FORESTRY IDEAS, 2010, vol. 16, № 1 (39)

VALUABLE WOOD PRODUCTION – AN OPTION FOR THE FUTURE?

Heinrich Spiecker

Institute for Forest Growth, Albert-Ludwigs-University, Freiburg, Germany. E-mail: instww@uni-freiburg.de

UDC 630.6

Received: 21 April 2010
Accepted: 20 February 2011

Abstract

Ecological and economic considerations increased the interest in growing valuable tree species. Timber quality depends on the genetic characteristics of the individual tree, site conditions as well as on management. Applying an appropriate treatment trees can yield high quality timber within relatively short production times. Forest management has to find new ways to increase net revenue from timber sales by increasing wood quality while keeping production costs low. Through precise and aim oriented management efficiency can be improved. All activities have to be linked to the value producing trees, as those are the economically relevant trees. When dealing with fast growing broadleaves the number of final crop trees per ha is relatively small. This is due to the fact that valuable trees need to have a large diameter, and those trees can only be produced with a big crown. In order to reduce costs the number of trees to be planted can be limited to much less than was considered in the past.

Thinning is applied for controlling the quality of the wood production; in particular, it is used for favoring future crop trees, controlling their diameter growth and natural pruning. A two-phase management system is recommended: first phase emphasizing pruning, and second phase encouraging crown expansion and stimulating diameter growth. There is a close relation between crown expansion and diameter growth. An allometric model describing the relation between crown width and stem diameter is used to calculate the intensity of thinning in order to control diameter growth. The time of harvest is determined by the time of maximum average value production, the marked situation and other factors. The idea of fixed rotation may be abandoned as trees of the same age can grow in groups. Group selection cut may be preferred as larger gaps are needed to fulfil the light requirements of the new generation.

Key words: economically relevant trees, pruning, revenue, timber quality, valuable tree species.

1 Reasons for growing valuable wood

1.1 What makes trees "valuable"?

Valuable species are considered to be valuable because of their high timber prices, and aesthetics of their timber, or simply because of rareness and beauty of the tree. Which species really is valuable, is often a matter of subjective opinion. However, common ash (*Fraxinus excelsior* L.), sycamore (*Acer pseudoplatanus* L.) and wild cherry (*Prunus avium* L.) are considered to be the most important

representatives of the group of valuable broadleaved species with still increasing economical importance in Europe (Thies et al. 2009). Not only these species, but also several other valuable broadleaves such as walnut (*Juglans regia* L., *J. nigra* L. and hybrids), wild service tree (*Sorbus torminalis* (L.) Crantz.), black alder (*Alnus glutinosa* (L.) Gaertn.), lime (*Tilia cordata* Mill.) and to a large extend oak sp. are cultivated for valuable wood production. Coniferous species may in exceptional cases produce valuable timber, as well. However, coniferous species will not be considered in this paper.

1.2 Ecological reasons for growing valuable wood

Valuable broadleaved forests may form important habitats for numerous plants, insects, fungi and animals and so increase habitat values, as well as contribute to biodiversity and nature conservation.Valuable broadleaves produce flowers in springtime, and their flowers and fruits enrich habitats. They enrich the understory and ground vegetation as crown competition of adult trees has to be avoided and therefore canopy closer will vary. Valuable broadleaves mixed with other species in groups or small stands reduce risks of pests and diseases. When planted in huge monocultures risks of pest and diseases may increase, on proper sites, mixed with other tree species or in hedge rows these risks are reduced.

1.3 Economic reasons

The net income of forestry depends on the difference between costs and revenues. Only some costs such as plant material, pruning, continuous release from competitors and special arrangements for marketing and selling are directly related to the quality of the timber. Other costs, such as cost of labour for planting, felling, logging, transport cost as well as cost for general administration are quality-independent. As a consequence high quality timber should be produced, especially when labour cost or transport cost are high. A simple example may show the attractiveness of valuable wood production:

(I) veneer wood of highest quality:

1.000 €.m^{-3} – 30€ (harvesting cost) = = 970 € (net income per m^3)

(II) average quality Norway spruce wood:

80 €.m^{-3} – 30€ (harvesting cost) = = 50 € (net income per m^3).

This example shows that 5 m^3 of valuable timber (I) can create the same net income as 100 m^3 of medium quality of a mass assortment (II).

1.4 Social reasons

Valuable wood is a source of income and creates jobs. Moreover, valuable broadleaves contribute with their colour and texture to the beauty of the landscape and increase the attractiveness of forests for recreational use. In natural conditions, valuable broadleaves grow scattered as single trees and in groups. Apropriate management including the formation of internal edges and gaps may change the visual

impacts and create high aestethic values. However, contribution to landscape varies from place to place (Bell 2009).

The public preference as well varies locally and depends on the social background of the people. Even so there is a trend towards more "broadleaved" forest, the public does not emphasize to a high extent valuable broadleaved tree species but clearly prefers mixture of species. Size and structure of the forest is more important than species composition (Schraml and Volz 2009).

2 Growing valuable wood

2.1 What criteria determine the wood quality?

The dimension and wood properties of the clear bole determine the value of the crop. The required dimension depends on the purpose for which the timber is used. For veneer wood for example the minimum length of the trunk generally is 2.8 m or 3.0 m (length of doors or panels) and the larger the diameter the higher the value for producing veneer. The branchy core should be as small as possible and the proportion of the clear wood without branches should be large. The stem should be straight and not twisted. These parameters can be controlled by forest management such as initial spacing, thinning, pruning and the time of harvest.

For producing as much high-quality and knot-free timber as possible two important general principles are targeted in the case of all valuable broadleaved tree species:

(I) *Restrict branchiness*: less branches mean better wood quality and higher market value.

(II) *Produce large diameter* ("the larger the better") *butt logs*.

Both branchiness and dimensions (diameter and length) can be manipulated by silvicultural measures (planting distance, cleaning-respacing, and thinning) controlling the stand density and available free space around tree crowns. Artificial pruning (formative and high) can have the same effect on branchiness as natural pruning.

High quality timber can be achieved by the application of adequate measures. Economic activities must be be linked to the value-producing trees only. When dealing with valuable broadleaved tree species the number of final crop trees per ha is relatively small. This is due to the fact that valuable trees need to have large diameters and crowns. At the rotation age, only a low number (for most species 40-80 per hectare) of large diameter trees is expected. The stand management has to focus on these value-producing trees and their choice and marking facilitates efficient management. Valuable broadleaves generally grow in naturally mixed stands and *single-tree management* may facilitate growing them under such conditions.

2.2 Which site conditions are required for growing valuable wood?

Trees should be well-adapted to the site and resistant to biological and environmental threats. When aiming for high wood quality in a relatively short time,

productive sites are required. The site conditions modify growth dynamics including height growth and crown architecture. On fertile sites the clear bole up to the crown base may be higher or the wanted diameter of trees with similar crown base will be reached earlier.

3. How to grow valuable wood?

3.1 General considerations

The management aims vary considerable in different regions and they change over time. Diversification and flexible management have to scope with this challenges. Natural processes help to reduce cost and precise management concentrating on the production goals increase the wood quality as well as environmental services of the forest without substantially increasing management cost.

3.2 Forest structure

Valuable trees can be grown successfully as part of an existing forest management regime, in private and public forests, and in a mixture with both broadleaved and coniferous trees. Furthermore, they can be grown as a result of afforestation of farmland, in orchards, along roads or in hedge rows combined with agricultural land use, either arable land or grazing land (Thies et al. 2009). These alternatives show that there is a huge variety of options on how to grow valuable wood: Single tree selection system, group selection or even aged forest management. The size of the land is of little relevance. It seams that growing valuable wood is especially attractive for small and medium sized forest owners, as they may like the idea of well concentrated, precise and consistent treatment of well selected trees. Valuable broadleaves mixed with other species in groups or small stands reduce risks of pests and diseases on proper sites, mixed with other tree species.

3.3 Genetic material

Timber quality depends not only on management of the trees but as well on the genetic characteristics of the individual tree. Stem form, crown architecture and growth characteristics, as well as resistance against pests and diseases are partly predetermined by genetic properties. Unregulated human interventions have changed the genetic composition of valuable broadleaved stands. Recent efforts in tree breeding and genetic conservation help to improve the situation. It is recommended to select site adapted genetic material that has proven to produce high quality timber.

3.4 Planting

When planting, only a small number of genetically well selected and site adapted trees are needed. Spacing: depends on the diameter to be achieved. The distance between trees that have reached the wanted dimension can be estimated by the rule of thump:

Equation 1:

$d_{1.3} \times 25 = D$,

where:

$d_{1.3}$ = *diameter at 1.3 m and*

D = *distance between the crop trees.*

In addition, the spacing design is influenced by the need of selecting best performing trees out of a larger number of trees in case the genetic material is not of excellent quality. Furthermore, the spacing is influenced by the landscape and technical aspects. Geometric forms such as rows facilitate the access to the trees and the use of machinery, on the other hand naturally shaped diffuse edges in an irregular and asymmetric way may enhance the beauty of a landscape. Valuable broadleaves as well regenerate naturally from seeds or root suckers. Young trees may need to be protected against mice as well as against browsing and bark stripping by red deer or other animals. Naturally regenerated minority tree species in mixed forests offer an often underestimated potential for growing valuable timber when properly managed.

3.5 Pruning

A two-phase management system is recommended: first phase emphasizing pruning, and second phase encouraging crown expansion and stimulating diameter growth. In this phase, the crown base should be kept at a fixed height. In the phase of pruning, artificial pruning can have the same effect on branchiness as natural pruning by competition. As competition induced natural pruning can be replaced by artificial pruning of open grown trees, alternative management options offer innovative ways for the production of valuable wood. These management options may at the same time also increase the supply of non-wood products and services. Valuable wood production has to concentrate on the individuals which are expected to produce the high quality wood in the wanted dimension. In order to improve management efficiency interventions have to be limited to actions, which support those value producing individuals (Fig. 1).

For efficient and precise quality oriented management future crop trees have to be selected. The number of future crop trees per ha depends on the target diameter and the production time: the larger the diameter and the shorter the production time the fewer trees per ha should be selected as future crop trees (see equation 1, rule of thump).

Future crop trees should be selected, when the future development can be predicted and measures for supporting the development of the future crop trees are needed. Such a measure is artificial pruning. The timing of pruning has an impact on the stem shape and development of the remaining branches. Artificial pruning has to be repeated in order to avoid pruning of large branches, to reduce the impact of pruning on the tree and to reduce the size of the knotty core inside the trunk. Two types of pruning are distinguished: (I) Proleptic pruning, where the biggest braches and the branches with steep angles including fogs are pruned first and (II) whorl-wise pruning.

The pruning systems and pruning intensities have an impact on the diameter growth as well as on secondary shoot development. Conventional whorl-wise reduction of the crown can be an appropriate method, if it is not done too intensely. While the height growth is not severely affected (Koupka 2007), a reduction of the crown to less than 5 whorls or a relative crown length under

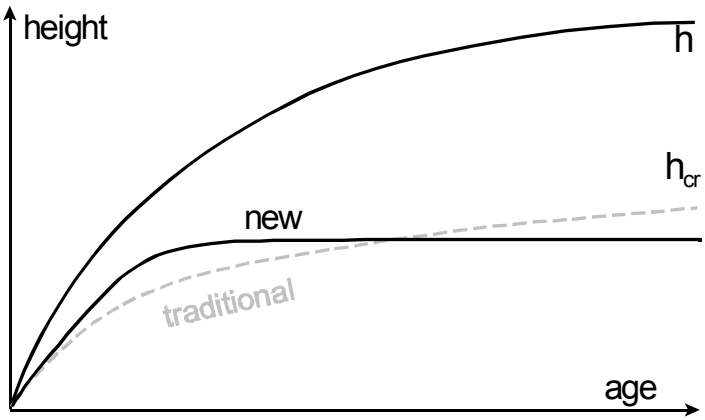

Fig. 1. Development of height (h) and crown base (h_{cr}). It is recommended to accelerating pruning in the early phase of development. Later the crown base is kept on a constant level, which means that no branch should die after the wanted crown base has been reached (Spiecker and Spiecker 1988, modified).

50% leads to a significant loss of diameter increment. In addition, it leads to vital secondary shoots, which may affect wood quality. In contrast, a moderate conventional pruning or proleptic pruning shows similar effects on diameter growth. However, proleptic pruning helps to reduce risk of fungi infections by avoiding large pruning wounds. Furthermore, it leads to a reduced vitality of the secondary shoots. Furthermore, the early removal of steep branches may improve the stem form. These advantages could legitimate the higher and more complex labour input of proleptic pruning (Springmann et al. 2011).

3.6 Thinning

One common feature of growing valuable wood is that generally regular release from competitors on most sites for survival and optimal growth are required, as many valuable broadleaves have a limited capacity to compete in forests. They require more interventions especially when mixed with fast growing and shade tolerant tree species (Fig. 2).

Moreover, thinning is applied for controlling the quality of the wood production; in particular, it is used for favoring future crop trees, controlling their diameter growth and natural pruning. In the second phase of development, crown expansion is encouraged and diameter growth stimulated. There is a close relation between crown expansion and diameter growth. An allometric model describing the relation between crown width and stem diameter is used to calculate the intensity of thinning in order to control diameter growth. The number of competitors to be cut depends on the development phase, the diameter growth wanted, and the thinning cycle. The competitors with the greatest negative impact on the valuable trees should be removed first. In the phase of crown expansion, the crown base should be kept at a fixed height. This requires regular interventions as valuable broadleaved tree species often are getting less competitive with increasing age.

3.7 Harvesting

The time of harvest is determined by the time of maximum average value production, the marked situation and other factors. High-quality timber of large dimension generally realise high prices on the market and demand exceeds supply. The wood of lower quality is of far less value. The answers to an questionnaire 1998–2000 clearly predict an increase of the relevance of veneer wood (Thies et al. 2009). The idea of fixed rotation may be abandoned as trees of the same age can be harvested individually or in groups. Group selection cut may be preferred as larger gaps are needed to fulfil the light requirements of the new generation.

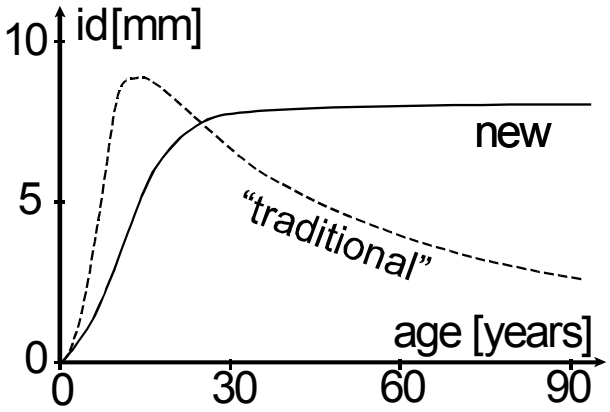

Fig. 2. Annual diameter increment (id) over time. In the phase of pruning, diameter increment is reduced. However, this phase does not last very long. Later the diameter growth is stimulated as the crown gets continuously larger.

3.8 Future perspectives

Even so the demand for valuable timber is increasing, and there is a notable interest among forest owners and farmers to grow valuable broadleaved species, on a global scale the relevance of growing valuable broadleaves is still low. However, these species offer an option to produce high value timber in a relatively short time. They may as well fulfil the needs of stakeholders such as small forest owners, farmers and the wood industry. The proposed management options at the same time also increase the supply of non-wood products and services, as well as the diversity of habitats through the varying forest structure and light regimes. Using the ideas of agroforestry in combination with the management of valuable broadleaved trees may create new and innovative management regimes. New ways of multiple land uses may arise, as better habitats offer opportunities for raising livestock, and may also generate jobs and new business ideas, ultimately offering people a possibility to make a living other than from pure farming and forestry. Valuable broadleaves at the forest edge may help to grade the edge from the full forest height to the shrubs by forming naturally shaped, diffuse edges in an irregular and asymmetric way. They can contribute to the uniqueness and beauty of the area in question, taking into consideration the aesthetic, ecological and economic values of the surroundings. As urban forests are becoming increasingly important for people living in cities, cultural values get more attention. Even so broadleaved forests become more popular, species often are not as important to people as the size or structure of the forest.

Valuable broadleaved tree species offer options for increasing ecological, economic and social values and may contribute to sustainability of forestry in Europe and other parts of the world. They may increase the production of high quality timber while maintaining and improving environmental values such as biodiversity, stability and naturalness. However, the high diversity in sites, ownership, economic and socio-cultural conditions in Europe require different strategies adapted to the local needs. There may be a wide range of management aims to be acomplished within the same forest. The aims vary considerable in different regions and they change over time. Diversification and flexible management has to scope with this challenges. Natural processes help to reduce cost and precise management concentrating on the production goals still produces high values.

References

Bell S. 2009. Valuable Broadleaved trees in the landscape. In: Spiecker, H., Hein S., Makkonen-Spieker K., Thies M. (eds). 2009: Valuable broadleaved forests in Europe. Brill, Leiden. European Forest Institute Research Report 22: 171–199.

Kupka I. 2007. Growth reaction of young wild cherry (*Prunus avium* L.) trees to pruning. Journal of Forest Science 53: 555–560.

Schraml U., Volz K.-R. 2009. Do species matter? Valuable broadleaves as an object of public perception and policy. In: Spiecker, H. Hein S., Makkonen-Spieker K., Thies M. (eds). 2009: Valuable broadleaved forests in Europe. Brill, Leiden. European Forest Institute Research Report 22: 213–236.

Spiecker H., Hein S., Makkonen-Spiecker K. and Thies M. eds. 2009. Valuable Broadleaved Forests in Europe. Brill, Leiden. European Forest Institute Research Report 22. 276 p.

Spiecker M., Spiecker H. 1988. Erziehung von Kirschenwertholz. AFZ (20): 562–565.

Springmann S., Rogers B., Spiecker H. 2011. Impact of artificial pruning on growth and secondary shoot development of wild cherry (*Prunus avium* L.). Forest Ecology and Management 261: 764–769.

Thies M., Hein S., Spiecker H. 2009. Results of a questionnaire on Management of valuable Broadleaved Forests in Europe. In: Spiecker H., Hein S., Makkonen-Spiecker K., Thies M. (eds.) 2009. Valuable Broadleaved Forests in Europe. Brill, Leiden. European Forest Institute Research Report 22: 27–42.