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Forestry Commission

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Research Information Note 225

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FARM FORESTRY RESEARCH

A summary of research projects sponsored by the Forestry Research Co-ordination Committee (FRCC) as a NERC Special Topic Programme

Compiled by T.W. Parr

FRCC

Forestry Research Co-ordination Committee

ALICE HOLT LODGE, WRECCLESHAM, FARNHAM, SURREY, GU10 4LH, TELEPHONE: 0420 22255

Abstract

A 3-year programme of research on socio-economic and environmental aspects of farm forestry has now been completed. The research was initiated by the Forestry Research Co-ordination Committee (FRCC), and was run as a NERC Special Topic Programme sponsored by the Forestry Commission, the Department of the Environment and the Natural Environment Research Council (NERC). Some of the key findings from the 11 research projects making up the programme are given in this Note.

Background

Government policy recognises that by planting more trees on agricultural land, farmers can help reduce the current over-production of agricultural products while at the same time bring greater diversity to our countryside and rural economies. Already one-sixth of British woodlands are found on farms, and incentive schemes such as the Farm Woodland Scheme and its successor the Farm Woodland Premium Scheme have been designed to encourage farmers to convert more agricultural land to woodland.

Two FRCC review groups on farm forestry in the lowlands (1983) and in the uplands (1985) highlighted the need for more research on environmental and socio-economic factors and subsequently established a £450 000 Special Topic Research Programme, administered by NERC. The end of this 3-year programme of research was marked by a national conference in September 1992.

The programme aimed at providing a better understanding of farmers' attitudes to woodlands as alternative crops and their potential benefits to wildlife and landscape. Eleven research projects were chosen to give a co-ordinated, integrated and, as far as possible, comprehensive coverage of the subject. The projects were broadly grouped into subject areas covering socio-economics, landscape ecology, dynamics and management of woodlands and interactions with agriculture.

Socio-economics of farm forestry

Farm forestry is likely to develop in the UK only if sufficient grant-aid is provided under UK or EEC woodland policy. To judge how much aid is needed and where it is likely to be most effective we require information on the economics of woodland production systems in comparison to alternative land uses and an understanding of the decision making process at the level of individual farms.

As part of a cost-benefit analysis of alternative farm forestry systems a team from the University College of North Wales has developed a model to identify where, and under what conditions, a change in land use from agriculture to forestry is likely to occur. The model includes ecological, landscape, financial and policy components. It is based on a widespread survey of farm costs and farmer attitudes which, when combined with existing data on land use, will provide a model allowing a rapid assessment of farm forestry proposals.

New farm woodlands could improve the landscape but socio-economic factors seem to be against this happening. *(40507)*

A complementary project at Edinburgh University has considered farmers' perceptions of farm forestry and examined the social and economic factors which influenced decision making relating to tree planting on farms. Survey work was conducted in the Central Belt of Scotland (a random sample of 100 farmers, 25% of total farming population) and amongst 28 tree planting enthusiasts in the Lothians and Borders. Amongst the enthusiasts, organisations such as the Farming and Wildlife Advisory Group have engendered a sea-change in farmer attitudes to small-scale forestry, but in the Central Belt hostility to farm forestry development remains strong, and there was widespread indifference to Government tree planting programmes, notably to the work of the Central Scotland Countryside Trust.

It was found that whilst most farmers appreciated the aesthetic and practical value of trees, they did not regard trees as a crop and all were extremely unlikely to plant trees on productive agricultural land. The major barrier to the planting of farm woodlands in the Scottish Lowlands was the uncertain economic prospects of the family farm unit. The project concluded that if the farming community of the Central Belt faced a secure future they would be able to participate in the farmer-led farm forestry renaissance manifest in other Scottish Lowland counties.

Benefits to wildlife and landscape

Design principles are necessary to maximise the benefits of farm forestry to wildlife and landscape and to guide decisions on *where* to plant woodlands. These principles have been reviewed at the

Front cover: Farm woodlands are valued not only for their timber but also for landscape, recreation, sporting, wildlife and conservation benefits. (*M. B. Usher*)

Table 1. The principles of landscape ecological planning.

1. Woods containing primarily broadleaved trees, with a small proportion of conifers, are likely to be richer in bird-life (both in terms of numbers and species) than those containing a majority of conifers.
2. Woods in which there is a mixture of habitat suitable for both woodland edge and forest interior birds (i.e. areas of woodland with a high diversity of tree species and a dense ground vegetation, together with areas of thicket – characterised by widely-spaced small trees and a diverse, dense shrub layer) are likely to maximise the total abundance of woodland birds.
3. More structurally complex hedgerows will be more effective in their ecological function than simple ones. Those with a herb layer, hedgerow trees and associated ditches are of particular benefit to woodland carabid beetles and birds.
4. The presence of even simple hedgerows in an open landscape may serve a useful ecological function.
5. Plant and bird species typical of woodland interior are favoured in compact, near-circular forest patches with a minimal perimeter to surface-area ratio.
6. Larger woodland blocks tend to support larger populations of more woodland bird species. This effect is especially noticeable for species which are characteristic of forest interior and for the more uncommon woodland species.
7. More woodland plant and bird species are associated with tall (>l.5m), wide (>4m) hedgerows than with smaller ones.
8. Woodland patches which are physically closer to other woodland patches tend to be richer in woodland bird species (particularly those characteristic of forest interior) than woods which are isolated.
9. Hedgerows which are close to other wooded landscape elements tend to be richer in forest carabid beetles, plants and birds than those which are isolated.
10. Woodland patches in landscapes which contain a high density of wooded landscape elements will tend to support a more diverse woodland-interior bird community than those in landscapes where woody vegetation is sparse.
11. The linking of woods by hedgerows may assist the movement of birds, small woodland mammals and forest carabid beetles between them, and hence may help to maintain local populations.
12. Woodland plant species are more abundant in hedgerows which are structurally connected to wooded landscape elements which are themselves rich in woodland plant species.
13. Landscape heterogeneity enhances species co-existence. The abundance of edge-species and animals requiring two or more landscape elements is increased, but at the expense of species dependent on patch-interior habitat.
14. Landscape heterogeneity increases ecological interactions between landscape elements.

University of Stirling where recent developments in landscape ecology have been used to explore how woodland size, shape and connectivity influences landscape and wildlife. The work has summarised 14 principles of landscape ecological planning which could be used to guide the planting of new farm woodlands (Table 1).

Two further projects, one based at the University of York and the other at the Institute of Terrestrial Ecology, Edinburgh, have considered in more detail the effect of woodland size and location on plant and animal populations.

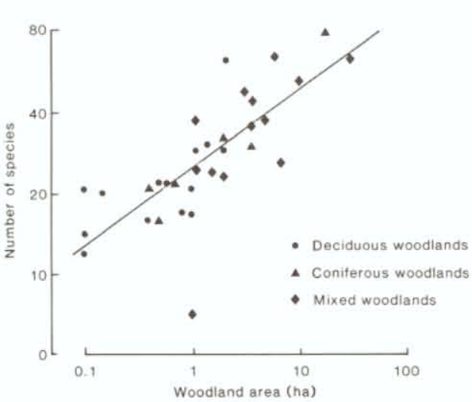


Figure 1. The relationship between the total number of herbaceous species and the area of 33 farm woodlands. Logarithmic scale. The line indicates the regression equation. (From Usher, Brown and Bedford, 1992)

A vegetation survey of 33 farm woodlands in the Vale of York (Usher, Brown and Bedford, 1992), showed that area was a good predictor of plant species richness (Figure 1) but that isolation or woodland shape were not. The majority of typical woodland plants were absent from woods smaller than 1.5 ha. A second study examined the moth species composition (Macrolepidoptera only) of 18 farm woodlands. The best predictor of moth species richness was the plant species richness of the woodland. Woodland area and shape were important factors in determining the species

Sticky boards being suspended in beech trees to catch dispersing adult moths or flies. (*P. Dennis*)

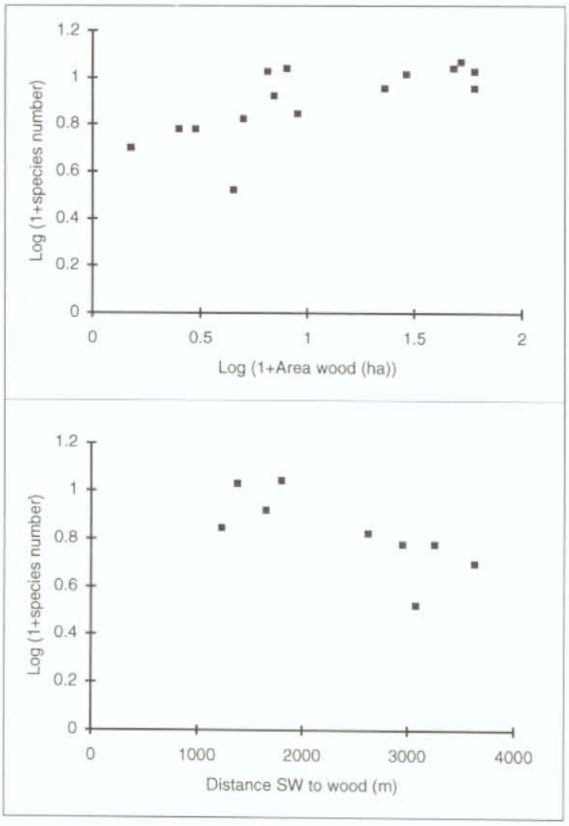


Figure 2. Small, isolated or exposed woodlands in Midlothian contained less leaf-dwelling arthropod species.

richness of those moths judged to be poor dispersers. In general these studies concluded that to achieve the potential 'wildlife dividend' of farm woodlands, larger areas should be planted, incorporating existing woody vegetation, but avoiding bogs and ancient meadow remnants.

At the Institute of Terrestrial Ecology, Edinburgh, work on the insect populations of beech trees has indicated that, in addition to woodland size, locational factors may be important in maintaining insect populations. Fewer leaf-dwelling species were found in small, isolated woodlands (Figure 2). One explanation is that in small woodlands immigrants may be essential for sustaining populations, and isolated woodlands may not receive enough immigrants to sustain the populations. However, further results suggested that the exposure of woodlands to the prevailing weather may be more important. In either case, the practical conclusion was that to encourage insect diversity, new woodlands should be as large as possible and sited in the lee of existing woodlands.

Woodland dynamics

Although it is useful to have simple rules to guide the location of new woods, the ecological processes which determine the economic and wildlife value of woodlands are usually complex. For example, Table 2 gives a more complete list of the factors affecting arboreal arthropods.

Table 2. Tree and woodland parameters which may affect the distribution and fitness or arboreal arthropods in farm woodlands.

Tree structure

Age
Diameter at breast height
Height
Mean leaf size
Wind damage to leaves
Extent of herbivore damage
Timing of bud burst and senescence

Tree situation

Abundance of tree species in the wood
Distance to other trees of the same species
Distance to edge of woodland

Woodland structure

Number of tree species
Range of age classes
Distance between trees
Complexity of the ground flora
Distribution of leaf litter
Edge structure
Presence of a network of hedges or tree lines between the woodlands
Area of woodland
Woodland cover per unit of land area
Woodland cover linked by hedgerows or tree lines to the target tree

Woodland situation

Distance to the nearest woodland
Distance to woodland into prevailing wind (SW)
Adjacent land use
Altitude
Level of stress (exposure to the weather, nutrient availability)

Insect population factors

Life history strategy
Range of habitat requirements
Form and range of dispersal

This complexity is also illustrated by work at the Oxford Forestry Institute on the ecology of sycamore. Sycamore is an invasive species, commonly found in farm woodlands. Although this species is of potential economic value it has been suggested by some that its invasivity may result in it ousting native tree species. A survey of ash and sycamore woodlands in Oxfordshire and Gwent has shown that under the canopy of one species, the regeneration consists mainly of individuals of the other. The apparent inability of sycamore to regenerate well under its own canopy may mean that sycamore will not pose the long-term threat to native tree species that had been previously feared.

The ground flora of new woodlands, and hence their wildlife value, is determined by the initial floristic composition of the site and by natural processes such as competition and immigration. At the Institute of Terrestrial Ecology, Monks Wood, models have been developed for predicting changes in the ground vegetation of new farm woodlands from data on soil, climate and management (Figure 3). Amongst other things, these models make use of vegetation data from woodland surveys and information on the plant biology of the 197 most common woodland species to estimate the probability of species getting into new woods (Figure 4). They will provide useful guidelines on regional planting policies and assist decisions on establishment and management at individual sites.

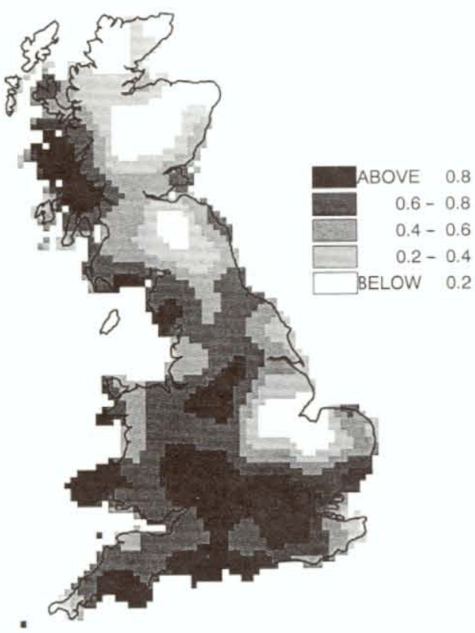


Figure 3. Probability of bluebell *Hyacinthoides non-scripta* occurrence in 10km squares. This information contributes to models that predict the probability of this species getting into new farm woodlands.

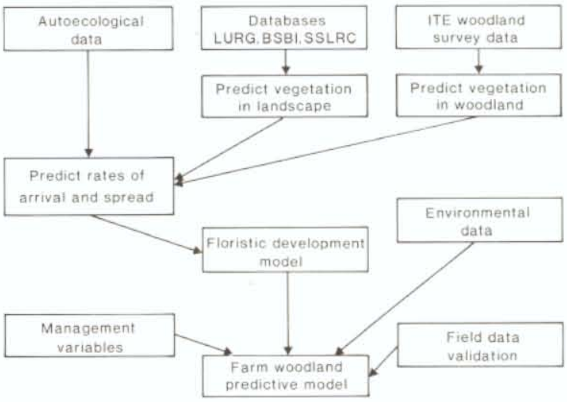


Figure 4. Main stages in the farm woodland floristic development model.

The models demonstrate clearly that the natural processes of colonisation are likely to be very slow in most new woodlands and that, to encourage early establishment of a diverse flora, efforts must be made to introduce species and manage the woodlands sympathetically.

Managing farm woodlands for wildlife

The introduction of ancient woodland field layer species into recent secondary woodlands has been the subject of a research project based at Imperial College, London. All the results and information from this project have been brought together into a decision support system for the enhancement of new woodlands.

The research addressed questions relating to pre-site treatment, selection of species, choice of seed or vegetative material and the timing of introduction in relation to tree establishment. All the planted species and most (19/20) of the sown species were still present after 3 years (Francis *et al.*, 1992). These results clearly demonstrate the feasibility of introducing ground flora into new woodlands by simple hand-sowing and planting methods.

Establishment rates varied considerably and this could be explained in terms of different growth

Correct management is required to establish a diverse ground flora in new farm woodlands. *(J. Francis)* strategies, two distinct groups of species being recognisable. The first group, characterised by those which were quick to establish and reach maturity, were all light-demanding woodland edge or marginal species; whereas species in the second group were shade tolerant, true woodland species which were slower to mature. Observations indicated that woodland herbaceous species which were quick to establish may have created a favourable environment in which slower growing, shade-tolerant species could survive and flourish.

Interactions with conventional agriculture

Woodland management may also be important in controlling the abundance of species which may be either beneficial or potentially damaging to farm economies.

At Aberdeen University the impact of roe deer on farm woodland and surrounding agricultural areas has been investigated through studies of the diet and condition of deer in farm forestry habitats. The work indicated that roe deer inhabiting farm woodland had a different diet, and were in better condition, than animals from neighbouring large forests. The work also investigated the potential effectiveness of carnivore odours as roe deer repellents.

Table 3. Flowers attractive to crop pollinating long-tongued bumblebees, especially *B. pascuorum* and *B. hortorum.*

Labiatae	
Lamium album	– white deadnettle
Glechoma hederacea	– ground ivy
Ajuga reptans	– bugle
Lamiastrum galeobdolon	– yellow archangel
Prunella vulgaris	– shelfheal
Stachys sylvatica	– hedge woundwort
Clinopodium vulgare	– wild basil
Lamium amplexicaule	– henbit deadnettle
Ballota nigra	– black horehound
Galeopsis tetrahit	– common hempnettle
Other perennial herbs	
Scrophularia nodosa	– common figwort
Odontites verna	– red bartsia
Anthyllis vulneraria	– kidney vetch
Trifolium pratense	– red clover

On the plus side, habitats provided by farm woodlands may be of considerable value to populations of crop-pollinating bumblebees. A study at Cambridge University has provided recommendations on management practices and plant species which could be used to encourage bee populations (Table 3). Sampling in and around 16 woods in Cambridgeshire showed that a mosaic of habitats including unshaded and undisturbed areas (e.g. new plantation areas, wide rides, ditches and tracks) were the best in terms of forage (Figure 5) and that perennial species were preferred over annuals. Very little forage was available under woodland canopies but newly planted compartments, rides and glades were particularly important as these tend to be well protected from agricultural disturbances of herbicide application and ploughing, which prevent a perennial sward developing. The use of controlled experiments set up by Bridgets' Experimental Husbandry Farm showed the value of plots planted with wild flower/grass seed mixtures, and that mown and herbicide treated plots were of little value. Areas of new 'Farm Woodland Scheme' plantations planted with red and white clovers (*Trifolium pratense* and *Trifolium repens*) and *Phacelia tanacetifolia* harboured many more bees than untreated or non-flowering cover cropped areas.

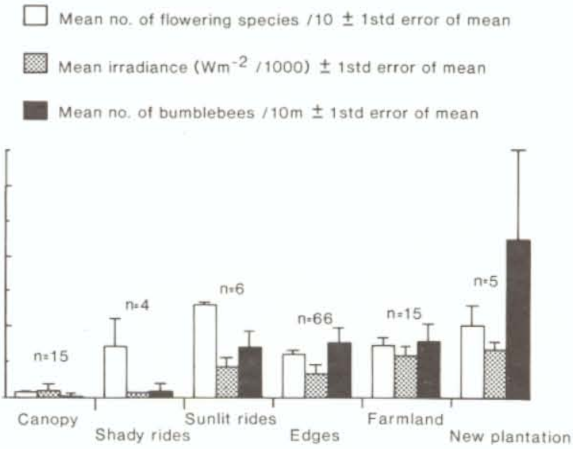
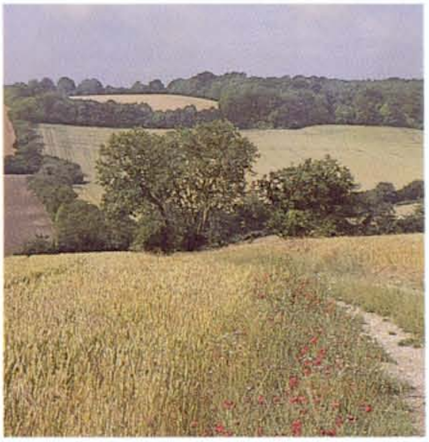


Figure 5. Variation between habitat categories in bumblebee numbers, irradiance and number of species in flower on transects. Sunlit areas, undisturbed by ploughing or spraying, provide the best forage and harbour the most bees.

New plantation areas can provide good habitats for crop-pollinating bee species. (*N. Saville*)

Effects of changing land use on the wider environment: water

The impacts of farm woodlands may go beyond effects on local wildlife, agriculture and even landscapes. For example, woodland cover is known to affect the leaching of nutrients from agricultural soil and in turn this may affect water quality in adjacent watercourses and aquifers. At Leeds University, measurements have confirmed that mature conifer and broadleaf woodlands can reduce both the concentrations of nitrate and the quantity of water draining to groundwater compared to arable and intensively managed pasture. But experimental results also showed that in the first 3 years after planting nitrate losses from new woodlands can be greater than from arable rotations if ground cover is controlled to avoid competition (Table 4). The past agricultural management and type of ground cover influenced leaching more than the choice of tree species. During the first 3 years, the concentrations of nitrates in the water draining to the aquifer for both the arable and new farm woodland commonly exceeded the EC drinking water directive of 50 mg of nitrate per litre.



Farm woodlands interact with agriculture and the wider environment. Hydrological processes such as nitrate leaching may be affected. (*J. Evans*)

Table 4. Annual nitrate losses from different land use plots over the period April 1990 to April 1991.

Land use	Total drainage (mm)	Drainage as a percentage of rainfall	Nitrate N leached (kg ha^{-1})
Ash (year 3)	204	37	89
Cherry (year 3)	196	36	79
Sycamore (year 3)	200	37	86
Ash (year 1)	262	48	89
Arable	161	29	40
Permanent pasture	137	25	35
Beech woodland	109	20	5
Larch woodland	163	30	22

Conclusion

The research programme has produced practical results and recommendations relevant to farm forestry. These range from models and design principles relevant to regional policy analysis to more detailed recommendations on woodland management for wildlife at a local level. The research has reaffirmed the positive benefits to wildlife and landscape that may be derived from increased planting of woodlands on farms, and the need to understand ecological processes in order to maximise these benefits. It has also shown how difficult it may be to achieve these benefits within the existing socio-economic framework.

References and further reading

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Participants in Special Topic Programme

Research grants

Socio-economics of alternative farm forestry systems.

Dr C.Price	**University College of**
Mr R.Willis	**North Wales**

The opportunity cost of farm woodland establishment and management.

Miss J.A.Johnson	**University of Edinburgh**
Miss S.Allan	
Miss G.Clark	

Landscape ecology as a basis for structured farm woodland planting.

Dr P.H.Selman	**University of Stirling**
Mr N.Doar	

The effects of farm woodland size, shape, structure and species composition on insect diversity.

Dr A.D.Watt	**Institute of Terrestrial**
Dr P.Dennis	**Ecology (Edinburgh)**

Effects of age and species composition of farm forestry on the soil water balance and nutrient leaching to an unconfined aquifer.

Dr G.M.Whitely	**University of Leeds**
Miss K.Rushton	

Vegetation development in relation to soil, site and tree species in new farm woodland; predictive models of colonisation and succession.

Dr M.O.Hill	**Institute of Terrestrial**
Mr M.Le Duc	**Ecology (Monks Wood)**

Research studentships

Island biogeography of farm woodlands.

Dr M.B.Usher	**University of York**
Dr M.D.Hooper	**Institute of Terrestrial**
Miss A.Nesling	**Ecology (Monks Wood)**
Mr A.Brown	
Mr S.Keiller	

Crop pollination: the role of farm woodlands as reservoirs for flower-visiting insects.

Dr S.A.Corbet	**University of Cambridge**
Dr R.H.Marrs	**Institute of Terrestrial**
Miss N. Saville	**Ecology (Monks Wood)**

Interactions between farm forestry and the population biology and dispersion of roe deer.

Dr M.Gorman	**University of Aberdeen**
Dr B.W.Staines	**Institute of Terrestrial**
Mr C.J.Calder	**Ecology (Banchory)**

The introduction of ancient woodland field layer species into secondary woodland.

Dr A.J.Morton	**Imperial College, London**
Dr M.O.Hill	**Institute of Terrestrial**
Miss J.Francis	**Ecology (Monks Wood)**

The ecology, silviculture and yield potential of sycamore.

Dr P.S. Savill	**Oxford Forestry Institute**
Mr T.L.Waters	

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Forestry Research Co-ordination Committee

The FRCC was set up in 1982 to identify and define forestry research needs, to advise on requirements and priorities, to stimulate the exchange of information and collaboration between organisations and to encourage the financing of research.

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