

Danish land-use and forestry policy

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Summary

Denmark currently has 12% of its land area under trees and proposes to increase this area to 25% in a tree generation, i.e. 80 - 100 years. The Danes have experience of planned forestry since 1762 and they have developed silvicultural systems to suit their own climate and conditions. Ireland, with its rapid development of afforestation can learn lessons from the Danish experience. Their well developed planning and consultative process, together with good environmental management and their multiple use concept of forestry have ensured that opposition to afforestation, prevalent in the developed countries, has not been an issue in Denmark.

1.0 Introduction

1.1 Location and general geography

Denmark is delicately balanced between Scandinavia and mainland Europe. Apart from a scattering of small islands, three main land masses make up the country – the islands of Zealand and Funen and the peninsula of Jutland, which extends northwards from Germany.

Denmark's total area is around 48,000 sq. km, – equivalent to about half the size of the island of Ireland. Agriculture utilises 62% of the area, forests 12%, nature areas 12% and the remaining 14% is covered by buildings and roads. It lies between 54°34' and 57°45' north latitude, and 8°5' and 15°12' east longitude.

Denmark's greatest length (N-S) is 250km and its greatest width (E-W) is 300km. Due to the great truncation of the landscape, it has a coastline of 7,300km, which is equivalent to one sixth of the earth's circumference.

1.2 Physical features

Along the west coast of Jutland stretches an almost unbroken row of high, denuded dunes. Mid-Jutland is characterised by heaths, lakes and "mountains" which do not approach a height of more than 170m. The highest hill, "Yding Skovhoj", soars to a mere 172m. The east coast of Jutland is indented with many fjords surrounded by woodland and fertile agricultural land. The islands of Funen and Zealand are flat with fertile land.

1.3 Development of the landscape

The landscape was mainly formed during the last Ice-Age, in which ice from north and east extended to a line (the principal ice-front) running east/west near Viborg and north/south through the middle of Jutland. To the north and east of this line the landscape was formed by the movement of the ice, and there the soil is mostly fertile. South and west of this ice front the country was formed by the melt water from the ice, resulting in a poor,

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leached soil. Dune formations are found along the west coast of Jutland. Smaller dunes are found in north Zealand and in the southern part of the island of Bornholm, where the country's only rock formations are found.

1.4 Climate

Denmark has a temperate insular climate. The precipitation varies from 900mm in the central Jutland, to less than 550mm in the coastal regions of the islands. The number of frost free days varies from 140 in the middle of Jutland to more than 200 near the coast. It is the date of the latest spring frost that is important for the growing of many tree species.

Denmark is a windy country, the prevailing wind direction is from the west. The forests are frequently exposed to gale disasters. In 1967, two gales blew down a total of 2.7 million m³ of both broadleaves and conifers. In November 1981, one gale blew down 2.8 million m³, mostly conifer, in less than 24 hours.

1.5 Soils

Compared to Ireland, Danish soils are not very complex. To the north and east of the ice front the soils are generally good and suitable for intensive agriculture and many tree species. This soil type, called "till", covers about three quarters of the country. To the west and south of the ice-front where the Danish heath is found the soils are poor, sandy and leached, with little organic material. During the previous centuries, large areas of heathland were formed west of the ice front on the poorer soils. The natural vegetation was mainly oak, but once removed by man, the underlying soil quality deteriorated.

1.6 Forest history

After the last Ice-Age, different tree species, mainly broadleaves, began to colonise the land. The only native conifers remaining are yew and juniper. The whole land area was under tree cover.

However, about 2500 B.C., man began to clear the forest and this process continued until almost all of the area under forest was cleared.

Planned forestry began in Denmark in 1762, and the planning ethos has survived to the present day. By the end of the 17th century, only 3% of the land was under trees and this too was subject to exploitation. In 1805, a new Forest Act, which protected all forested areas, came into force. After losing the 1864 War, it was decided to utilise the remaining land, to a greater extent, to alleviate the land loss to Germany. The State Forest Service and the Danish Heath Society planted the heathland extensively, and by 1900 a total of 6% of the land area was forested.

In the middle of the 19th century, afforestation with mountain pine and Norway spruce was initiated on large parts of the heaths. However, not all heathland is afforested. At present approximately 75,000ha of heathland remain, mainly in Jutland. The heathland in Denmark is a threatened biotope and much work is needed to prevent its natural afforestation and to promote self-regeneration of the heather. The last remaining habitats of the almost extinct black grouse are also found on the heaths. About 50 specimens still remain.

The Forestry Act, 1935 strengthened the 1805 Act, while the recent Nature Protection Act 1992 and the new Forest Act 1989 give a special position to nature conservation and the multiple use of the forest respec-

tively. A new Act in 1992 gives special protection to the archaeological and

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natural heritage.

Today, 493,000ha or 12% of the total land area of Denmark is forested. The current programme plans to plant 5,000ha per annum and to increase the percentage of forest from 12% to 25% in the next 80 to 100 years.

It is expected that half the programme will be carried out by the State and the remainder by the private sector.

1.7 Ownership

Approximately two thirds of the forests are privately owned. Annual felling is 2.1 million m³. However, this only accounts for one third of consumption, and as a result, there is a significant trade deficit in timber based products. There are over 20,000 forest owners and on average each owner has about 22ha of forest. Almost all private forest owners are farmers, which helps to integrate the two industries.

The forest areas are split up into thousands of small properties, evenly distributed in all parts of the country, leaving only a few small islands without forests. Private forestry development is the responsibility of the Ministry of Agriculture.

The country's State forests, which amount to 180,000ha, are divided into 26 districts, usually with five forests in each district. The State Forest Service

which is the responsibility of the Minister for the Environment is called the National Forest and Nature Agency (NFNA), and has responsibility for wildlife, archaeology and nature matters. It is also responsible for the administration of the broadleaved woodland scheme.

2.0 Tree species and utilisation

2.1 General

Deciduous forest is the natural forest type of Denmark. Today most of the tree species planted are conifers. In State forests it has been decided that a minimum of 25% of trees planted will be broadleaved, regardless of location. In the established woodland areas, i.e. in eastern Denmark and eastern Jutland, the selection of tree species is expected to change in favour of a larger proportion of deciduous species, particularly beech. In the new woodland districts west of the line of the ice front, where a considerable amount of afforestation is expected to take place, conifers will continue to predominate, but deciduous species, principally oak,

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are expected to be accorded greater priority, particularly on woodland fringes and as stabilising elements during the

establishment phase and for recreational purposes.

Private growers receive grants covering 75% of costs (plants, planting and fencing) for planting broadleaves and 60% for conifers.

2.2 Broadleaves

Beech

Beech is the most important tree in the old forests east of the ice front. There are now 73,000ha of beech. In Denmark beech is at its northern limit, but it still grows well. For the past 150 years, efforts have been made to select for good form. In addition to Danish beech, imported plant material from Central Europe has been used successfully. Now beech is regenerated mainly by natural seeding, and rarely by planting. While the average rotation is 110-120 years, beech, which is grown on the better soils and thinned heavily, can have a rotation of 80-90 years. However, some of the beech is on poor soils with a considerably longer rotation. Average annual production is 9m³/ha.

Oak

The most common oak species in Denmark is the pedunculate oak (*Quercus robur*). When the Danish navy was taken by the British during the Napoleonic wars, at the beginning of the 19th century, large areas were planted with oak, this was done to prevent a future scarcity of oak timber for shipbuilding. This is a good example of Danish forestry's long term planning.

Oak can reach the greatest age; it stands firmly against the wind and is therefore used together with other broadleaves as a stabilizing framework in the forests. An understorey of other tree species is grown in order to pre-

vent epicormic growth and to achieve the best possible quality of the mature bole. The rotation length is 120-150 years and average annual production is 6m³/ha.

Ash

Generally ash is not grown in large pure stands, but is found intermixed with beech or as smaller stands in well drained hollows rich in humus. The rotation length is 60-80 years and the average annual production is 7m³/ha.

Sycamore

Sycamore like ash, is used as a mixture in other stands, and develops well on good soils with humus. After the violent gales of 1967, extensive pure stands of sycamore were planted. Because of uncertainty about its performance, it is now planted less. The rotation length is about 80 years and the average annual production is 12m³/ha.

2.3 Conifers

The only native conifers in Denmark are the yew and juniper. Other conifers were introduced about 200 years ago, by the German forester Johan Georg von Langen. Previously, conifers were planted at close spacing, 1.25m by 1.25m. After the gales in 1967, economic considerations made wider spacing of 2m x 2m, more desirable. Today the usual spacing lies somewhere between these two figures.

Norway Spruce

Norway spruce is the main conifer and it covers about 135,000ha. On good sites, Norway spruce produces up to three times the volume of beech. The rotation length for Norway spruce is 40-70 years and the average annual production is 15m³/ha.

Sitka Spruce

Although Sitka spruce only forms a small portion of Danish forests, amounting to 35,000ha, its importance is increasing in Danish crop establishment. Sitka spruce is mainly planted in the coastal areas and on clayey soils with a high ground water table. Sitka spruce can produce from 10-100% more than Norway spruce depending on site characteristics.

Other Conifers

Since 1864, areas of heaths and dunes, amounting to 11% of the land area, have been afforested with mountain pine. This is a low volume producer with poor quality pulp but it

these areas. The distribution of other coniferous species is as follows: Douglas fir and larch 17% and other fir species 9%.

2.4 Silviculture

The forests of Denmark are mainly artificial, built up over the last 200 years, and this is evident in the silviculture with very intensive planting followed by heavy thinning intensity. Denmark has a long tradition of heavy thinnings, carried out at relatively short intervals. The thinning intensity is not only dependent on conditions of biology and production, but is also influenced by the forest's standard of mechanization.

2.5 Wood industry

In Denmark 2.1 million m³ are felled annually. The demand for round timber in Denmark is 7 million m³, and the net imports are 4.5 million m³. The imports are almost entirely softwood, while half the hardwood from Danish forests is exported as partially processed products. Denmark has a relatively large number of small sawmills. The sawmills use 1.3 million m³ round timber annually.

Besides these, there are sixteen other round-timber processing factories, which use a total of 320,000m³ round timber. The most important ones are particleboard factories and "Juncker's industries", which makes flooring from hardwoods, mainly utilizing beech.

3. Forest and environmental management**3.1 General**

Forest management in Denmark is governed by the Forest Act (1989). The Act is designed to ensure the

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improved the soil for the subsequent crop. It is now being replaced on the dunes with Scots pine and Sitka spruce, and on the heaths, where late spring frosts are not too severe, with Sitka spruce. Norway spruce is still the main species in the heath plantations. In some of the dune areas trees are not being replanted and the felled areas are being allowed return to their natural state. However, there has been local opposition to this scheme and demands have been made to replant

forests are managed to increase and improve wood production as well as protecting landscape amenity, nature conservation, recreation, cultural heritage and environmental interests. It is envisaged in the Act that wood production, recreation and nature conservation are compatible – the emphasis is on multiple use of the forest. As well as the Forest Act 1989, there is the Nature Management Act, which allows for the provision of funding for the State afforestation and nature programme. The Forest Subsidy Act, 1989 provides funding for private forestry; 75% of direct costs when planting broadleaves and 60% of direct costs for conifers in the designated forestry zones, and 50% and 40% respectively outside the zone for areas exceeding 2ha. The Agricultural Holdings Act 1989 gave tree crops the same status as any other agricultural crop. The Act on National and Regional Planning gives guidelines to local authorities for designating areas for afforestation. A new Nature Act which came into force in July 1992, gives further protection to nature areas as well as areas of cultural heritage and included the Nature Management Act.

3.2 Multiple use forest management

The Act envisages that in the long term the sustainable forest is the best for individual users and for society as a whole. The multiple use forests would have increased and improved timber production while also protecting landscape amenity, nature conservation, cultural heritage, environmental considerations and promoting recreation at the same time and location.

The Act recognises that forests are an extremely valuable resource, but the public must realise that forest manage-

ment is about the optimization of an industry that must realise a financial return just like any other enterprise. Sustainable forest use is the basis for multiple use forest management. The Act safeguards the many different interests and has rules for:

- subsidies for reforestation with broadleaves and the management of the forest edges;
- the conservation of small biotopes;
- good forest management.

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The Act declares that clearfelled areas should be replanted quickly. All tree stands must be properly tended and thinning must be carried out in all stands in order to improve the return on the investment. Clearfelling should not take place until the age of maximum mean annual increment. Felling must take place with due consideration to limit the risk to windthrow. It also states that trees must be removed after felling as quickly as possible, in order to reduce the incidents of diseases and insects.

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trees or bushes around each new plantation and along roadways. In the heath areas broadleaved belts are planted internally in order to provide shelter.

No domestic animals, including deer farming, may be kept in forest reserves. This rule also applies to all forest owners.

The Act permits up to 10% of the area to be used for Christmas trees and foliage production; prior to this Act it was illegal to use forest reserves for short rotation forestry.

3.3 The forest reserve

The concept of the forest reserve began in Denmark almost 200 years ago with the passing of the 1805 Forest Act. This stated that all areas that are registered as forest reserves must be subjected to silviculture. The area should be allowed to develop to a high forest with good silviculture practice. In all 85% of all forest areas are forest reserves. The following areas are forest reserves;

- forests that are the property of the State, county councils municipalities and the public church;
- forests recorded as forest reserve in the Danish Land Register;
- oak scrub.

3.4 Change of ownerships

On change of ownership the new owners must inform the authorities of the change. He will then be informed about the rules and the advice that is available to him.

3.5 Guidance and advice

The National Forest and Nature Agency (NFNA) has prepared advice on good forest management. Advice is

also available to owners from the Danish Land Development Agency and the Federation of Danish Forest Owners' Association and others.

3.6 Subsidies for existing forests

Grants are made available for the improvement of broadleaved woodland. Grants are paid for planting, sowing or natural regeneration. If cutting of an immature plantation takes place grants will not be paid. Grants are also paid for the creation of forest edges with broadleaved trees and bushes that blend with the landscape; for edges the emphasis is on the use of indigenous species. Where the natural regeneration method is not practised, the plants must be of an approved provenance. There are also subsidies for the propagation of plants and for research and development of broadleaved woodlands.

Subsidies for other improvements are also available. These are administered by the Ministry for Agriculture, e.g. subsidies are available for thinning and clearfelling in younger stands, planting strips of broadleaves internally where there is a risk of fire or windthrow, for roads, and the preparation of Management Plans.

3.7 Afforestation

The Nature Management Act 1989 expects the areas under afforestation to increase substantially, and that afforestation must be for the best possible benefit to society as a whole. While not stated in the Act, the current policy is to plant 5,000ha per annum for the next 80 to 100 years and to increase the area under forest from 12% at present to the EU average of 25%.

It has been estimated that between 250,000 and 500,000ha of farmland

will be taken out of agricultural production in Denmark by the year 2000. In order to counter any unfavourable consequences of this development, the Ministries of Agriculture and Environment carried out an analysis of alternative uses of this surplus land. The study's conclusion was that afforestation was the most economic environmentally sound alternative. The Ministry of Environment also decided that some of the new afforestation should be near towns to provide recreational facilities. It is expected that 25% of all State afforestation will be urban forests.

The Forestry Act has been the basic foundation of Danish forestry for about 200 years and it is expected that the changes in 1989 Nature Act will continue to build on the firm foundation already laid down.

3.8 Funding for the afforestation programme

The funding for the State programme comes from the 1989 Management of Nature Act (now the Nature Protection Act). It was envisaged that the funding would be in the ratio 40-40-20, 40% afforestation, 40% nature projects and 20% for recreation. To date, because of the reluctance of the NFNA to proceed with afforestation until the Regional Councils have completed their plans, more has been spent on nature.

3.9 The planting of farmland

Unlike Ireland, where much of the land used for afforestation has not been intensively used for agriculture, in Denmark all afforestation will take place on land that was previously intensively managed. In order to ensure that there is no conflict, a broad-based con-

sultative committee has been set up. The group meets three to four times a year, and is chaired by the Ministry of the Environment, which provides the Secretariat. The Regional Authorities are involved in projects on private land for which the National Forest and Nature Agency, (NFNA), is responsible. The Agricultural commission, made up of three people, a chairman and two representatives of the farmers, are consulted in all acquisition cases. There is an agricultural committee in each of the 14 regions.

To ensure that the NFNA does not acquire land at prices higher than current market prices in the area, the price level is assessed by the Central Customs and Tax Administration.

In general, co-operation from land owners and between authorities has been an essential element in the implementation of the national management projects.

Local support is seen as an essential element of the process. The consultative committee and the NFNA believe that compulsion should only be used in exceptional cases in connection with key nature restoration or recreational projects.

3.10 Environmental management

The direction forestry should take in relation to the natural environment is clearly defined in the 1992 Nature Protection Act. For afforestation, no disturbance can take place within 100m of archaeological remains. In Denmark an archaeological remain is defined as a structure over 100 years, in Ireland it is defined as pre 1700. Development is not allowed within 100m of rivers and streams or 150m of lakes or the coastline.

A major environmental issue in Denmark is the high level of nitrates

in ground water. Because of its low levels of fertiliser and pesticide use, afforestation is an important mechanism in redressing this trend.

4.0 Forest and environmental planning

4.1 General

Planning has been an integral part of forestry development in Denmark for over 200 years. A German forester, Johan Georg Von Langen introduced the concept of forest planning in 1762 and it now forms a pivotal role in forest management both in private and State forests.

He divided the forest into compartments, formulated forest maps and calculated volumes. He also founded the forest school. For more than 200 years Danish forestry has been influenced by Von Langen's principles, and management plans are now an established part of the forest administration. The aim of management planning is to ensure the appropriate use and maintenance of the forest resource. The planning process takes account of environmental, recreational, nature management and wood production considerations.

4.2 Regional planning

The fourteen regional councils have been given the guidelines by the Government to designate 6% of the agricultural land area under their control for forestry development. The plans are 12 year plans and they are updated every 4 years. In drawing up the plans the council are asked to consider all the interests involved: agricultural, forestry, ground water protection with trees, nature preservation and recreation. The designated areas are:

- (1) where afforestation is desirable;
- (2) intermediate areas;
- (3) where afforestation is undesirable.

State forestry will only take place in category 1 areas, except where the afforestation is taking place beside an existing plantation in a category 2 zone. However, private forestry can take place in categories 1 and 2.

4.3 The Planning process

While planning is carried out in the public and private sectors, this paper only deals with the process in the State forest sector. The emphasis of the plan is in the management of the existing plantation and appendices are added should new areas be purchased or if a major windthrow should occur during the period of the plan. The plans are for a 15 year period. Various other periods (10-20 years) were used in the past but the 15 year period was found to be the most satisfactory. The plan is made on a district basis and currently there are 26 districts with usually 5 forest units in each. Each district completes an annual operational plan for the forest in accordance with the long term plan. A simple summary of the plan is as follows:

- (1) It analyses what is in the forest.
- (2) It examines what can be achieved.
- (3) It examines how it is going to be achieved.
- (4) It estimates what the results will be.

4.4 The Consultative phase

Since 1987 consultation is held with the local authorities in the district the

plan is being prepared in. At the meeting, representatives of the statutory and voluntary bodies attend. The Open Air Council is an umbrella organisation of the environmental interests and the Danish Society for the Conservation of Nature are given a statement of the intent of the plan. These organisations must then make submissions in writing to be included in the planning. Other areas of the State forest agency make contributions; the biology section, the ecology section, the landscape office (deals with regional plans), the archaeological office and the recreation office.

While the plan is prepared at the agency headquarters, it is done in cooperation with the district's staff. In the planning process the planning office has the co-ordinating role and makes the final decisions. As well as being important for everyday planning, the plan also acts as a control mechanism. The structure is a very flat one. All 26 district managers and the 15 heads of section in the headquarters work directly to the Directors so that there is no room for day-to-day consultation about operational matters.

4.5 The Analysis Phase

After the consultation phase the analysis phase begins. The basis for the analysis is the inventory of the estate, which is updated annually by the inclusion of all new planting and the addition of increment based on yield models. A full inventory is carried out every 15 years prior to the plan update. The inventory consists of a registration of land, updating maps, register of species and volume estimation. The inventory forms the basis of the 15 year forecast and this dictates thinning and clearfelling proposals for the period. While a date for thinning and clear-

felling to be carried out is not dictated by the plan, the plan stipulates that such operations should be implemented within the planning horizon. A balanced view is taken of the estimates of the respective volume and type of material, i.e. percentage pulp sawlog etc. This is very detailed down to defining the sub compartment to be treated. Then the types of species to be used are outlined and also the limit to commercial development. Plans for areas for nature conservation, cultural history or recreation are also made.

4.6 The Plan Format

4.6.1 General

The format of the plan varies from district to district, but usually it has ten sections.

4.6.2 Draft Plan

Initially a draft plan is prepared, and after formal discussion between the Planning staff and District staff chaired by the Deputy-Director, the final plan is prepared. The draft plan is usually in three sections; an outline of the district with updated maps showing all boundaries, a register of all land and their uses, and the species and age class distribution presented in tabular form. The growth pattern and the volume at the beginning of the increment and the harvest are summarised.

This is followed by a control mechanism, which is composed of a critical analysis of the performance of the previous plan.

The silvicultural policy outlines whether there should, for example, be more broadleaves, Christmas trees, or recreation in the district. It includes policy on rotation length and thinning intensity as well as a policy for nature and environmental considerations.

The final section of the draft plan outlines the forecast models that are used, and the total thinning and clear-fell volume by species. This forms the basis of decision and change of species from, for example, mountain pine to Sitka spruce. This process takes about two years to complete, one year in which the field work is carried out and one year formulating.

4.6.3 *The Final Plan*

Following consultation and agreement, a final plan is prepared. The main bulk of this plan is an expansion of the items in the draft plan, including the following:

- (i) geographic information;
- (ii) nature historical information;
- (iii) district historical information;
- (iv) statement of boundary dispute problems;
- (v) summary of growth patterns and expected increment;
- (vi) inventory of special features in the district e.g. gravel, houses, lakes, seed procurement, camping sites, conservation areas, picnic areas, etc.;
- (vii) details of felling and replanting phases by sub compartment;
- (viii) details of timber categorization such as pulp and sawlog;
- (ix) this chapter carries out the economic analysis and estimates costs and revenues for the period based on current cost.

Establishment and maintenance costs are estimated, and revenues and costs for harvesting, recreation hunting, lettings plus an account of general revenues and costs are calculated.

Finally, a profit/loss account for the district for the planning period is prepared, together with a statement of the value of the asset at the beginning of the period plus the increment and the value of the asset at the end of the period. An assessment is then made of the cost and savings within the period.

4.6.4 *Changes in the Plan*

The final area of the plan is reserved for expected changes that may occur in the period. Any other changes that the district wants to make have to be agreed in writing with the planning office and then inserted into the plan as an amendment.

4.7 **The Budget Process**

At the beginning of each year monies are allocated to each district on the basis of the information in the plan. While the plan is designed for a long time period, the units in the plan are physical units i.e. hours, m³, and they can easily be converted into money each year. When the budgets are agreed, the districts take ownership of them. At this stage, there is no room for further discussion. The District Manager then has the freedom to manage the district according to the plan within the budget.

5. **Conclusions**

The Danes have experience of planned forestry since 1762. Since that time they have amassed a lot of information on forest management and planning. They have developed a silvicultural system to suit their own climate and conditions.

Today, there is in Denmark a very valuable forest resource which provides raw material for a well developed wood industry exporting mainly hardwood finished products. Denmark has

also managed to develop a niche market for Christmas trees and foliage in Europe.

Although Denmark has predominantly good soils capable of growing most tree species where frost is not a

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problem, it has also managed to develop good silvicultural practices for tree development in the heathlands. When the initial pioneer species are gradually removed, a system of internal shelter belts is developed by using a variety of tree species. The great gales of 1967 and 1981 have taught the Danes the importance of developing shelter systems.

In Denmark there has been a planning ethos in public and private forestry for over 200 years. This has helped to bring about an orderly development of the industry. Taking land out of agriculture and transferring it to forestry has environmental advantages such as reducing the use of fertilisers. The quality of ground water in Denmark is a major environmental issue.

With the concept of multiple use forestry in Denmark, the public perceive forestry as a positive force in the environment. The Danish public use the forest a lot for recreation and are very appreciative of the efforts of forest owners, public and private, in providing literature for the public. The development of urban forestry has also helped to educate urban dwellers of the value of forestry.

The formal consultation process which has developed parallel with the planning system has also helped to explain to the public the direction and importance of the forest industry. While there has been some recent opposition from farmers and their representatives to the proposals to plant farmland, the Danes are confident that with further consultation their programme of afforestation can be achieved amicably.

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