of slash, which is a component of litter return.

b) Conservation & increase of fertility

Litter return with its major adjunct, nitrogen fixing is the second major aspect of the maintenance of long term fertility. Both are to a significant extent interconnected and will therefore be discussed together.

The use or non-use of nitrogen fixing tree species is a contentious point in forestry at present. In some situations there is no problem as the production species is a nitrogen fixer itself (Acacia, Alnus, Robinia). Outside that, at least in commercial forestry, there is always a tension between the loss of canopy space that must be allowed for if a nitrogen fixer is to be part of the plantation and the alternative, being the cost of nitrogen supplements out of the bag. The greater certainty of results by the use of bag nitrogen usually tips the scales against use of nitrogen-fixing trees in a plantation forest, unless there are auxiliary advantages from them: They can be useful as fire retarders, favour more rapid breakdown of litter or may be harvested and sold for a separate purpose.

Research on proper use of nitrogen fixers is only slowly getting underway. A problem has been their non-persistence, particularly with the use of lupins, gorse and broom, which are quickly shaded out of existence by the main crop. The narrow range of species used so far is also a handicap; non-leguminous nitrogen fixers such as alders (*Alnus* spp) having almost completely been neglected ~~until recently.~~

Promising work is now underway locally by various groups interested in forestry and conservation research. In the Lincoln College coppice a wide range of leguminous and non-leguminous nitrogen-fixing species have been brought together and some interesting observations are hoped for.

Little is known about the function of nitrogen fixers in native forests. It would also be interesting to know why Laburnum, which was a regular part of forestry in England in the nineteenth century has all but gone out of use. We are planting them all but it must be kept in mind that any experiment will be purely observational and demonstrational as the number of trees that can be accommodated is below that required for statistically significant comparisons.

Nitrogen and litter return

Nitrogen fixing shrubs and trees do not only supply nitrogen by the common means of root nodules for which they have to be planted close enough to the productive trees for the roots to intermingle. They also tend to supply leaf litter with a high nitrogen content and in many cases of a texture that allows quick de-composition. This can resupply nitrogen to the soil more or less directly by the decay of fallen leaves and distribution of it is often very even and regular over time.

Decidious trees tend to have softer textured leaves than evergreens and will therefore have a litter return that is more rapidly incorporated into the soil and made available to the trees. Soft-leaved nitrogenous litter can also help the digesting of decay-resistant litter when mixed with it in falling.

For instance Eucalyptus and conifers have litter that decays only slowly. It can also be toxic: Eucalyptus litter is conspicuous for wiping out herbgrowth under the trees quickly and completely. A report from the UK Institute for Environmental Studies, which is Government subsidised, suggests that the germination rate of seeds of wild flowers and shrubs, left in the soil, begins to fall off after 13 years under coniferous litter. This would seem to call for a comparative study for New Zealand where litter decay under these tree species may be further negatively affected due to the absence of some animals and fungi that can live in decay resistant litter: For instance the red wood ant which very actively helps digestion of pine needles in areas where it occurs.

On the other hand, due to the predominance of coniferous trees in native forests in New Zealand there may be an adaptation available having exactly the opposite effect. Very little work has been done in New Zealand on litter return (Dr J Sheppard pers.comm.) under native or introduced forest. Accurate data from soil sampling over a prolonged period have seldom been made available and are then related mainly to commercial forestry. From under natural forests and coppices the data can be expected to be largely anecdotal and based more on observed changes in vegetation patterns than on chemical analysis.

Litter return. Conservation of major elements other than nitrogen.

Climates where tree growing is successful tend to have annual rainfall that exceeds annual evapo-transpiration. Or at least a pronounced wet season in which this is the case. Therefore the resultant water movement through the soil over the long term is downwards. So soil minerals would also tend to move downwards, depleting the top layer and tending to accumulate deeper in the soil, where they could be out of root reach.

Litter return can wholly or partially reverse this process. To be successful it depends on soil minerals on the way down being overtaken by the tree roots and deposited again on the surface via falling leaves. The effectiveness of this process depends on the quantities of minerals being moved upwards in this way and this is a function of:

1. Deep rooting trees with fast root-growth and a vertical pattern of rootspread. Well known northern hemisphere deciduous trees with this character are Robinia, some species of alders and poplars.

2. Trees with a high rate of water transport upwards, a heavy canopy and/or large leaves, which are by inference mineral rich. Such trees are oaks, beeches, sweet and horse chestnuts and others.

3. Trees with rapidly decaying foliage that may stimulate the decay of more resistant litter mixed with it. Such trees are amongst many others poplars, willows, birches,elms, chestnuts and many N-fixers.

All things being equal, it is likely that for reasons of even root distribution through the soil (a mixture of shallow and deep rooted species) and of even spread of diverse foliage in the canopy (a mixture of tall and broad trees with varying leaf textures) the best litter return characteristics can be expected from a mixed species plantation. This is typical of a coppice and is enhanced by the methods of harvesting which produces variations in size of the trees in time.

<u>Other uses</u>

Apart from yielding wood for a variety of uses on a sustainable basis and helping to stabilise soil fertility, a coppice can fulfill other purposes related particularly to an agricultural and horticultural environment. Some of these can also be met by trees growing under methods of plantation forestry, but arranging them as a coppice has some advantages which will be highlighted subsequently.

1. <u>Shelter</u>

   The trees in a coppice can provide shelter in exactly the same way as plantation trees do and the same conditions apply for its effectiveness: There should be an approximately 50% permeability for the moving air, distributed as regularly as possible over the full height of the trees. The sheltered distance in the lee of a coppice is likely to be also of the order of 10 to 20 times the coppice height and determines the distance apart that strips of coppice can be planted.

The shelter produced by a coppice is, however, variable over time and this may sometimes be an advantage. For instance: After harvesting, the shelter given by a coppice returns temporarily to zero before increasing again over a number of seasons by regrowth. (From an established coppice stool, this happens two or three times as fast as from a newly planted tree.) There are a number of agricultural and horticultural crops in existence that react negatively to shelter to a varying extent. (cereals, some vegetables) and management could be adjusted for those to be made to grow alongside a recently harvested coppice. Overall permeability of a coppice is lowest during the establishment period. After the first cycle (when regrowing after harvest), coppiced trees tend to be more slender and open and have a greater final height, reached more quickly. A coppice is also very resistant to windthrow - after the first cutting cycle - as the root to top ratio is high. If damage does occur roots remain generally unaffected and regrowth will take place.

A coppice planted on the contour is very effective in preventing soil erosion. Observations from overseas show that as it gets very old, such a coppice will eventually effectively terrace a hillside without much human intervention.

2. <u>Biological control sanctuary</u>

Various forms of integrated or fully biological pest control are gradually coming into operation in agriculture and horticulture. The combined effects of the cost of modern pest control chemicals and the growing public resistance against their use are in part bringing this about. A future reversal of this trend seems unlikely. All the methods of pest control under this heading involve the use of organisms that prey on the pest to be controlled. They all result in the eventual establishment of a balanced population of both pest and predator, each being at low population levels, generally below the density where significant damage to the crop occurs.

It is important that such a pest plus predator population remains in existence as the changeover from crop to following crop is made. Modern mechanical harvesting methods leave little scope for escape of these organisms and usually result in total annihilation of them. This is aggravated by the fact that chemical weed control usually results in completely clean surroundings for the crop and there is little scope left for wild growing crop plants or their relatives to survive. No sanctuary exists therefore for the organisms of the pest/predator complex that may have been lucky enough to escape the harvesting operation. A part solution lies in the advice given often in Europe and Britain at present, to have "dirty" headlands and leave a boomwidth around the crop area unsprayed.

A major auxillary function for a mixed species coppice may be to provide a sanctuary for pest and predator complexes. The traditional mixed character of a coppice may be helpful there.

As an example: amongst the deciduous hardwood species that often figure prominently in a temperate climate coppice are oaks, mainly Quercus pedunculata or Q. sessiliflora. Oaks are considered to be capable of harbouring the greatest variety of associated birds and insects of any trees outside a tropical rainforest.

The harbouring function can be further improved by mixing in, additional to previous suggestions, further nurse species. Each can have desired functions such as stock and mustellid proofing the coppice (hawthorns, blackthorns, Pyracantha, barberry, etc). Mustellids are, together with some rodents such as rats, predators on small birds and large insects. In the same way species can be added to provide year around food supplies for organisms of direct economical importance such as bees or bumblebees. The aesthetic appeal can be enhanced by planting any number of flowering, berry-bearing or autumn colouring shrubs. In the absence of specific information one should simply go for diversity.

3. Finally there is the herb-layer of the coppice. This can be extremely important in more ways than one:
At the time of establishment of a coppice and to keep costs low, weed

control under the trees is usually sketchy. It may be confined to keeping the newly planted trees "released" by maintaining nothing more than a clear circle of about a metre diameter around each to avoid weed competition with the young trees. Two years after planting, weed control may cease altogether, relying on shading by the trees to modify weed growth into species that compete little or not at all with the trees.

The micro-environment in a coppice changes drastically during a coppicing cycle. Weeds or wild plants growing on the site at establishment are those adapted to an open, sunny site. As the trees grow, shading increases and the original herblayer is gradually replaced by species for a cool, shady site. At harvest, the open, sunny aspect returns and seeds from the original herblayer remaining in the soil get a renewed chance.

This varying environment tends to gradually result in an extremely species - rich plant population. In Europe it is held as a likelihood that the assortment of plant species growing in an older coppice over a full cycle is exceeded in the world only by tropical rainforest. This plant population is also likely to contain feral forms or "throwbacks" of the crop species grown in the area and in this way makes an exceedingly suitable environment as a sanctuary for biological control organisms.

The coppice in New Zealand

Horticultural, agricultural and forestry literature published lately in New Zealand makes it obvious that a certain amount of coppice-growing is at present going on. It is also clear that "coppicing" as a management practice is interpreted in the narrow sense of a plantation of trees in monoculture that is harvested by cutting down and allowing regrowth. Examples of declining fertility after two or three cycles are already being quoted.

The characteristics of coppices described here belong to a traditional style of mixed species coppice with the production - target species growing at most in groups large enough to allow for reasonably efficient harvesting. Or, alternatively, individually planted wide enough apart to fulfill the same criterion. In all instances interplanted with enough nurse - species to fulfill all or most of the functions described so far.

It should be made clear that the intention of this work is for it to apply to areas of New Zealand where northern hemisphere forms of agriculture and horticulture are in place. It should certainly at present exclude conservation areas for native vegetation unless necessary for properly circumscribed purposes such as erosion control.

Nevertheless it would be an interesting object for study to see how native vegetation reacts to coppicing - a few considerations may apply:

Native forest tends to consist of evergreen trees having decay resistant leathery leaves, being shed only slowly.
Litter return, although possibly helped along by especially adapted organisms of the forest floor, may be slow. It would be interesting to see whether coppicing, by allowing a wider range of under-tree vegetation, speeds the process up.

A major problem is the presence of native bird species needing hollow trees for nesting. These do generally not occur in coppices. Experience from Europe indicates that widespread use of nest boxes may retrieve the situation.

As an aside: Birdwatching in coppices has major advantages. A bird species that nests in the top of a large tree is out of easy observational range. Birds have been found to be likely to nest in similar positions in coppiced trees. They are then much closer to the ground and often can be observed well.

Personally I would like to see a small area of native forest being carefully subjected to coppicing treatment to see what happens. As a conservationist, however, I would counsel great care.

Recent published observations have brought the importance of using prickly tree species into closer focus. Locally the giant Weta is reported to have found sanctuary in gorse bushes.

From overseas comes the observation that weasels are the only
Mustellids that will go into prickly trees such as hawthorn, Pyracantha and some Prunus species. Larger kinds such as stoats and also cats avoid them. Holly is particularly important as a safe nesting site for small birds. No mammal with soft pads under its feet will go near an established holly tree with a good layer of leaf litter under it, and this includes weasels.

CHAPTER TWO

THE BRANDENBURG COPPICE
ITS ESTABLISHMENT AND PURPOSES

Introductory notes:

The Principal Research Communications Officer of the Forestry Commission in the United Kingdom Department of the Environment has, at the request of Lincoln College, kindly lifted the copyright on "Arboricultural Research Note 21/80/S.I.L.S. for New Zealand. In addition to using the information in this note for the establishment of the coppice at the college, this has also enabled us to use it for incorporation into our booklet. This was all arranged about 3 years ago, to wit, in mid-1985.

It also coincided with the beginning of a revival in the U.K. of the growing of coppices consisting of temperate-climate deciduous hardwoods, using as its resources largely historical data. There has since been rapid development due to the perceived negative affects that commercial forestry using predominantly conifers has on the environment combined with an expected shortage of hardwood timber in the near future. In New Zealand there is also an increase in interest but it has not yet translated itself into really large plantings, at least not of mixed species self-sustaining coppices, as we are investigating here.

In the three years that have passed since the establishment of the coppice at Lincoln College, much has been learned about management practices and this was enriched by observations that coppice enthusiasts in other parts of New Zealand have described to us. I consider it is now time to incorporate this in a new edition. I am gratified that the college has taken the initiative in expanding the material into the booklet that now lies before you.

What kind of coppice?

Historically, coppiced trees were cut in a variety of lengths of cycle ranging from as short as annually for osier willows used for basketry via 4 - 6 year cycles for firewood, posts and poles, through to 15 years and more for timber for building or furniture making. Since the industrial revolution in Europe and the concomitant development of plantation forestry the range of uses for coppice materials has narrowed considerably. In Europe most of the remaining coppice activity was with sweet chestnut (Castanea sativa) for fencing, fruit tree and grape supports, hazels (Corylus avellana) for fences and hurdles and osier willows (Salix spp.) for basket making plus a few minor specialist uses.

Many coppices traditionally contained scattered trees which had been allowed to grow on through several coppice rotations to produce larger diameter timber. If too many of these "Standards" are retained the yield from the coppice was reduced because of the effect of shading. Thirty fully developed trees per hectare was the traditional number allowed in a "Coppice with standards". Standards should generally be recruited by leaving straight and vigorous regrowths to grow on after at least one coppicing cycle has been taken, to allow selection.

Choice of trees

At the present state of our knowledge the bulk of trees recommended for coppicing are non-coniferous Northern hemisphere trees, mainly deciduous hardwoods. Amongst them are oaks, beeches, sycamores, ashes, chestnuts, elms, hazels, poplars, willows, alders, honey locusts and others. Since coppicing has been going on for many centuries, the choices are well established and most trees have uses apart from wood such as fruits, nuts, bee forage, livestock fodder, litter, etc. With the exception of the species Nothofagus which is a recommended coppicing species in the United Kingdom, there is no established use of New Zealand native species for coppicing, although trials are almost certain to turn up suitable species. Part of the cause of this may be the fact that many native trees are related to the conifers, of which it was thought with some justification that they would not allow coppicing and tended to die when severely cut. In the United States several conifers such as firs and spruces have recently turned out to be suitable for coppicing under the right management and this may eventually also apply to native gymnosperms. There is also increasing anecdotal evidence that due to the pattern of native and introduced diseases that affect trees, stump survival may be less automatic here than it is in the Northern hemisphere.

Eucalyptus species share a caution with conifers when used in coppices. A number of species have been proven to be suitable for coppicing and are capable of growing very fast. However they affect the fertility of the soil underneath them after only two or three coppicing cycles as their litter does not decay and may be toxic. This they have in common with some conifers where however a longer time may pass before they do substantial soil damage. Eucalyptus litter is under natural conditions restored to the soil by fires.
Large monocultural blocks of Eucalyptus represent a severe fire risk, especially when under coppicing management and for this reason and to limit the damage to the soil as much as possible they should be used in small blocks only or mixed with other trees in such a way that the falling litter gets combined as much as possible. In some areas of the world the same applies to some extent to conifers (The Yellowstone National Park fires of summer 1988 in the U.S.A.).

Long term maintenance of fertility under most climates suitable for growing trees requires the return of minerals to the surface soil and the fixation of atmospheric nitrogen. This opens up the question of nurse-species of trees and shrubs and sometimes herbs added to coppice plantings. Interplanting with nitrogen fixing leguminous trees (wattles, Robinias, Laburnums, kowhais) or shrubs (tagasaste, Mt Pellier broom and - dare I say it - gorse and broom) or establishing herbaceous undergrowth of nitrogen-fixers (lupins, clovers, vetches) are possibilities together with non-legumonous nitrogen fixers such as alders. In the few years of observation behind us to date it is becoming apparent that this aspect is of major importance to the extent that we at present consider advising the planting of nitrogen fixers first and allowing them to establish before planting the main assortment of trees. Choice of actual species of nitrogen fixers, will have to remain subject to observation and experiment as frost tenderness and reaction to possible shading out by the other trees are uncertain as yet and also for some species the ability to cope with coppicing treatment.

The second major consideration in the choosing of trees, either the main producers or the nurser species, lies in the maintenance of other aspects of soil fertility : Deep rooted deciduous trees are capable of overtaking and absorbing nutrients on their way down from the surface layer of the soil as the result of leaching and subsequently delivering them back to the surface by dint of fallen leaves. A knowledge of the root pattern of trees, allowing choice of particularly deep rooted trees (some alders, some poplars, black locusts, sycamores and many wattles) for this purpose will help much. At the same time it will pay to keep an eye on the speed with which accumulated litter decays and its minerals become available again. A deliberate planting programme assuring the mixing of hard to digest litter such as that from eucalypts, conifer needles and any evergreens used, with easily decaying litter from such trees as silver birches, alders, ashes, sycamores, poplars, sweet chestnuts, etc. can help much. Here again, attention to managing the herb layer underneath is of some importance as there are plants that may help to digest litter faster by producing enzymes, as some species of spring bulbs are suspected of doing. Some herbaceous plants, including ferns, have large, sappy leaves that collapse and decay quickly after the growing season, taking other litter along into the process.

The total growth and decay cycle is an aspect of what I would like to call the metabolism of the forest (or coppice in this case). It does not appear that much quantitative analysis of these processes has been done under New Zealand forests, but knowing them and European forests reasonably well I suspect a slow rate of metabolism of local forests due to the fact that there is a predominance of evergreens with hard, leathery foliage in it. There could also be an absence of many organisms that contribute to organic breakdown in Northern hemisphere forests, due to New Zealand's long geological isolation. Since coppices are meant to be a part of the productive landscape, it is legitimate to try and improve the metabolic processes and so increase production. If properly done there may be favourable side-effects as well, such as increased density of bird and insect life.

<u>Harvesting</u>

This part still consists substantially of quotas from the English bulletin referred to before, as there is not yet much harvesting experience locally available. Observations on unintentional coppicing by looking at trees, meant to be removed but inadvertently regrowing, prompts the making of some recommendations that vary from the English ones.

Cutting should normally be carried out in winter, which allows the whole of the summer for coppice regrowth and for the cut wood to dry prior to use in the following winter. Summer cutting will result in less vigorous coppice shoots. There are some partial exceptions : silver birches often refuse to regrow after wintercutting, but do better when cutting is delayed until the first signs of renewed sap movement are visible by observing bud break. There may be other trees, for instance black poplars, that benefit from the same management method.

Although statistically valid evidence is not available, it appears that cut stumps are more likely to be affected by disease in New Zealand than elsewhere. Fungous diseases affecting roots and damaged wood are very prevalent. Examples are silver leaf (Stereum purpureum), cankers (Nectria spp.), honey fungus (Armillaria mellea), and in particular collar and root rots (Phytophtora species in particular P.cinnamoni). High levels of ultraviolet in the sunlight are also under suspicion of causing damage to exposed cambium cells, affecting wound healing and regrowth. Until more is known I suggest that a degree of tightening up on the traditional ways of coppice cutting is justified as follows:

The final cut surface should slope up to 45 degrees from the horizontal to aid water runoff. There may be a relationship between the angle of cut and the number of regrowth shoots emerging. We hope to investigate this in the future. The lowest part of the cut should be well clear of the ground, in most cases 30 to 50 cm above. There are a number of trees that grow new shoots mainly from adventitious buds on the root-crown (limes, willows, some poplars, elms and others). An exception to the recommended height of cutting may be possible with them. Cut surfaces should as much as possible face away from the sun, unless shading by uncut growth is present. Finally, on some high risk areas and on some high risk species (for instance willows near river bed areas where feral willows occur) a wound treatment with bitumen emulsion or fungicidal paint may be required. The matter may be simplified by harvesting in two stages:

1. Fell the trees by cutting them slightly above the final cut using scarfing, etc. as required to control the direction of fall. Remove cut wood to storage area. Coppice stools can be damaged or killed by fires, so if branchwood has to be burned, fires should be well away from stools. Unwanted branchwood or slash may be left on site to decay naturally. (In traditional coppice working, all branchwood would be made up into faggots and used to heat ovens : fires were not needed in the coppice). Nowadays shredding machines are available that can turn slash into mulching or compost material.

2. With a sharp and high-revving chainsaw make a final trimcut according to the rules given earlier. This should take only a few minutes.

Finally, when making a planting plan for a coppice, the lay-out should carefully take account of the needs for harvesting. Design requirements are discussed later in this bulletin.

Establishing a new coppice - planting

It must be emphasised at once that most of the recommendations in this sector stem from work with the "Brandenburg Coppice" at Lincoln College - in other areas, climates or soils different methods may be needed to fill the bill. More by accident than by design our work has fallen well within the low input-low output management method which we have gradually become convinced we should demonstrate.

The site of this coppice is an abandoned trial site that had been given over to weed-growth for some years. The soil runs from a sandy silt of poor structure to a gravelly phase and is decidedly alluvial, very variable in drainage capacity and with a bad plough-sole at depth of cultivation. It lies in an area of coastal Canterbury with low rainfall and is subject to pronounced spring and late summer droughts. In addition upward moisture movement is impeded by the plough-sole. The land is level and due to the surrounding shelterbelts cold air drainage is poor to non-existent, so it is subject to severe frosts.

When we started planting there was a small amount of money available to cover establishment costs. This was almost all expended in the first year on labour costs, cultivation and some herbicide spraying to keep the worst of the weed-growth under control, so that we could plant some small cutting material that was susceptible to weed competition. This was in spite of generous free assistance by the college. There was no money available to lay down an irrigation system although water is available on the site.

We quickly had to stop spraying for weed control due to lack of money. This turned out to be an advantage since the coppice lies alongside an area where biological growing was being investigated. Since we started this has rapidly gained importance. We also discovered that the seedload of weeds in the soil was so high that cultivation made the weed problem worse rather than better. Out of all this developed the planting system that we have now used for three seasons and which appears satisfactory.

Weed-growth is generally ignored apart from that on the site of each tree planted. With an ordinary short-handled garden spade, which is kept almost as sharp as a knife and shiny clean, an area of up to 1 metre in diameter is skimmed taking no more than the surface sod to a depth of about 2 cm. We find that once the knack is mastered even large tussocks of prairie grass and Yorkshire fog can be easily lifted even during rather dry soil conditions. In other parts of the country, for instance where Paspalum occurs this may have to be handled differently, possibly by mechanical pre-skimming with a rotary hoe set very shallow. The lifted sods are laid upside down around the planting site and left. A clean patch results, usually fairly free from rhizomes as long as these have not previously been cultivated down to greater depth: On undisturbed soils the rhizomes of such things as clover, twitch and yarrow of which we have a lot, tend to lie on or very near the surface. This treatment assures that regrowth of weeds later consists mainly of annuals. The tree is planted in the middle of this patch in the normal way. Since the tops of weeds are frost resistant but roots generally are affected, the overturned sods usually die. The summer droughts help in this respect. Birds tend to scratch the soil away from amongst the roots of the overturned sods, especially in the spring and help to disintegrate them completely in most cases. After about 6 months each tree sits in a slightly dished area of soil affected only by annual weeds, which must be kept under control.

The circle around each tree is kept weed free by hoeing, using a small but very sharp push-hoe. We have found that in our area a major hoeing is required in about October/November when the spring drought tends to contribute to the success of the work and again in February/March once more keeping an eye on the weather forecast to make sure that at least 24 hours of dry, sunny weather follows the operation. Volunteers have assisted at thpose points. Apart from that, the area is regularly patrolled at least once each fortnight and any trees threatened by weeds are freed.

We have found that by this method, if skimming and planting is done entirely by one person, 10 trees per hour can be managed. This allows for rather careful planting. If one person skims and digs the planting hole and another plants, 30 trees per hour can be managed. The major release hoeings twice per year, take 26 - 30 man hours per hectare. This takes into consideration the planting distance of 2 by 2 metres giving 2500 trees per planted hectare, plus the nitrogen fixers in the centre of each square of 4 trees adding another approximately 800 trees. On average, newly planted trees need to be kept completely weed free in the first year, while in the second year the need gradually diminishes depending on growth rate. In the third year only the odd tree dragging its heels may need releasing. It must be emphasised again that this information applies to our particular site and climate. In warmer, moister climates more frequent hoeing is likely to be required but this may be offset by faster early growth of the trees.

Plastic film mulches and weedmats around the trees have been tried and discarded. We find that with them, control of any rhizomatous weeds growing towards the trees from the surrounding area is imperfect and then the mats seriously interfere with the hoeing. We only use them as signals now, to mark the sites of very small plant material.

It would be possible to use chemicals to clear the plant sites and to cut out or reduce the hoeing operation by using surface applied residual herbicides. For environmental and site reasons as discussed earlier we do not use them but suitable materials are available that may cut out the hoeing operation. Personal preference can be used but there is one warning that applies where herbicides are used <u>after</u> skimming : Planting of the trees is likely to leave loose and cracked soil around them until there has been some substantial rainfall. Applied chemicals may be washed towards the trees and into the root zone. Post skimming application of herbicides must wait until sufficient rain has fallen to wash the planting holes thoroughly shut.

Using chemicals to cut out the skimming operation introduces a totally different management technique which we are not in a position to evaluate.

In Canterbury the summer drought usually ends with rain anytime between March and May. Soil temperature declines only slowly towards the onset of winter and good growing conditions may be maintained for some time. This is the best time for planting bare-rooted tree stock. Stock grown in root-trainers and other containers can be planted until the end of September and sometimes again around Christmas. Many nurseries are delivering bare-rooted stock far too late in the planting season. This is caused by the fact that they delay wrenching until after rain has fallen. Pressure should be brought to bear on them to start deliveries earlier, even if it means using irrigation after wrenching.

Planting of bare-rooted stock ought to be finished by the end of July, if at all possible, earlier.

In other areas of New Zealand this may not be so critical.

Establishing a new coppice - design

Coppices can become an important landscape element. Design, size and location of them can be left safely to the individual landowner who is usually sensitive to the look of the landscape around him or can call in professional help. A few basic considerations apply however:

The recommended planting distance in the United Kingdom for the permanent trees, later to become the coppice stools is 4 ft. (1.20m.) in both directions and planted on the square. In the opinion of the local Forest Research Institute it should be 2m. on the square and we have followed that recommendation. Stools gain in diameter at each coppicing cycle and are eventually capable of filling in much of the intervening space. Nitrogen fixers can only be of use to neighbouring trees when roots intermingle. We are planting them in the middle of each square so that root contact is achieved early.

Blocks of individual species of trees are harvested together provided they were planted at the same time and this operation determines at least the minimum dimensions of the block so that the cut trees can fall within it. Consultation with experienced tree cutters has yielded the advice that the minimum dimension of a single species block must be the expected height of the tree at harvest plus 2 metres. So, trees, expected to be cut at 20m. height as determined by local observations (which are important in this respect) should be planted in blocks with a minimum dimension of 22m. Timber extraction gear can usually be expected to be able to run over the tops of the cut stools. Wood dimensions from a coppice are usually not very large and for ecological reasons the use of the lightest possible equipment is always advocated. So provision of alleyways should not be needed. A mixed species coppice will eventually have cut over areas in varying places every few years and these can provide interesting and varied access for recreational purposes.

The maximum dimension of a single species block can be left to choice and could be extended indefinitely subject to some considerations:

1. Mixing of leaf litter is important. It can be brought about by wind provided the block is not too wide in the downwind direction. This will mean that usually long, narrow blocks will be chosen, which must lie across the prevailing wind.

2. In hill country the longitudinal side of the blocks should follow the contour : With long established coppices a kind of natural terrace building will then occur. To modify the visual effect of long alleys of trees that may occur with planting on the square and to alleviate possible wind damage caused by this pattern of planting, the outer trees (2 rows) on each block could be planted on the diagonal.

It should finally be noted that most of the adverse effects of a systematic planting pattern can be alleviated by making sure of the presence and the wise use of nurse-species. Monotony can be broken by adding different trees, if possible of an ornamental character. Early flowering and berry-bearing species in particular enhance the value of a coppice. There is a sufficient number of suitable species known, that will tolerate coppicing, to make it possible for them to be renewed by coppicing them along with the others. Early flowering pussy willows, wild plums and cherries, rowans, Cotoneasters, spindle berries, currant trees, flowering currants, lacebarks, hawthorns all withstand coppicing and can be used. The question of litter digestion in a situation where larger than optimum blocks must be planted can also be addressed by giving some attention to the herb layer under the trees by planting or sowing-in suitable species with large soft leaves, not forgetting legumes for nitrogen supply to the litter.

List of tree and shrub species planted in the Brandenburg Coppice as at September 1988 and their main uses.

Notes: In the context of this table "groundfast" is taken to mean the wood is suitable for placing in the ground without conservation treatment and remaining sound for at least 20 years.
Under "bee forage" falls food for bumble bees, wild bees and other beneficial insects and honey-eating birds. Bird attractant trees are part of an experiment to try and lure birds away from fruitgrowing areas by providing competing attractions.
Cookery includes winemaking:

Common name	Latin name	Useage
Alder, grey black red green	Alnus incana " glutinosa " rubra " viridis	Nitrogen fixers, firewood, possible livestock fodder and craftwood
Ash, European mountain	Fraxinus excelsior " ornus	Craftwood (wheelrims, tool handles, aeroplane propellors
	etc.), posts and poles	
Beech, European	Fagus sylvatica	Craftwood (furniture framing, chairs etc.) livestock fodder (Beech mast)
Beech, N.Z. red	Nothofagus fusca	Craftwood (framing, furniture, turnery), flower arranging, possibly bee forage
Blackthorn	Prunus spinosa	Small craftwood, bee forage, cookery

Common name	Latin name	Usage
Cabbage tree	Cordyline australis	Fibre, sugar
Cherry	Prunus avium cult.	Craftwood (panelling, turnery, sculpture), cookery, bird attractant
Crab apple	Malus spp.	Craftwood (sculpture, turnery) cookery, bird attractant
Cotoneaster	Cotomeaster spp.	Bird attractant
Plum	Prunus domestica cult.	Craftwood (sculpture, turnery) cookery, bird attractant, bee forage
Douglas fir	Pseudotsuga Menziesi	Coppicing trial for Xmas trees, firewood
Elderberry	Sambucus nigra	Firewood, cookery, bird attractant
Elm	Ulmus campestris	Craftwood (framing, furniture chairs, wheelhubs) livestock fodder, firewood

Common name	Latin name	Usage
Eucalypts		
Tasmanian Blue Gum	Eucalyptus globulus	Craftwood (building
Silvertop Gum	Eucalyptus nitens	timber, furniture,
	turnery), firewood,	
Cider Gum	Eucalyptus gunni	beeforage
Swamp Gum	Eucalyptus ovata	
Red River Gum	Eucalyptus camaldulensis	
Manna Gum	Eucalyptus viminalis	(Koala fodder)
Coast Grey Box	Eucalyptus bosistoana	
Yellow Gum	Eucalyptus leucoxylom	
Hazelnut	Corylus avellana	Nuts, hurdles, posts and poles
Holly	Ilex acquifolium	Bird attractant, flower arrangement, firewood
Black locust	Robinia pseudoacacia	Nitrogen fixer, groundfast posts and poles, livestock fodder, craftwood (screws, gears, pegs, turnery, extremely strong and dense) or firewood

Common name	Latin name	Usage
Hornbeam	Carpinus betulus	Craftwood (screws, gears, pegs, turnery, extremely strong and dense) charcoal, firewood
Horse chestnut	Aesculus hippocastanum	Possibly craftwood, firewood, cosmetics
Kowhai	Sophora tetraptera " microphylla	Nitrogen fixer, craftwood, bee forage
Laburnum	Laburnum anagyroides	Nitrogen fixer, craftwood (turnery), firewood
Lacebark	Hoheria populnea	Bee forage, firewood
Lime or Linden	Tilia intermedia	Craftwood (sculpture, casting moulds, drawing boards, air diffusers, bee forage, livestock fodder, firewood
Catalpa	Catalpa speciosa	Groundfast posts and poles
Mt. Pelier broom	Teline monspessulana	Nitrogen fixer, livestock fodder

Common name	Latin name	Usage
Oak	Quercus sessiliflora " pedunculata " rubra " palustris	Craftwood (framing, panelling, sculpture, turnery, wheelspokes etc.), tannin, livestock fodder firewood
Pine	Pinus radiata " muricata	Coppicing trial, firewood
Rowan	Sorbus aucuparia	Bird attractant, craftwood (sculpture turnery), firewood
Russian olive	Eleagnus angustifolia " spp.	Bird attractant, nitrogen fixer
Silver birch	Betula pendula	Craftwood (panelling), firewood, livestock fodder
Spindleberry	Evonymus europea	Craftwood (spindles)
Sycamore	Acer platanoides	Craftwood (framing, panelling turnery), firewood
Tagasaste (Tree lucerne)	Chamaecytisus palmensis	Nitrogen fixer, livestock fodder, bee forage

Common name	Latin name	Usage
Tree medic	Medicago arborea	Nitrogen fixer, livestock fodder, bee forage (Suitability now in doubt due to frost damage).
Wattles		
Cootamundra Wattle	Acacia baileyana	Nitrogen fixers,
Silver Wattle	" dealbata	craftwood (framing,
Varnished Wattle	" verniciflua	panelling, sculpture,
Tasmanian Blackwood	" melanoxylon	turnery), livestock
Veined Hickory	" binervata	fodder, bee forage,
Sydney Golden Wattle	" longifolia	firewood
Black Wattle	" l. mearnsi	
		*) (A. verniciflua now in doubt due to frost damage).
Willow	Salix aethiopica	Bee forage, firewood
	" triandra semperflorens	Bee forage, firewood
	~~Salix triandra~~	

Common name	Latin name	Usage
Willow	"Black Maul"	Basketry
	Salix viminalis	
	gigantea	Basketry
	Salix purpurea	Basketry
	" purpurea nana	Basketry
	" caprea	Bee forage, firewood
	" discolor	Bee forage, firewood
	" matsudana x alba	hybrids, various
	clones	Preliminary shelter, firewood.

(The foliage and slash of all willow species is suitable for livestock fodder although palatability varies).

Yew	Taxus baccata (Definitely unsuitable for livestock)	Small craftwood (Archery bows).

Acknowledgement

In the three years since the beginning of this project, many interested friends from all over New Zealand - too many to list here have helped with plant material, information or just told me their experiences and ideas, often by letter.

Having worked for most of my career in a different branch of agriculture I started this coppice experiment with little background knowledge but have since learned an immense amount. A small part of that knowledge forms the basis of this bulletin, which I would like to dedicate to all our helpers.

Special thanks are due to Dr. J.S. Sheppard for useful suggestions and help in compiling species lists.

I am most grateful and hope something useful will come from this work.

W. Brandenburg
Christchurch September 1988