Norwegian Journal of Agricultural Sciences

Supplement No. 8 1992

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Papers presented at IUFRO 6.06.-4 Workshop
held in Norway 25.8.–1.9. 1991

Norwegian Agricultural Advisory Service, Ås, Norway

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The drawing on the cover is from Kjell Aukrust's *«Guttene på broen»*.

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Edited by Oddvar Haveraaen

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Content

Preface

IUFRO, The International Union of Forestry Research Organizations, celebrates its 100 year' anniversary in 1992. The organization is composed of six divisions:

Division
1. Forest Environment and Silviculture
2. Forest Plant and Forest Protection
3. Forest Operation and Techniques
4. Inventory, Growth, Yield, Quantitative and Management Sciences
5. Forest Products
6. Social, Economic, Information and Policy Sciences

Each division in turn is divided into several subject groups or working parties.

Some years ago a group of professors of Silviculture, mainly from Europe, created a new Working Party, S 6.06-4. The goal was, within the IUFRO organization, to have a forum where the teachers responsible for the subject of Silviculture at the universities could come together and exchange experiences and discuss common matters relating to higher education.

The members of the group usually meet every second year, and as well as the meeting, excursions are arranged with the purpose of supporting and elucidating the topic concerned.

In 1991 the arrangement took place in Norway at the Agricultural University, division Sem in Asker at the end of August. The topic was «Multiple-use forestry».

Some short excursions to the Municipal Forest of Oslo and the forest at the Agricultural University of Norway, Ås were arranged. Further, a journey westward from Oslo, across the mountains to Bergen, ended up at the sea-shore on Sotra - an island facing the North Sea. Different aspects of multiple-use forestry were demonstrated, showing the great importance of forestry and the influence of forest management on wood production, the landscape, environment and the welfare of the population both economically and socially.

The following papers presented at the meeting, demonstrate a wide perspective on the concept of multiple-use forestry; certainly a consequence of different natural, economic, and social situations in the countries concerned.

Oddvar Haveraaen
Professor of Silviculture
Agricultural University of Norway

Multiple-use forestry in Norway

Historic view and present situation

ODDVAR HAVERAAEN
Agricultural University of Norway, Department of Forestry , Ås, Norway

Ever since man first settled in Norway, some kind of multiple-use forestry management has always taken place. Trees provided the material for building, for fire-wood, etc., and the forest itself furnished man with wild and, later on, domestic animals with berries, fodder and hunting facilities. The importance of these different factors has varied throughout the centuries depending on the technological and economical situation in the country.

When man began to use trees for trading, either as roundwood or sawn material, and later also as the raw material for different paper products, wood production advanced to become the dominating factor. After World War II, the rebuilding of our country and the increase in the world-wide demand for wood based products strengthened the forest wood production aspect of the multiple-use concept of our forests. More intensive agriculture forced the domestic animals out of the forest to be fed on cultivated pastures during the summer period.

The main objective of the Forestry Act in Norway has been revised several times during this century. In the period between the two World Wars the emphasis was on forest protection, while forest production became the dominant element in the rebuilding period in the first two decades after 1945.

The improved economic and material well-being of the population led to more leisure time. Better transport communication, either collective or by privately owned car, increased the physical possibilities for getting out into the forest and into nature in general. Poor communications between the majority of the population and the primary industries, political trends with less confidence in the idol of pure technology and short-term economic profit, and an increasing understanding of the long-term ecological philo sophy, all contributed toward forcing the authorities and politicians to revise the Forestry Act in both the 1960,s and the 1970s. In particular, people in the Oslo region dominated the discussion and the attack on the establishment.

In Section 1, the objective of the Forestry Act is now stated as:

> *The objective of this act is to encourage forest production, afforestation and forest protection. It shall be aimed that forestry through rational management can give a satisfactory result for the people connected to the forest enterprise and secure an effective and regular supply of raw material for the industry. Further, there should be emphasized the importance of the forest as a source for recreation for the population, as an important part of the landscape, as environment for plants and animals, and as areas for hunting and fishing.*

The multiple-use aspects, taking into consideration wood production, wildlife management and the recreation factor, have been accepted by many educated foresters and forest owners. It seems, however, more difficult to accept the need for leaving some dead trees in the forest in additon to those that are left as a result of technical or economical obstacles.

At the beginning of the 1960,s the Department of Silviculture of the Agricultural University of Norway sought to establish a separate professorship at the department, with the intention of conducting research into and the teaching of multiple-use forestry and nature conservation. For a variety of reasons this was not approved. However, some fellowships offered to young forestry graduates in the 1960,s and 1970,s facilitated the development of knowledge and research on the relationship between forestry management and recreation.

At the beginning of 1970 a professorship was established within nature conservation, outside the influence of and cooperation with the forestry departments. At that time the professional and, to some extent, also the personal conflicts between forestry and nature conservation were at their most bitter.

The syllabus for the forestry students contains both basic and applied subjects in the first three years, and, roughly speaking, is common to all the students. However, some specialization within silviculture (biology), engineering or economy takes place in years four and five.

So far, multiple-use aspects have more or less been included in the applied forestry subjects. We have, however, met criticism both from some students and from different organizations dealing with nature conservation and recreation on the grounds that the topic does not receive the attention it deserves.

At the university we have now decided to establish a new, separate course in multiple-use forestry in addition to the existing multiple-use aspects in ordinary forestry courses.

The content of the new course has not yet been thoroughly discussed. An academic and philosophical approach to the subject related to forestry management will have to be developed. The course could include the following three main topics:

1. Recreation
   - Outdoor activities
   - Aesthetics
2. Plants and animals
   - Nature conservation
   - Nature heritage
   - Long-term ecological aspects
   - Hunting
   - Diversity
3. Economy and society
   - Estimation of benefits
   - Legislation
   - Framework

So far, it seems that some other study groups at our university are interested in taking part in the development of the above-mentioned course. At least the Department of Forestry intends to work further along the lines of this approach.

The attitude of the Flemish private forest owner towards multiple-use forestry and the new forest decree

N. LUST
Research Centre for Silviculture, State University Gent, Coupre, Gent, Belgium

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The importance of the private forest in multiple-use forestry in Flanders should not be underestimated. Generally speaking, the attitude of the private forest owner is far from negative. Practice has revealed some positive achievements. The private forest owner is not only interested in wood production and investment, but he also takes a very keen interest in hunting, nature conservation and recreation. Forest legislation is a sound means to increase the significance of multiple-use forestry in private forests. In this respect, the recent Flemish Forest Decree makes a considerable contribution by, on the one hand, imposing some obligations, such as a management plan, and on the other hand by promoting wood production as well as forest conservation, recreation and nature development in the forest.

N. Lust, Research Centre for Silviculture, State University Gent, Coupre 653, B-9000, Gent, Belgium

In the recently regionalized Belgium, a Forest Decree for the Flemish Region was drawn up in 1990. Two major features of this Decree are: (1) its application to the private forest; and (2) it stresses the importance of multiple-use forestry.

Private forests cover about 70% of the forest area in Flanders. In the past they were not submitted to the Forest Law. Consequently, on the one hand, management as well as accessibility were free, but, on the other hand, there were no incentives either. Other features are the considerable parcelization, the artificial and homogeneous character of the forests and their young age. This means that the existing situation was a rather unfavourable starting-point for a multiple-use forestry.

Very little is known about the private forest in Flanders. Therefore an investigation was carried out, by means of an inquiry, in order to have more insight into the attitude of the private forest owners with respect to the Forest Decree, and in its striving for multiple-use forestry.

A total of 189 questionnaires were sent to the private forest owners. Out of these, 64 (or 35%) were appropriate for processing. These were reasonably representative of all the forest size classes (Table 1).

The inquiry does not completely correspond to the real situation of the private forest. Nevertheless, the owners represent 2.5% of the private forest area. The reliability of the answers, however, remains an open question.

Table 1. Repartition of the surveyed owners into size classes

Size class	1	2	3	4	tot.
Size of forest, hectare	< 1	1-2	5-50	> 50	
No. of owners	9	19	23	13	64
%	14	30	36	20	100

GENERAL OBJECTIVES OF THE PRIVATE FOREST OWNER

Generally speaking, multiple-use forestry is found to be a natural feature of the private forest. Indeed, on average the forest owners indicate two main objectives for their forest possession (Table 2).

Table 2. Objectives of the private forest owners (number and percentage)

Size-class	1	%	2	%	3	%	4	%	tot.	%
Wood production	5	56	7	37	14	61	10	77	36	56
Investment	4	44	7	37	9	39	4	31	24	38
Nature conservation	1	11	7	37	10	43	5	38	23	36
Hunting	0	0	1	5	5	22	12	92	18	28
Recreation	2	22	6	32	7	30	1	8	16	25
Soil protection	1	11	0	0	1	4	1	8	3	5
Others	2	22	4	21	1	4	1	8	8	13

It is quite obvious that financial motives are the dominating ones with the private forest owners: wood production and/or investment are mentioned in 75% of the cases:

- Wood production is mainly important with the large forest owners (77%)

- Investment is a major objective for 38% of the owners, especially for the small forest owners.

Despite the strong preference for financial goals, there are still an important number of forest owners who are not at all interested in either wood production or investment. It is remarkable, too, that 36% of the forest owners consciously strive for nature conservation. It is not clear, however, what exactly they understand by this term. In any case, experience has shown that they do not think of it in the same way as the "real" conservationists.

It is also surprising, that only 28% of the owners mention hunting as a major objective. Hunting is not important for the majority of small forest owners. For the owners of large forests, on the contrary, it is of major importance (92%). This means that hunting is very important in a large area of forest in Flanders.

Recreational purposes, either by the owner or by third persons, are not significant (25%). It is most important to the middle-sized owners, whereas it is practically of no significance to the larger owners. Other specific goals, such as soil protection or hobbies, are only mentioned briefly.

The results prove that the objectives of the large forest owner differ largely from those of the small forest owner:

- The large forest owner is strongly interested in hunting and wood production; he has a moderate interest in investment and nature conservation, whereas recreation and other objectives do not have much significance.

- The small forest owner does not have any clear dominating objective: wood production is, however, his main interest, followed by investment; nature conservation and recreation are not unimportant, in contrast to hunting and various other specific objectives.

ECONOMIC ASPECTS OF THE PRIVATE FOREST IN FLANDERS

The private forest owners can be classified in three separate groups:

- personal possession: 62%
- family possession: 20%
- company possession: 18%

Family possession mainly occurs with the large forest owners. It originates from inheritance (60%). Generally speaking, the last category accounts for 40% of forest possession. It is mainly of importance to the large forest ownerships (85%), most of whom acquire forest by purchase, not by inheritance. The considerable number of forest purchases is an indication of the interest in the forest, whatever the objective might be.

On average, an owner keeps a private forest in Flanders for 27 years. However, family possession lasts longer, whereas personal possession generally lasts less than 20 years. More than 50% of the forest owners are opposed to selling their forest. However, 16% of them favour it strongly, usually those belonging to the smallest forest owners, but they can come from all the size classes.

On average, the financial rewards of the Flemish private forest are considered to be negative. Although very few owners keep accurate accounting records, nearly half of them experience their forest results as financially negative. The main causes are: low yields (34%) and high expenses (16%). Taxes are only considered as secondary elements: property tax of 11% and inheritance tax of 8%. The confrontation of the forest business results with the forest objectives mainly indicates that:

- each goal can lead to a different financial result
- hunting in particular has a positive financial result
- recreation is mostly experienced as financially negative

Only 14% of the owners declare that they are financially dependent on their forest, on average to the extent of 44%. In this respect it is remarkable, however, that the income from fellings is not so important, compared with that from recreation.

Before the Forest Decree the private forest owners did not qualify for subsidies. At present, the Forest Decree provides for considerable incentives, even though only 56% of the owners evaluate subsidies as a positive measure. Indeed, up to 17% declare that they oppose the idea of subsidies, on principle. They are particularly opposed to the restrictive conditions linked with the incentives. It is remarkable that 70% of the owners are not informed about the subsidy regulations. This suggests that forest administration should provide them with useful information.

RECREATION, HUNTING AND NATURE CONSERVATION IN THE PRIVATE FOREST

It is obvious that private forests are also important from the point of view of recreation, hunting and nature conservation. According to both the old Forest Law and the new Forest Decree, private forests in Flanders are on principle not accessible to the public. Nevertheless, 25% of the owners declare that recreation is an important goal and up to 31% declare that their forests are accessible. (There is a certain contradiction between these two declarations.) The small forest owners in particular are in favour of accessibility, in contrast to the larger ones.

The large owners are, as already indicated, mainly directed towards hunting. Therefore they are for the most part against accessibility, as it is difficult to link these two objectives, and the more so as they practise hunting in more than 95% of the forest area. Nevertheless, according to the declarations, 30% of the private forests in which hunting is possible are still accessible.

Despite the voluntary opening up of their forests, many private forest owners evaluate this forest function or task as negative.Only 35% are in favour, whereas 20% are opposed to it. In any case, a compulsory opening of the forest is evaluated as very negative. All groups of forest owners are against it. Accessibility, linked with incentives, is slightly better appreciated:

- positive to subsidized accessibility: 23%
- neutral to subsidized accessibility: 21%
- negative to subsidized accessibility: 56%

from these figures, it can be concluded that a spontaneous opening of the private forests in Flanders will, despite subsidies, not be realized in the next few years. The owners are especially afraid of losing some of their privacy, and of hunting and forest damage.

Contrary to this tendency, it is remarkable that most of the privte forest owners strongly support nature conservation: 52% are in favour; 25% are against, mainly large owners. It probably means that they are themselves aware of the very poor natural character of most of their forests. The more negative attitude of the large forest owners is caused by two facts:

1. The importance attached to the results of positive enterprise and the fear that more natural forests will lead to a decrease in yields.

2. The importance attached to hunting and the continuous battle with conservationists with regard to hunting.

THE MANAGEMENT OF THE PRIVATE FOREST

Up to now, management of the private forest has been, with the exception of some local measures, completely free. The Forest Decree determines, however, that for each unbroken forest with an area of at least 5 ha, a management plan must be made.

Generally speaking, the private forest in Flanders is relatively poorly managed. Just a few private forest owners make an inventory (19%) and even less make a management plan (8%) - with the exception of some large owners. Felling in private forests is limited. According to the inquiry results, this occurs in on half of the properties. In these forests an average of 2.9 per hectare is cut yearly. The average annual removal in the whole private forest reaches just 1.3 m^3. Not even the forest owner who strives for wood production, carries out felling on a regular basis. On the other hand, almost half of the forest owners are interested in an additional free silvicultural training. Despite the general lack of management, more than 40% of the owners are in favour of making an inventory (43%), but 25% are still strongly opposed. The attitude against the management plan is a result of the imposed constraints:

- In principle the management plan is appraised relatively positively: 40% in favour and 20% are opposed; in particular, the positive approach of the large owners is remarkable.

- Two-thirds of the owners are against an obligatory management plan, while only 3% are in favour; mainly the large owners, who in principle are in favour, are against this particular obligation.

- Almost three-quarters of the owners are opposed to an obligatory management plan that, moreover, must be approved; again, the opposition comes mainly from the large forest owners.

The last-mentioned of these constraints is very important, as this particular regulation was taken up in the Forest Decree. It means that the introduction of an obligatory management plan will meet with some resistance and that, at the same time, it should not be done one-sidedly. Therefore, the forest administration, aware of this critical situation, has coupled both the inventory and the management plan with subsidies for plantations and maintenance. Incentives, however, do not solve all problems. Indeed, 35% of the private forest owners still declare that they are against the management restrictions, even when these are linked with subsidies. The Forest Decree also tries to improve the private forest by promoting forestry associations. This, too, will not be so simple, though some facts have to be considered as being quite positive. First, 20% of the forest areas are already in family possession. Even though only 12% of the owners declare

that a certain form of collaboration exists at the moment. Furthermore, a number of owners show a certain positive attitude towards collaboration:

- 30% are in favour of a collaboration with private forest owners; at the same time, however, 30% are opposed to the idea.

- 22% are in favour of a collaboration with the forest administration; 44% are against.

- 38% are in favour of a collaboration with the forest administration, provided it is coupled with subsidies.

The last-mentioned attitude is encouraging. In a first phase, the formation of forestry associations is expected to be successful, provided it is well backed-up. Even more so, a limited number of owners (10%) are willing to hand over the management of their forests to the forest administration.

CONCLUSION

Although in the past the contribution of private forests to the multiple-use forestry in Flanders was not appreciated very highly, it should not be underestimated. The attitude of the private forest owner is certainly not as negative. Forestry practice, too, shows many positive achievements. The private forest owner is not only interested in wood production and investment, but he also takes a keen interest in hunting, nature development and recreation. Only a limited number of forest owners are opposed to forest conservation. Forest legislation is a sound means to increase the importance of multiple-use forestry in private forests. The Flemish Forest Decree seeks to contribute to this:

- It promotes the general management of private forests by means of the obligatory management plan, subsidies for plantations and maintenance and the formation of forestry associations.

- A well-managed forest must lead to financially and economically better results.

- The natural value of the forest is promoted by subsidies for the planting of indigenous tree species and by the creation of forest reserves.

- The social function of the forest is also promoted by subsidies.

Multiple-use of land by growing alder (*Alnus glutinosa* (L.) gaertn. *subsp. Barbata* (C. A. Mey) Yalt.) in hazel (*Corylus spp.*) plantations

CEMIL ATA
Black Sea Technical University, Faculty of Forestry, Silviculture Division, Trabzon, Turkey

Ata, C. 1992. Multiple-use of land by growing alder (*Alnus glutinosa* (L.) gaertn. *subsp. Barbata* (C. A. Mey) Yalt.) in hazel (*Corylus spp.*) plantations. Norwegian Journal of Agricultural Sciences. Supplement No. 8. 17-23. ISSN 0801-5341.

In the northeast Black Sea region of Turkey, there are 415,000 hectares of hazel plantation. Hazel plantation areas occupy the land from the seaward side up to an elevation of 700-800 m. Yield of hazel-nut holds a prominent place in the Turkish economy. In this region, forestry, tea plantations and other agricultural activities are important, but hazel-nut production is the largest yield source. *Alnus* is a fast-growing, important forest tree species which occurs from the seaward side up to an elevation of 1,200-1,300 m in the northeast Black Sea region. However, pure and mixed forests of alder have been converted to hazel plantations. In the past, these lands were covered with forests of alder and other broad-leaved forest trees, but are now mostly occupied by hazel plantations. In order to supply the native people with enough wood, alder is grown along with hazel. The climate and soil features of the region are suitable for these two species to be grown together. The only problem is shortage of light in this multiple-use concept. Hazel trees cannot produce seeds (hazel-nuts) under the dense canopy of veteran alder trees. In order to provide sufficient light for the hazel trees, the number of alder must be limited in the upper canopy. More alder can be planted on the south- facing slopes than on the north-facing slopes, because the south slopes receive more light than the north slopes.

Cemil Ata, Black Sea Technical University, Faculty of Forestry, Silviculture Division, 61080 Trabzon, Turkey.

There are three native-grown hazel species in Turkey. These are *Corylus avellana* L., *Corylus colurna* L. and *Corylus maxima* Miller. *Corylus maxima* and *C. avellana* have been cultivated for more than 400 years in the northeast Black Sea region. The hazel plantation area covers about 415,000 hectares and hazel-nut yield holds a prominent place in the Turkish economy. In the west and east Black Sea regions, especially the Ordu, Giresun and Trabzon provinces, hazel-nut production is a main yield source.

Alder (*Alnus glutinosa* (L.) *Gaertn. subsp. barbata* (C.A. Mey) Yalt.) is a dominant forest tree species from sea level up to an elevation of 1,200-1,300 m in the northeast Black Sea region. In the same zone sweet chestnut (*Castanea sativa* Mill.) and beech (*Fagus orientalis* Lipsky) are also important native forest trees.

In the northeast Black Sea region native forests have been cut and hazel planted up to 1,000-1,100 m a.s.e. However, alder is still an important tree species for wood supply in the region.

Hazel and alder can be grown together, and the native people have been growing these two species in the region.

SILVICULTURAL CHARACTERISTICS OF HAZEL

Corylus avellana is a shrub that can reach a height of 6 m. It has no pure forest, but the species occurs under canopy of broad-leaved forest trees such as oak, hornbeam and beech (*Quercus*, *Carpinus* and *Fagus*) and of broad-leaved conifer mized forests (*Fagus*, *Abies*, *Picea*) at an elevation of 1,000-1,500 m in the northeast Black Sea forest regions. In addition to this distribution area, this species can be seen in South, West and East Anatolia with pseudomachie along the banks of brooks. This species has two varieties (*Corylus avellana var. avellana* and *var. pontica* (C. Koch.) Winkler). Both of these taxa had been used in the hazel plantation areas for a very long time for the production of hazel-nuts in the agricultural lands.

Corylus colurna is a straight-stemmed tree species which can reach a height of 25 m. Its wood is used in cabinet-making. This species frequently occurs in the northwest forest regions. It has no pure forests, but can be seen individually or in small groups in deciduous forests (oak, beech) and in mized forests of deciduous and conifer species (beech, fir, pine). *Corylus colurna* occurs 800 and 1,700 m a.s.l. in this region (Yaltirik 1988). This species is not involved in the hazel plantations.

Corylus maxima is a shrub and can reach a height of 10 m. This species had been cultivated on a large scale in north, northwest and northeast Anatolia, and in the Marmara region. Its nut is savoury and is greatly preferred. This species is therefore used in the plantations more than the other taxa.

Corylus species grow under maritime conditions. They grow well in mild and humid sites. At high altitudes where the temperature is low, the yield of hazel is also low. Corylus species cannot be grown in a continental climate. They need a high humidity percentage. In the Black Sea Mountains every season has a rainfall (see for example the rainfall and temperature values of Gireson and Ordu in Table 1).

Hazel species planted from the seaward side up to an elevation of 700-800 m can produce abundant yields of hazel-nut. At higher elevations, over 700-800 m, the hazel-nut yields tend to decrease in accordance with the altitude. At lower elevations and on the warm slopes, hazel trees can produce seeds almost every year, but at higher altitudes and in cold regions seed production only occurs every 2-3 years or even 4 years, and the amount of yield is also very low. In the northeast Black Sea region, hazel plantations can be seen at 1,000-1,2000 m a.s.l., but this is not a profitable kind of land use. Furthermore, seasonal frosts have serious effects on the hazel trees and their seed production at high altitudes. Even at lower elevations frost damage can be seen in April and May in some years, as shown in Table 1. Rainfall and temperature values for Giresun and Ordu are shown in Figure 1.

Frost damage to hazel trees and their seed production indicates that these species are susceptible to the frost.

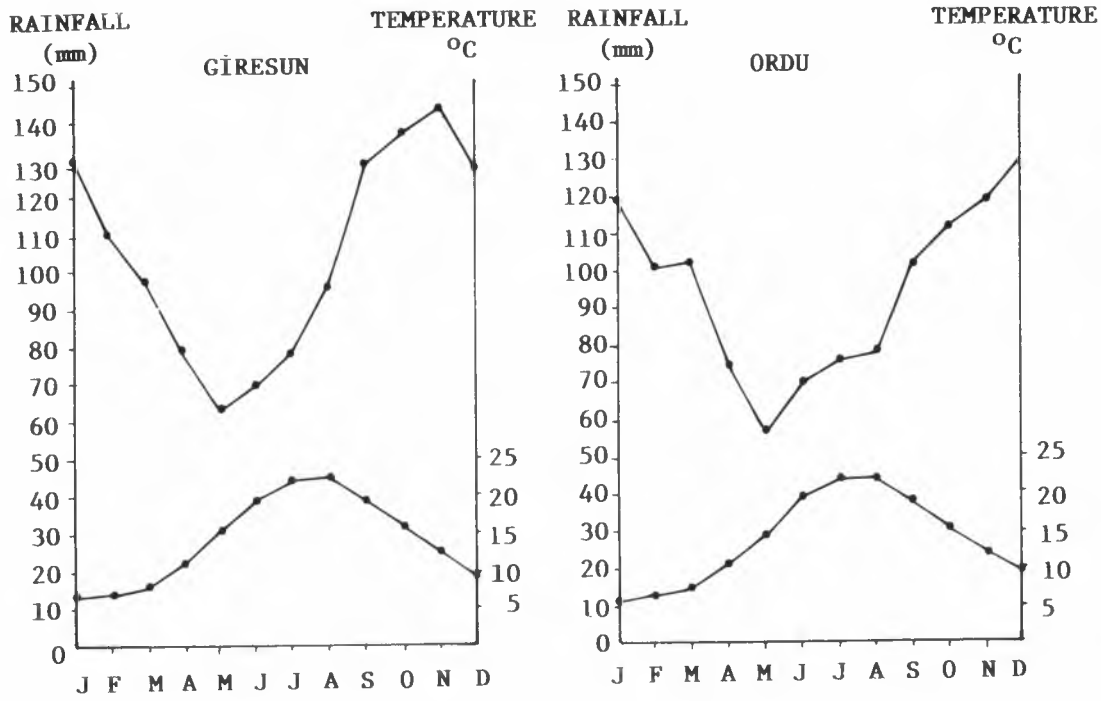


Figure 1. Rainfall and temperature values of Giresun and Ordu

Corylus species are mostly seen in the understorey of natural forests. This feature indicates that these species are semi-tolerant to the shade (Saatçioglu 1976). In the hazel plantation areas alder and sweet chestnut trees occur naturally, and these species grow along with hazel. That is, yield of hazel-nut and wood of alder and sweet chestnut can be produced together on the same land. This feature also indicates that hazel species are semi-tolerant or semi-light demanding species.

In the hazel plantation areas the number of cloudy days is ample in the vegetation period, as shown in Table 2.

On clear days at noontime, light measurements were carried out and found to be 105,000-110,000 lux in flat areas. However, these intense light values can only be measured on completely clear days with low humidity. In the hazel plantation areas on the north-facing slopes between 10.00 and 15.00 on open land it was measured as 60,000-95,000 lux, whereas on the south-facing slopes it was 65,000-115,000 lux on the same days. On cloudy days, the light intensity is always changeable, fluctuating between 10,000 and 35,000 lux, so that a constant value could not be found.

For many years in the northeast Black Sea region, forests of alder and sweet chestnut have been converted to hazel plantations by planting hazel seedlings under the stands of alder and sweet chestnut. Hazel seedlings can survive and can continue to grow very well for five or ten years at 30-40% light intensity under these trees, depending on the soil fertility. After the hazel seedlings attain a height of 1-1.5 m, most of the veteran trees above them are cut and the hazel plantation released, that is, more

Table 1. Rainfall and temperature values for Giresun and Ordu

	GIRESUN								Temperature for 51 years Rainfall for 49 years				
	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Monthly mean Rainfall (mm)	131.0	110.5	98.2	79.1	63.6	70.2	78.5	96.0	128.7	137.1	143.9	127.8	1267.7
Monthly Max. Temperature (C°)	24.9	29.5	34.9	35.2	35.1	36.2	35.3	35.2	31.7	37.3	32.8	28.0	37.3
Monthly Min. Temperature (C°)	-6.2	-9.8	-4.8	-1.4	4.0	8.8	12.1	12.1	8.1	4.2	-4.7	-2.4	-9.8
Monthly mean Temperature (C°)	7.0	7.1	7.9	11.1	15.4	19.8	22.3	22.5	19.6	16.0	12.7	9.3	14.2
	ORDU								Temperature for 20 years Rainfall for 49 years				
	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Monthly mean Temperature (C°)	5.8	6.5	7.4	10.7	14.6	19.8	22.1	21.9	19.1	15.3	12.0	8.7	13.7
Monthly Max. Temperature (C°)	23.4	28.3	28.7	32.5	31.4	34.0	34.7	32.1	31.8	33.0	32.4	29.7	34.7
Monthly Min. Temperature (C°)	-7.2	-6.2	-1.9	-0.4	4.5	8.4	12.6	14.1	8.2	2.5	0.4	-2.3	-7.2
Monthly mean Rainfall (mm)	118.5	101.0	101.7	74.4	55.9	70.1	75.7	78.2	101.4	111.1	188.5	128.8	135.3

Table 2. Cloudy days of Giresun and Ordu

	GIRESUN								For 49 years				
	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Clear days	2.7	2.5	2.7	3.0	3.5	6.5	6.0	6.1	5.4	6.0	4.3	3.5	52.2
Cloudy in patches	12.9	11.1	11.8	12.1	16.2	16.8	16.0	16.4	14.9	14.9	13.4	14.0	170.7
Full cloudy	15.4	14.7	16.5	14.9	11.4	6.6	9.0	8.4	9.7	10.0	12.3	13.5	142.4
	ORDU								For 49 years				
	Jan.	Feb	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Clear days	2.6	2.7	3.0	3.4	4.1	6.1	6.8	6.1	5.6	7.3	4.3	3.0	55.1
Cloudy in patches	13.0	13.8	11.0	13.4	16.6	18.8	17.7	17.1	17.6	13.4	17.4	15.1	185.1
Full cloudy	15.4	11.7	17.0	13.1	10.3	5.0	6.4	7.7	6.8	10.3	8.3	12.8	125.0

intense light is given to the hazel in order to promote seed production. Hazel cannot produce seeds (hazel-nuts) in a light intensity below 30-40%. On the north-facing slopes of the hazel plantations, fewer alder trees are left over the hazel plantations than on the south slopes because of the greater light intensity on the south-facing slopes. Although these two slopes may have the same number of alder trees, light intensity is always higher on the south slopes, and for this reason, landowners keep more alder trees on the south slopes over the hazel plantations than on the north-facing slopes.

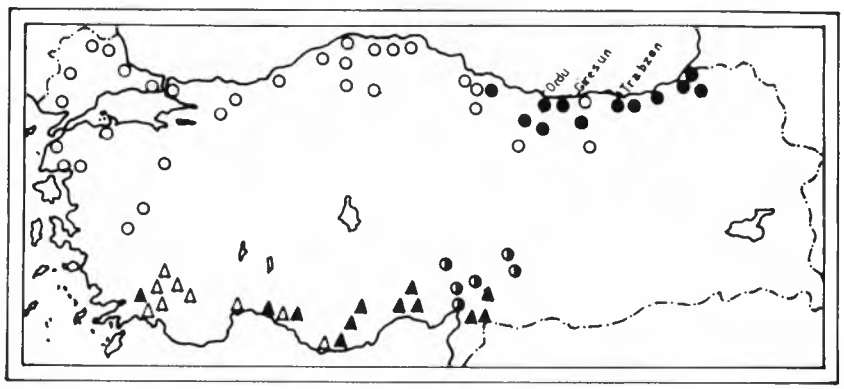
According to these light measurements and planting applications, intense light is not needed for establishing a hazel plantation and so it can be said that hazel is a semi-tolerant species to the light. However, in order to obtain a good yield of hazel-nut, intense light is needed, and it can therefore be said that hazel is a light-demanding species.

Hazel cannot grow well on unfertile, sandy and dry soils. In the plantation areas deep or very deep loamy soils are prevalent. On the shallow soils yield of hazel-nut is very low. In order to achieve a good yield, the plantations have to be fertilized. Hazel is not an easy species, it needs deep, fertile and moist soils.

SILVICULTURAL CHARACTERISTICS OF ALDER

Five taxa of alder occur naturally in Turkey (Map 1).

1. *Alnus glutinosa* (L.) Gaertn. *subsp. glutinosa*
2. *Alnus glutinosa* (L.) Gaertn. *subsp. barbata* (C. A. Mey) Yalt.
3. *Alnus glutinosa* (L.) Gaertn. *subsp. antitaurica* Yalt.
4. *Alnus orientalis* Dence. *var. orientalis*
5. *Alnus orientalis* Dence. *var. pubescens* Dippel.



Alnus glutinosa (L.) Gaertn. Subsp. glutinosa: o; subsp. barbata: ●; subsp. antitaurica: ◐; Alnus orientalis Dence var. orientalis: ▵ : var. pubescens: ▲

Map 1. Distribution of alder species in Turkey (Yaltirik and Merev)

Subsp. barbata occurs naturally in the hazel plantation areas. This species can be seen from the seaward side up to an elevation of 1,700 m. In the past, all these lands were

mostly covered by forests of this species. The hazel plantations abandoned by the owners many years ago have been converted naturally to forests of alder.

As shown in Table 1, *subsp. barbata* occurs in the humid regions. In dry provinces it can be seen only along the river banks.

Subsp. barbata appears in the mixed forests of beech or sweet chestnut at low altitudes and also at high altitudes in the forests of spruce (*Picea orientalis* (L.) Link). This species can grow in mild as well as in cold climates. It can be said that the subsp. barbata is not susceptible to cold and hot climates and is resistant to the frost.

Young seedlings of alder are tolerant to the shade, but when they become older, they need light. Pure stands of alder are always one-storeyed stands. The suppressed individuals die out rapidly in the understorey because of shortage of light. Alder can be accepted as a semi-tolerant or semi-light demanding species.

Alder species tend to sprout vigorously. For this reason, privately owned forests of alder are mostly regenerated by coppice methods. However, the stumps of alder decay rapidly, and they are renewed by planting after one or two sproutings. Naturally high forests or planted high forests of alder are prevalent in the Black Sea region. The Subsp. barbata occurs in 107,000 hectares of forest (Saraçoglu 1988).

The *subsp. barbata* grows very well on deep, fertile, moist soils. In the very good sites it can reach a height of 33-38 m and 40 cm diameter by the 50 years standard age (Batu & Kapucu 1991). This species can also grow well on sandy soils if it finds suitable moisture. The roots of alder can fix the free nitrogen in the air and increase the fertility of soil (Yaltirik 1988, Saatçiogly 1976).

Small seeds of alder can be wind blown for a long distance and they can also be carried by running water, so that waste lands, burnt forest areas, roadsides, landslide areas and also abandoned agricultural lands can be occupied by alder seedlings.

GROWING ALDER AND HAZEL TOGETHER

The production goal in the hazel plantation is to achieve a high hazel-nut yield. Although a yield of wood is not as important, owners of hazel plantations do require wood for firewood or construction. For this reason they need to produce hazel-nut along with wood of alder on the same land.

The temperature is suitable for both species (hazel and alder) from the seaward side up to an elevation of 700-800 m. In this zone the hazel-nut yield and wood production of alder are maximum. Any forest damage hazard to the hazel is minimal.

The rainfall is also suitable for both species. Alder increases the amount of nitrogen in the soil by fixing the free nitrogen in the air with its root. The only problem in growing hazel and alder together is the slight competition between the two species. Hazel cannot produce seeds (hazel-nuts) under the dense canopy of alder. For this reason, in the upper canopy intense light should be released to the understorey.

On the south-facing slopes the light intensity is greater than that on the north-facing slopes, measuring 65,000-115,000 lux and 60,000-95,000 lux, respectively. Because of the differences in light intensity, more alder trees can be grown on the south slopes than on the north slopes over the hazel plantations.

As a general rule, hazel plantation owners do not plant alder in the hazel plantation areas of the north slopes. However, planting is carried out on the south-facing slopes.

On the north slopes, alder is planted at the border of the hazel plantations or along the brooks. When alder is planted in the hazel plantations, their branches in the crown are pruned in order to reduce the shade effect on the hazel.

On the south slopes landowners plant alder at distances of 25-30 m in the hazel plantations. The yield of hazel-nut in these areas is not lower than that of unplanted areas. Moreover, the light intensity has been measured and found to be more than 90% in all alder-planted hazel plantation areas.

On the north slopes, in the alder-planted hazel plantation areas, the light intensity was also found to be more than 90%, but the amount of light was always lower than that of south slopes.

Landowners who need wood, produce hazel and alder together on both slopes by planting alder at shorter distances of about 10-15 m in order to produce firewood or sawmill wood. Indeed, when the yield of hazel-nuts is low, the owners give more attention to wood production.

In accordance with the hazel plantation owner's application and the data found by light measurements, it is possible to grow alder in the hazel plantation areas. However, this is more viable on the south slopes than on the north-facing slopes.

Hazel plantations are grown on different sites and therefore not only light but also site conditions can have an effect of growing alder with hazel. For these various effects no constant number of alder for planting in the hazel plantation areas has been estimated. However, in general on the south slopes alder can be planted at a distance of 20-35 m, and on the north slopes at a distance of 35-50 m. Moreover, it will be useful to plant alder on all slopes at the border of hazel plantation areas and along the brooks.

In order to produce wood in the hazel plantation areas, another tree species, *Populus nigra var. pyramidalis* is used. This species can be planted alone or with alder in the hazel plantations. In this region the climate is suitable for growing poplar. Pyramidal poplar is less harmful to the hazel-nut yield than alder because poplar does not reduce the light as much as alder. However, poplar does not grow very successfully on heavy soils. This point must be taken into account when planting poplar in the hazel plantation areas.

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New aspects of multiple-use in education and research at the Department of Silviculture in Sweden

JAN FALCK
Department of Silviculture, Swedish University of Agricultural Sciences, Umeå, Sweden

In Sweden, nearly all productive forest land (23.6 mill. ha) is managed for the production of pulpwood and timber. Excluded are forests in our national parks and other protected forests, which cover an area of 584,000 ha (2.47% of the productive forest land). From 1996 all forest owners will be legally required to maintain a detailed map of their forest estates and a 10-year plan for the management of every stand in their estates. In principle, all forest owners are required by law to use the clearcutting system, with or without seed trees, as the one and only silvicultural system for their forests. The law applies in the case of forests owned by the state (25%), by private companies (25%) and in privately owned forest estates (50%). The annual cut, clearcutting and thinning, in 1989 was 79 mill. m^3, which was 20% less than the increment this year.

Is there any need for education in the multiple-use of forest land given the situation described above?

MULTIPLE-USE IN THE FOREST TODAY

In Sweden, all forest land is open to the public and the right to go walking, jogging, picking berries and mushrooms and camping without the permission of the landowner is indeed exercised. These activities, as well as hunting, have until now proven to be combinable with clearcutting, monoculture and even-aged forest stands. Multiple-use is hence practised in Swedish forests, although the main use is, and has been for many years, commercial wood production. I would predict that this is going to change.

At the Faculty of Forestry this situation is reflected in the education given to our students. Plantation forestry dominates the curriculum. The focus is on the production of pulpwood and timber, but many other aspects of the use of forest land have such high priority that they dominate the work of some professors, their staffs and departments. Wildlife, ecology, soil science, plant physiology, recreation and economy are a few examples of the areas dealt with by the departments of our faculty.

Most of the faculty participate in the education of the students. Teaching silviculture includes growth and yield theories, the effects of silvicultural treatments on stand and site, and the economic syntheses of aspects given elsewhere in their education. Out of 4.5 years at the university, the students spend a minimum of 9 weeks and a maxi-

mum of 32 weeks studying silviculture. Usually, approximately 90% of this time is devoted to plantation forestry and the clearcutting system.

Quantitative and economic aspects have been the focus of the education of students in this subject, but due consideration to flora, fauna and recreation has always been included in the curriculum.

In commercial forestry this knowledge is put into practice in a variety of ways.

A RISING NEED FOR NEW METHODS

An increasing awareness of the vital importance of nature in Scandinavia, with its special flora and fauna, has aroused criticism from the public concerning forest operations leading to clearcut areas and monoculture. The faculty has set up lists of rare animals and plants that are being threatened by present silvicultural practices. The connection between air pollutants, the accumulation of nitrogen in the forest, forest decline, and the state of the seas (the North and Baltic Seas) has been brought to the public attention. Another reason is that the area of man-made forest has now become a more dominant feature of our forests. We now have 40-year classes of planted, adequately treated, young forests, i.e. more than 40% of all the forests in Sweden.

A main problem in (education in) silviculture is that although our silvicultural practices are critically discussed by naturalists and the public, and some treatments really do harm ecosystems, perhaps even irreversibly so, we have no well-established alternatives for thecommon sites in Sweden that we can teach the students. There is no alternative that has been scientifically evaluated on any major scale.

This means that really valuable biotypes must be bought up by the state and gazetted as reserves in which the trees are left to grow for very long periods without any silvicultural attention. There is an obvious risk that as the volume accumulates, the field layer will become impoverished and floristic values are lost.

Some foresters are frustrated by the lack of well-established alternative methods where present methods are unsuitable.

FORESTS WITH SPECIAL NEEDS

In Sweden there are several major "forest categories" in which the need for new or revived silvicultural methods is particularly great. These categories are listed below. I refer to systems with no clearcutting.

1. Forests close to cities and villages
2. Forests at high altitudes in the mountains
3. Forests on islands, in lakes and in the sea archipelagoes
4. Forests close to nature reserves
5. Forests on water catchments
6. Forests, fauna and flora dependent on a particular density or species composition
7. Grazing areas for reindeer
8. Very small forest estates (privately owned)

ALTERNATIVE TO EVEN-AGED FORESTRY

There is a serious shortage of knowledge and practical experience of alternative systems. Since the early 1950's all alternatives have been legally restricted and research has been hampered through lack of resources.

We feel that, in the long run, hearing options, sometimes voiced by students, such as "We know nothing about the alternatives", or "We know no alternatives suitable for Scandinavian forests", indicates a need for studies in the subject. Since 1982 we have received modest financial support for a project dealing with Single Tree Selection Systems (Plenterwald). A thesis has been published (Lundqvist 1989) and work continues. Since the early 1980,s the students have been given theoretical and practical education in single tree selection. I will not at this juncture go into details about the results of the project, but we have found that a few experimental plots in Darlecarlia that have been followed up for 60 years have had a growth rate corresponding to their site index.

Of greater interest is the general reaction to our preliminary studies on two-storeyed stands.

PARTIALLY TWO-STOREYED STAND FORESTRY

On some sites it has been found that the natural regeneration under the fully stocked overstorey has become more abundant over the years.

In examining these biotypes we try to design silvicultural methods which, it is hoped, are not as dependent on stand structure and site quality as the single tree selection system. As a starting-point I can see different management models giving partially two-storeyed stands.

The literature dealing with this kind of silvicultural practice from the European continent is scarce and it would be of interest to hear of experiences from education and research in this field.

We have identified some two-storeyed stands, naturally developed or through management by forest owners who have used illegal silvicultural practices. Theoretically, the situation can be illustrated in figure 1.

This method seems to suit some forest owners better than clearcutting in even-aged forestry. Some reasons for this are:

(1) Regeneration is cheap
(2) The final size of mature trees is bigger than in normal practices
(3) The overstorey trees restrict, through shading, the development of weeds
(4) If an overstorey is maintained long enough, the quality of the bottom logs will be higher than with conventional practices (smaller branches, straighter growth and better form).

The combinations we have seen involve the regeneration of spruce under spruce, spruce under pine, spruce under birch, pine under pine, spruce under oak, oak under birch.

In most of our preliminarily studied stands, the new generation has been established by natural generation. A few cases of supplementary planting have been observed.

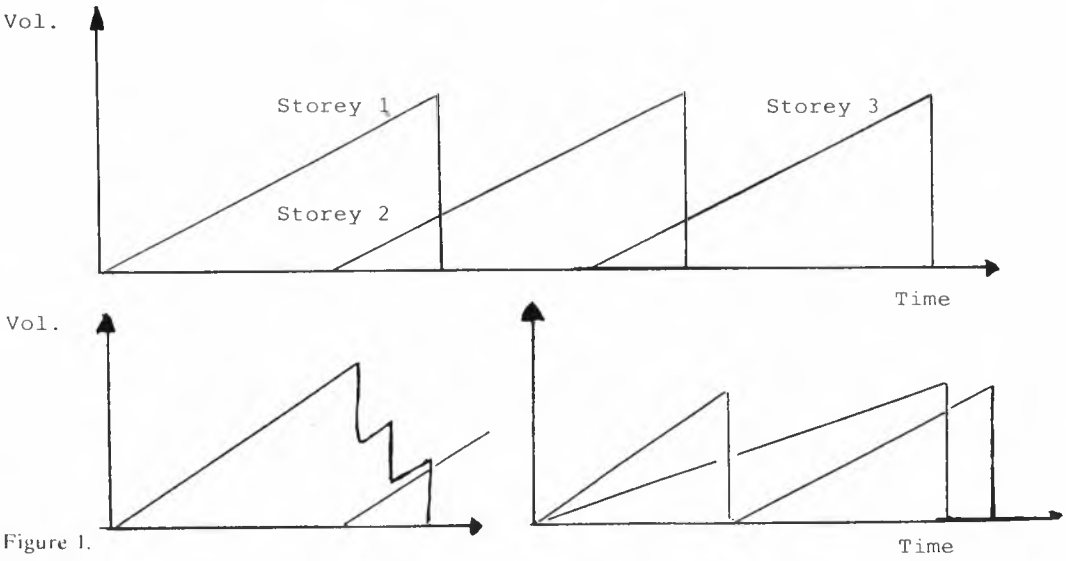

Figure 1.

One of the main objections to this method is that normal sites in Sweden need a clearcut "recovery" period. The heat from the sun reactivates the store of nitrogen and other nutrients. The deep-rooted grasses on clearcut areas can bring up nutrients to the topsoil.

A more substantial objection is that it will be impossible to take the final crop out of the stand without destroying the understorey. Practical experience has shown that this is possible if the understorey is dense. We have studied a case with spruce under pine where a thinning harvester (ÖSA-Eva) was used.

An important advantage of the method is that the nitrogen coming from air pollution will be stored in the forest and will, at least from the time being not contaminate the sea.

We surmise that these methods are «marketable» for all eight situations listed earlier.

FORESTRY WITH AIMS OTHER THAN TIMBER PRODUCTION

We have also introduced another way of avoiding clearcutting, which may be of use in forests inside urban areas.

If the purpose of silviculture is recreation and ornamentation I think that it should be possible to thin the stand in the upper storey from the beginning so heavily that it never reaches maturity. It is easier to use this method with broad-leaved sprouting species, but spruce will be an important tree species, especially in the northern part of Sweden where the winter is long and the main purpose of the urban forest is wind protection.

We have found that mature forests near houses and gardens very often constitute a nuisance to the owner, shading the sun and causing anxiety during stormy weather. If we can accepta forestry without timber production as a primary goal, then we must also concentrate on the wishes of those living in the neighbourhood of these forests. Besides

recreation, production will include pulpwood and firewood (a combination that is on the increase in Sweden).

Close to our faculty building we have established a small forest from a degraded young stand naturally regenerated to a height of 4-6 m. This forest is divided into several sections, each given different treatment according to the special purpose of the section. Some of these will be managed with restrictions on top height and density. I think that the most important part of this forest is the «children's forest». We need to develop appropriate management practices for the three species of Salix in the «forest for the bees». Some of the management regimes resemble the old coppicing practices.

In this short paper I have tried to give a review of the situation today in Sweden. The political climate for forestry is changing from strict governmental control, aiming at the highest possible production of timber, to a more flexible attitude toward the use of forest land. Environmental aspects and public use of the forest have come more into focus. A major problem at our department of silviculture is the lack of knowledge and experience of alternative silviculture regimes for our forests. However, some ideas have been presented in this summary.

Figure 2. To avoid damage to the regeneration, logging must be done with care

Multiple-use forestry in Portugal: A case study

A. CARVALHO OLIVEIRA & JOSÈ C. BORGES
Department of Forestry, Instituto Superior de Agronomia,Tapada da Ajuda, Portugal

Oliveira A.C. & J.C. Borges 1992. Multiple-use forestry in Portugal: A case study. Norwegian Journal of Agricultural Sciences. Supplement No. 8. 31-38. ISSN 0801-5341.

After pointing out the importance of multiple-use forestry in Portugal, some results of the analysis of representative production systems in two ecological regions are presented. Financial appraisal is emphasized. Constraints on economic and socio-economic evaluation of multiple-use forestry projects in Portugal are identified.

A. Carvalho Oliveira, Department of Forestry, Instituto Superior de Agronomia,Tapada da Ajuda, P-1399 Lisboa Codex, Portugal.

Traditional multiple-use management of the oak-dominated forest (montado) became widespread over a large part of south Portugal. A characteristic agroforestry system prevailed. Under the oak canopies *Quercus suber* (the cork oak) and *Quercus rotundifolia* (the green oak) a system of pasturage that allowed some ecological and socio-economic stability was developed. Livestock, cork, firewood, vegetables and game provided revenues to a region with low demographic densities and high economic contrasts. The demographic distribution pattern is very concentrated and so is property, particularly in the Iberomediterranean ecological region.

In the past economical and political strategies contributed to the degradation of these ecosystems. Recently, cereal culture was expanded, as a way to achieve Portuguese cereal self-sufficiency. This policy failed, but by the time it was abandoned it had already led to ecological and socio-economic degradation or even to desertification. More recently, the entry of Portugal into the EEC and the opening up of the economy has led to a redefinition of Portuguese agricultural policy. Former specialization trends have been encouraged. Forestry and, in particular, fast-growing species such as Eucalyptus globulus will play a major role in Portugal's specialization pattern because of the economic comparative advantage.Furthermore, research and investment programmes have been designed in order to develop sound agroforestry strategies capable of reversing the current degradation in the depressed regions of south Portugal, where intensive silviculture seems to be inadequate.

The five-year curriculum of the Forestry Engineering degree of the technical University of Lisbon does not include any specific courses on multiple-use forestry. This subject is approached in different courses which emphasize Silviculture and Forest Management and Economics. These approaches benefit from the research being carried out in multiple-use management which has identified some of the constraints on forestry projects evaluation in Portugal.

- The lack of organized accounting on the part of firms does not allow the precise definition of production and cost functions when multiple-use management is considered. Moreover, the joint cost allocation to individual activities is arbitrary (Hof & Field, 1987) and even the accounting-based separable costs have been shown to be different from the true separable costs in multiple-use forestry (Hof & Field, 1989), leading to a problematic modelling process.

- The non-existence of input-output models and the lack of experience on the valuation of non-market services or of externalities also contribute to the difficulties facing the economic or the cost-benefit analysis of agroforestry projects in Portugal.

Therefore, the analysis that follows considers only revenues and costs accruing to the firm that undertakes the project. Market prices are used to calculate them. This financial assessment disregards benefits and costs to society as a whole, as well as the true social value of products supplied or of resources used. Nevertheless, the importance of the evaluation of economic and socio-economic efficiency of multiple-use forestry projects or the appraisal of their socio-economic and environmental impacts, in order to base private and public decisions, should not be underestimated.

Present technical and economic knowledge advises the analysis of systems which integrate only productive activities whose technical relations are sufficiently known (Borges et al. 1990). Therefore, in this analysis each land-use type is considered exclusive. Silvicultural and economical characterization of alternative land-uses is based on field inquiries and on the secondary data available.

In order to present some results of the research being carried out, we selected two representative regions of south Portugal where the alternative production systems analyzed could be installed:

- The submediterranean ecological region, in particular the «Charneca Pliocénica do Ribatejo», with the following average climatic parameters: mean annual temperature (T) = 16.6°; mean annual precipitation (P) = 588 mm; mean of the maximum temperatures for the hottest months M = 28.7° C; mean of the minimum temperatures for the coldest months m = 5° C. According to the Emberger Pluviometric Coefficient

$$Q = \frac{2{,}000 \cdot P}{(M + m + 546.4)(M-m)} \qquad Q_2 = 85.5$$

the climate can be classified as *Mediterranean subhumid*. The climatic diagram of Salvaterra de Magos identifies the dry season ($P < 2T$), which lasts from May till September. The soils are of alluvial origin with a sandy loam texture, with drainage problems in winter and acid reaction (pH = 5). The natural forest includes species such as an evergreen oak (*Quercus suber*), maritime pine (*Pinus pinaster*) and stone pine (*Pinus pinea*).

- The Iberomediterranean ecological region, particularly the «Perímetro Florestal da Contenda», with the following average climatic parameters: T = 16.8° C; P = 390.2 mm; M = 34.4° C; m = 5.4° C; Q_2 = 45.9. According to the Emberger Pluviometric

Coefficient ($Q_2 = 45.9$), the climate can be classified as semiarid. The climatic diagram of Moura identifies the dry season, which lasts from May till the end of September. Soils are mainly schists and are very thin as a consequence of erosion.

The natural forest includes species such as an evergreen oak (*Quercus rotundifolia*), *Juniperus oxicedrus* and *Olea europea var. silvestris*.

In this paper four alternative production systems are analysed for both the submediterranean and the Iberomediterranean ecological regions (Table 1).

Table 1. Alternative forestry systems

Production systems Ecological region	"TRADITIONAL FORESTRY"	MULTIPLE-USE FORESTRY RANGE"	"GAME"
SUBMEDITERRANEAN	*Eucalyptus globulus* system (SEG) wood --- *Pinus pinaster* system (SMP) wood and resin --- *Quercus suber* system (SCO) cork and firewood	*Quercus suber* Pasturage system under the oak canopy (SCOP) cork, mutton and wool	
IBEROMEDITERRANEAN	*Pinis halepensis* system (SAP) wood	*Quercus rotundifolia* pasturage system under the oak canopy (SMA) firewood, mutton and wool	Big Game System (SCMA) *Sus scrofa* and *Cervus elaphus* extensive system, no fencing is considered --- Little Game System (SCME) *Alectoris rufa*, *Oryctolagus* *cuniculus*, *Lepus capensis*, *Anas* spp

In order to guarantee the comparability of the financial rentability criteria, a general perpetual planning period was considered. The areas occupied by the four systems in the Charneca Pliocénica do Ribatejo and in the Iberomediterranean region were considered to 900 and 2,000 hectares, respectively, according to the distribution of land among property area classes in both regions and the possible economies of scale.

ANALYSIS OF THE PRODUCTION SYSTEMS

The purpose of the analysis that follows is to provide the ranking of the four systems in each region according to their financial rentability.

Decision criteria such as the net present value (NPV) or the benefit/cost ratio (B/C) are used to evaluate the profitability of the investments. The calculations were performed using constant prices to avoid an uncertain price forecasting. The period considered, and the probable changes in the rate of return advise both a sensitivity analysis of the NPV and B/C to interest changes and the use of complementary decision criteria, such as the internal rate of return (IRR) or the payback period (PP).

These parameters provide information concerning the capacity of the agroforestry sector to attract private investment in the region. Simultaneously, the analysis of the chronological distribution of the agroforestry firm financial availabilities allows the definition of adequate public funding programmes.

The results of the financial analysis of the four production systems in the submediterranean ecological region are presented in Figures 1-3.

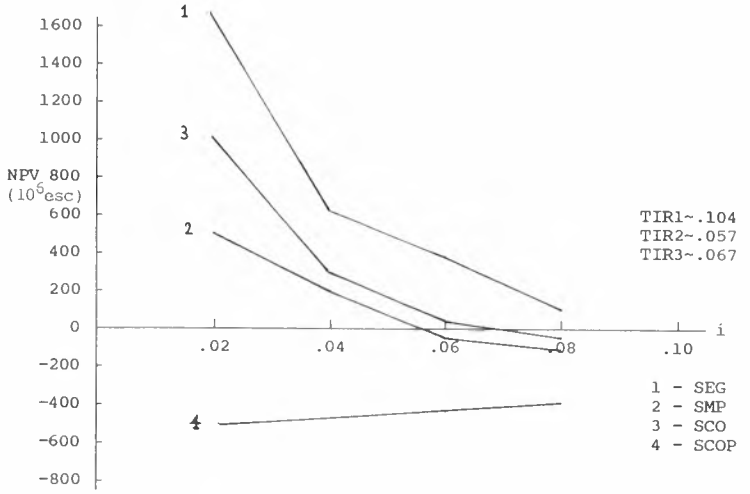

Figure 1. Sensitivity analysis of the NPV of the three investments to changes in the rate of return (i)

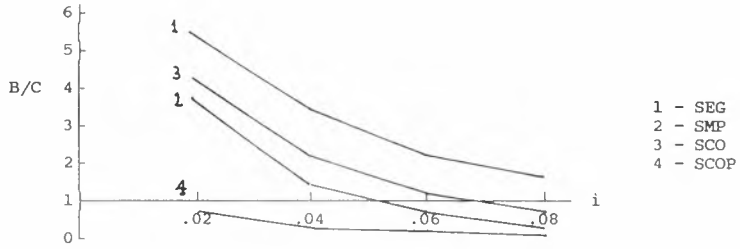

Figure 2. Sensivity ananalysis of the B/C ratio of the three investments to changes in the rate of return (i)

Cork production (SCO) is financially superior to the joint production of wood and resin (SMP). The NPV of the SCO is higher than the NPV of the SMP for all rates of return considered, although the disparities are more important in the case of lower rates. Nevertheless, the difference between the IRR of the two systems is still significant (0.015). This inequality is justified by the concentration of revenues proceeding from

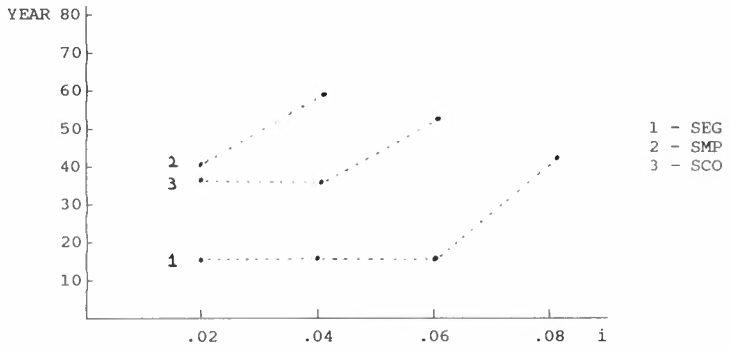

Figure 3. Sensitivity analyses of the PP of investments with positive rentability to changes in the rate of return (i)

the clear cut in IRR (year 60) in the case of the SMP, which contrasts with a more uniform income distribution in the SCO. Higher initial investment in the former also contribute to it. The Maritime Pine regional productivity of about 6 m^3/ha/year (Hidrotécnica Portuguesa 1965) and the revenues from the extraction of resin from trees, the last four years before its cut, do not allow a NPV of the SMP higher than that of the SCO, with an average cork productivity of 2.7 x 10^3 kg/ha (Costa 1990).

The option for an extensive pasturage system (SCOP) under the cork oak canopy proves to be financially inferior to the other three options, with NPV always being negative. The weight of the initial investment, the delay in the introduction of the pasturage system in order to guarantee the success of the cork oak regeneration, the lower cork production as a consequence of the wider spacing considered, and the low productivity of pasture allowing only 3.2 raising units per hectare, all contribute to it. The consequences of the Portuguese economic integration in the European Community on the price of mutton may lead to an even lower rentability of this system (Borges et al. 1990).

The wood production for the pulpwood industry (SEG) is the alternative land use that has gained the best financial result (NPV higher) for all rates of return considered; this is mainly due to the chronological distribution of revenues, which began in year 15, and by the productivity of about 16 m^3/ha/year (1st rotation).

The ranking of the four investments according to the B/C ratio is similar to that evidenced previously. The SEG proves to be superior for all rates of return considered: the revenues obtained from each monetary unit invested are higher.

Risk and uncertain considerations recommend the determination of the PP of the four investments. These criteria again prove the financial infeasibility of the pasturage system. The superiority of the SEG is confirmed, for all rates of return considered; only 15 years are necessary to pay the investment realized. The calculation of the PP also shows that the firm financial availability is very low during the first 40 years of the planning period, both for the SCO and the SMP, when a rate of return close to 0.02 is considered. Higher rates, closer to the equilibrium values in the financial market, significantly worsen this deficit. This information may contribute to the definition of public funding programmes in order to promote the investment in the agroforestry sector in the region.

The results of the financial analysis of the four production systems in the Iberomediterranean ecological region are presented in Figures 4-6.

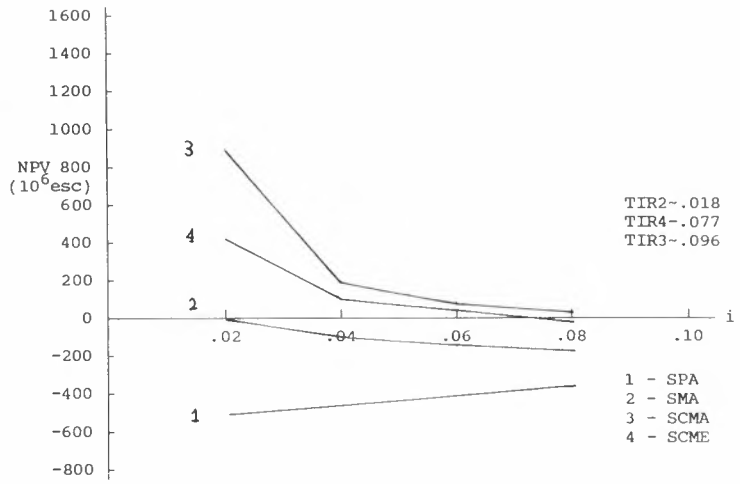

Figure 4. Sensitivity analysis of the NPV of the three investments to changes in the rate of return (i)

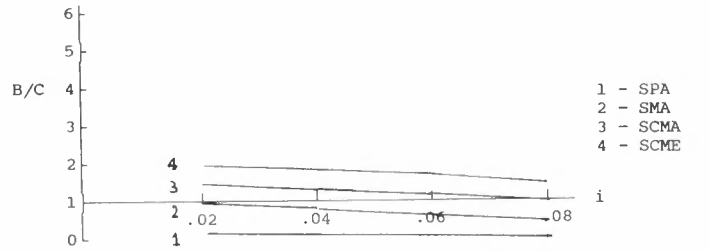

Figure 5. Sensitivity analysis of the B/C ratio of the three investments to changes in the rate of return (i)

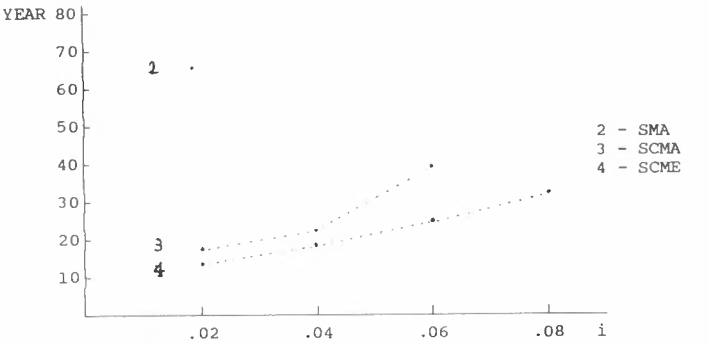

Figure 6. Sensitivity analysis of the PP of investments with positive rentability to changes in the rate of return (i)

Wood production (SPA) seems to be infeasible. High afforestation costs, low stand productivity (1 m^3/ha/year) and an uneven chronological distribution of revenues and costs lead to a negative NPV for all rates of return considered.

The pasturage system under the oak (*Quercus rotundifolia*) canopy (SMA) is financially profitable for rates of return lower than 0.02. The value of the initial investment, the delay in the introduction of livestock in order to guarantee the success of the oak regeneration and the low pasturage productivity (2.4 and 3 raising units per hectare before and after the thirtieth year, respectively) justify the low profitability of the system.

The two game management systems (SCME and SCMA) are financially superior to the former systems; the IRR's are 0.076 and 0.096 for the SCMA and the SCME, res-

pectively. Game management seems to be the activity which may attract private investment more readily to the region. The environmental change is of lesser importance and the technical activities involved are not as financially demanding, particularly in the beginning of the planning period. Moreover, revenues begin earlier than in the SPA and the SMA and are distributed evenly over time.

The B/C ratio also ranks game management first. Lower initial investments explain the superiority of the SCMA over the SCME, even for rates of return lower than 0.05, when the NPV of the latter is higher.

The determination of the PP for the investments with positive rentability emphasizes the importance of public funding in order to reverse current desertification trends in the region. The number of years it takes to recover the investment in the SMA is 75 for an interest rate of 0.018; very few private investors will engage in a project like this one if there are no specific subsidies or financial incentives. Although the investment in the SCME and the SCMA is recovered sooner, where commercial interest rates are considered the PP is still comparatively long (25-40 years), which hardly attracts private funding either.

CONCLUSION

The analysis of some forestry production systems presented in this paper is a result of the technical and economic research being carried out in Portugal. It offers relevant information concerning the financial profitability of alternative investments in different regions. Simultaneously, it has allowed the identification of the constraints on multiple-use forestry projects evaluation and it suggests research lines to be developed.

The socio-economic analysis of agroforestry projects includes the evaluation of impacts on other firms and other productive sectors, on the environment, on social practices and local communities stability. The assessment of these global effects is necessary when public decision-making is involved. Undesired contrasts between different regional development and ecological and human desertification clearly ask for the use of these criteria. SCOP and SMA, for instance, are financially infeasible but, at the same time, have the largest positive impact on the labour market, which is not negligible, particularly when undesired human desertification such as the one faced by the Ibero-mediterranean region is taking place.

However, although financial analysis is only a part of a wider appraisal, it is inescapable. It shows also what might happen if no public interference took place and all decisions were left for the market to make. The importance of a strategy for public funding and of the development of public investment programmes is emphasized. Information relevant to the determination of adequate subsidies, rates of return for loans and other financial parameters are provided.

Finally, some research lines are suggested in order to surmount present difficulties:

Identification of technical and economic relations between non-exclusive land uses and definition of production and cost functions largely depend on the possibility of consulting the accounting systems of organized firms.

- Development of specific methodologies for the socio-economic evaluation of forestry projects largely depends on the availability of secondary data, in order to integrate the agroforestry activity in the regional and national economies.

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