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CONVERSION POSSIBILITIES OF OAK (*Quercus sp.* L.) COPPICES INTO HIGH FORESTS IN BARTIN, TURKEY

Ali DURKAYA*[1], Birsen DURKAYA[1], Mehmet ÇETİN[1]
[1] Bartın University, Faculty of Forestry, 74100 BARTIN, TURKEY

ABSTRACT

In this study the possibilities of converting Bartın-region oak coppices (*Quercus sp*.L) into high forests. The study has been performed in 50 sample plots and in addition to the data obtained from sample plots stem analysis values of 30 oaks have been inspected. The development of volume and volume components of oak in single tree has been determined by using stem analysis values of sample trees. The data obtained from sample plots have been utilized to examine the development of stand volume and volume components with respect to time. By the help of the amount of product types, product amounts from stand have been calculated according to various rotation length alternatives. Present Net Values have been calculated by using income and expenditure data. High forest and coppice investment alternatives have been compared in the aspect of wood production abilities and discounted net values they provide and their effectiveness have been stated.

Keywords: Oak, coppice, high forest, conversion

BARTIN YÖRESİ MEŞE (*Quercus sp*. L.) BALTALIKLARININ KORUYA DÖNÜŞTÜRÜLME OLANAKLARININ ARAŞTIRILMASI

ÖZET

Bartın yöresindeki Meşe (*Quercus sp*.L.) baltalıklarının koruya dönüştürülebilme olanakları araştırılmıştır. Çalışma 50 örnek alanda gerçekleştirilmiş ve örnek alanlardan toplanan verilere ilave olarak, 30 meşe ağacının gövde analizi değerleri incelemeye tabi tutulmuştur. Meşenin tek ağaçta hacim ve hacim elemanlarının gelişimi, alınan örnek ağaçların gövde analizi değerlerinden yararlanılarak saptanmıştır. Meşcere hacim ve hacim elemanlarının zamana göre gelişimlerini incelemek amacıyla alınan örnek alanlardan elde edilen verilerden yararlanılmıştır. Ürün çeşitlerinin miktarları yardımı ile meşcereden idare süresi sonuna kadar elde edilebilecek ürün miktarları çeşitli idare süresi alternatiflerine göre hesaplanmıştır. Gelir ve gider verileri kullanılarak 100 yıl idare süresi için iki farklı iskonto oranı ile Net Bugünkü Değerler hesaplanmıştır. Koru ve baltalık yatırım alternatifleri toplam odun üretim gücü ve sağladıkları iskonto edilmiş net gelirler yönünden kıyaslanarak etkinlikleri ortaya konulmuştur.

Anahtar Kelimeler: Meşe,baltalık, koru, dönüştürme

1. INTRODUCTION

There are 18 species, 7 subspecies and 2 varieties of oak (*Quercus sp.* L.) naturally grow up in Turkey and having 2000 species in the Earth, 200 species in warm regions of Northern hemisphere, many subspecies, varieties and natural hybrids. The most of the total forest area of Turkey is covered by oaks. Therefore, Turkey is one of the few places all around the world in terms of species richness and the area it covers (Yaltırık, 1984;

* Yazışma yapılacak yazar: alidurkaya@hotmail.com
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Kayacık, 1985). The oak occupies 29.40% (6089327 ha) of the total area by 34 species within the broad leaved tree species.

The most abundant tree in the coppices of Turkey is oak. Despite their uncared utilization for centuries oak species have been able to keep their existence due to various properties (keeping the ability of sprouting for a long time, quick recovery of their wounds, being a suitable species for clear cuts by its light requisition etc.) (Canal and Özalp, 1987). Oak forests haven't been shown interest in Turkey and they are under pressure of intense and irregular usage because of either their wood properties or local needs. Because of these reasons most of the oak forests have been damaged. The extent of this damage has even reached to digging up of roots under soil (Sabuncu, 2002).

The coppices are silvicultural systems which are still widely abundant in European Mediterranean countries and cover an area of almost 23 million hectares (Anon., 2000). The coppices in Turkey cover an area of almost ¼ of total area (5749152 ha) covered by coppices in European Mediterranean countries but most of this area (4068146 ha) is unproductive. Mean growing stock and mean annual increment in this unproductive coppices are 5.615 m^3/ha and 0.165 m^3/ha/year. Therefore, coppices should immediately be rehabilitated (Anon, 2005). Although the management goal of the coppices in Turkey has been described as producing mine pole, fuel wood, wood coal, etc. it has been applied only for producing fuel wood in practice. The coppices are also widely used for grazing, and the utilization of branches and leaves in Eastern and South Eastern Regions of Turkey. The rotation length of the coppices varies between 3-8 years to 40-60 years but it is usually assumed as 20 years (Saraçoğlu, 1999).

The principal function of the oak coppices in Turkey has been the reduction of human pressure on forests and the provision of fuel wood from these sites has minimized the pressure on the other forests. The oak coppices have lost importance due to the changes in socio-economic structure and the migration of forest villagers to big cities for quality life. This situation has reinforced the opinions about the converting these coppices into high forest. The consideration, the converting of the coppices into high forests, entered into forestry area in 1940's. Although the opinion of converting all of the coppices into high forests in 40 years, no success has been reached since social and economical factors were taken into account. Despite not being the result of silvicultural interferences, intense migrations to cities have minimized the pressure on the coppices and thus sprout forests naturally got old and looking like high forests have formed in several regions of Turkey (Sıvacıoğlu, 2001).

Converting coppices into high forests with continuous cover has often been established during the last decades as a management goal in hilly and mountainous Mediterranean areas to attenuate the negative effects that frequent clear cutting may have on soil, landscape and biodiversity conservation (Ciancio et al., 2006). Therefore, studies are generally focused on silvicultural treatments (Amorini et al., 1997; Serada et al., 1998; Cañellas et al., 1998).

In Turkey, oak coppices were completed their social and economic functions into time and management goals were changed. These forests are under construction for high quality wood production and environmental services. Therefore, the determination of the changes in total wood production and in net income by converting oak coppices into high forest stands having sprout origin composes the aim of this study.

2. MATERIAL AND METHOD

Material and the method used for the comparison of coppices with sprout-origin stands in terms of total wood production and net revenue are presented below.

Study area: The working area belongs to Bartın Forestry Management Branch of Zonguldak Forestry District Management. It is on 41°18'29"- 49°51'01" northern latitude and 32°06'33" - 32°46'37" longitude. The total area of the branch composed of 11 management units is 175134.1 ha. 90376.4 ha of this area are forested and the rest, 84757.7 ha, is composed of open area.

Oak coppices and sprout-origin oak stands in Bartın Forestry Management Branch were determined before starting the study. It is desired that high forest and coppice stands are within the same site in order to be suitable for evaluation.

Since it has been observed that the stands in Duzmese region of Yenihan Forestry Management Office had properties desired the region has been chosen as working area. The area has a mean altitude of the area is 540 m, the slope between 0% and 30%. It is usually in North (N) and Northwest (NW) exposure groups. Coppices and sprout-origin high forest stands are side by side in the region.

Climate data: Black sea climate is dominant in the research area. In this type of climate having rainfall almost in every season, summers are not very hot and winters are warm. Proximity of working area to sea and parallel position of mountain ranges to coast cause decrease in temperature differences, increase in moisture and influence of air streams coming from Balkans to the region.

The data of last 27 years obtained by meteorological station in Bartın has been used to reveal the climate properties of research area. According to these data average annual temperature is 12.5 °C. The minimum average temperature is seen in January. The average temperature of this month is 4.1 °C (Anon, 2004a).

Annual rainfall is 1097,9 mm in the research area where there are rainfall in almost all seasons. This reaches to 1200mm in higher parts. Maximum rainfall is seen in autumn. The amount of rainfall in autumn is 336 mm. The least amount of rainfall is seen in spring by 176,5 mm. (Anon, 2007).

Experimental data: During field work 50 sample plots which have a dimension of 10*15=150 m^2 in coppices and 20*20=400 m^2 in high forests have been taken into account. 30 of sample plots are coppice stands and 20 of it are sprout-origin high forest stands. The diameters at breast height and heights of the individuals in sample plots have been attempted to be measured in mm and cm sensitivity, respectively. In order to assess the development of product types depending on the age mean tree according to basal area has been strived to be cut as sample tree. It has been paid attention to the selection of the trees so that they are dominant individuals and have no defects. Sample trees have also been used in the determination of the age of the sample plots.

Distribution of the number of prescribed sample plots to the places where they are as comparative to their areas is aimed in yield researches. For this purpose, sample plots from the coppices and sprout-origin oak stands having suitable density and where there are also individuals from age groups have been taken and measurements have been performed. The sample plots have been selected from same site class (IV), same slope group and dominant exposure to make comparison possible.

The determination of amount of product types: In sample plots, it has been attempted to cut a tree which can represent the area best. It has been paid attention to the selection of dominant trees having no defects. The trees chosen to perform stem analysis have been cut and divided into 2m-sectionss. Disks have been taken for 0.30 m heights and midpoints of 2 m-sections. Section volumes are calculated by Intermediate Surface (Huber) formulae. The volume of remaining end part of 2 m-section has been calculated as a cone by the help of base diameter and length of that part. Amounts of product types have been determined by using sample tree cut for stem analysis and correlated by age. Both the development of the amount of product types of single trees and the whole tree volume have been modeled with respect to age by regression equations.

Determination of the age-tree number and age-stem volume relationships: The age-tree number relationship has been found by associating the number of trees in a hectare obtained from the measurement of coppices and sprout-origin high forest stands with stand age. Since stand ages vary between 20 and 30 in coppices and 60 and 80 in high forests, the numbers of trees for the ages of 30-60 and 80-100 have been taken from regression equation suitable to growth laws. Stem volumes according to age in a hectare have been found by multiplying the numbers of trees in a hectare by values obtained from the equation of age-single trees volume equation. Volumes for 100+ years hectare has been taken from yield table developed by Eraslan-Evcimen (1967) for sprout-origin oak stands since the sample plots data does not cover these ages. Because values in the table are close to values determinated for young ages in this study, it has been assumed that the case is the same for 100+ years.

Wood prices and production costs for oak: Current prices for 2007 have been taken from Forest Service.

Table 1. Wood prices and production costs for oak

Yield Sorts	Wood Prices ($/m³)	Production Costs ($/m³)			
		Felling	Skidding	Loading	Transportation
Mine prop	63.35	3.83	1.6	1.75	4.22
Fuel wood	33.35	1.83	0.8	0.78	1.9

15 % of total production costs have been accepted as management costs.

Net Present Value (NPV): The selection of the suitable method is required since these two investment alternative will be subjected to commercial profitability analysis and compared. In commercial profitability analysis, criteria like net present value, internal rate of return and net cost benefit ratio which take time into account are used. Net present value criterion has been utilized in this study.

Annual or periodic cost and benefit flows formed during the economical life of a project are reduced into present values with a prescribed discount rate in this criterion. If NPV has a positive value then this means that the project is acceptable (Isguden, 1980; Davis and Johnson, 1987).

NPV can be formulated as:

$$NBD = \sum_{t=0}^{t=n} Ft.dt - \sum_{t=0}^{t=n} Mt.dt \tag{1}$$

Ft = benefit at the year t, *Mt*= cost at the year t, *n* = Economic life of the project, *dt* = discount factor.

In projects the biggest NPV is selected provided that it is a positive value. Top to bottom order is followed in ordering the options according to profitability.

Net Present Value criterion takes the time value of money into account by reducing net cash flows in different periods. In calculation of NPV determination of appropriate discount rate is highly important. The discount rate in commercial profitability analyzes is capital cost of resources used in financing of the project or minimum profitability expected by entrepreneur from the project. As the studies about the evaluation of forestry investments is examined various discount rates changing between 3 % and 9 % are common (Speidel, 1967; Price, 1988; Tunaka, 1991; Kocer, 1999). In this study discount rates are taken as 4 % and 7 %.

3. FINDINGS

Amounts of product types: The amount of single tree product types for oak stands (site class of IV) has been modeled by using measurements performed on sample trees. The most significant problem in determining oak single tree product type distribution is that the trees in same site classes have very different diameters at breast height at the same ages. This situation affects the product types and causes coefficients to be relatively low in regression analyzes. The equations modeling the development of oak product types of IVth site class according to the age are given below. Furthermore, the development of product types with respect to age is presented in Figure 1.

Fuel wood: $y = 5E\text{-}09x^4 - 8E\text{-}07x^3 + 3E\text{-}05x^2 + 0.0003x - 0.0033$, $R^2 = 0.479$ (2)

Industrial wood: $y = 2E\text{-}05x^2 + 0.0027x - 0.1011$, $R^2 = 0.7727$ (3)

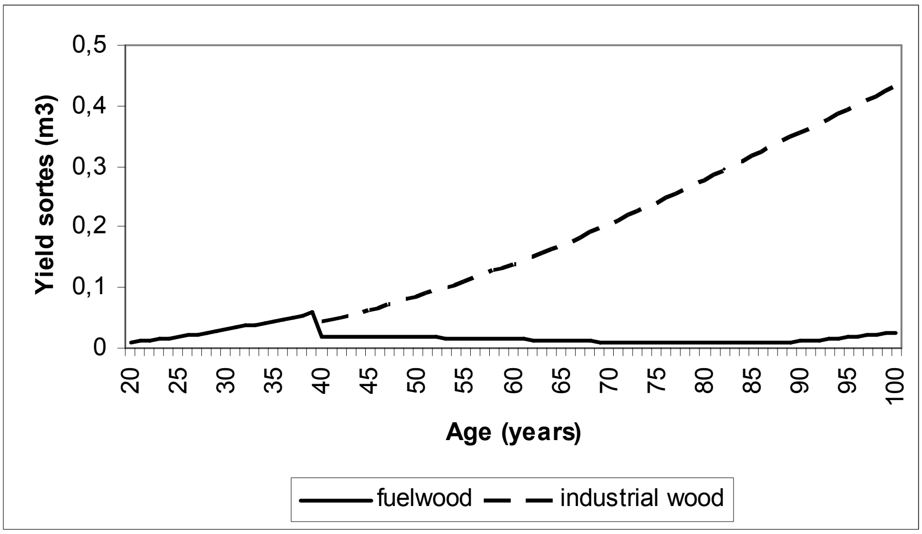

Figure 1.The amount of single tree product types of IVth site class.

The age-tree number and age-stem volume relationships in a hectare: In determining the age-tree number relationship, the numbers of trees in a hectare obtained by the measurement of coppices and sprout-origin high forests stands have been correlated by stand age. The age of mean tree according to basal area and the number of trees determined in sample plot have been converted into hectare and fitted to the coordinate system. Since stand ages vary between 20 and 30 in coppices and 60 and 80 in high forests, the numbers of trees for the ages of 30-60 and 80-100 have been taken from regression equation suitable to growth laws. The equation is given below and the relationship is as it is shown on Figure 2.

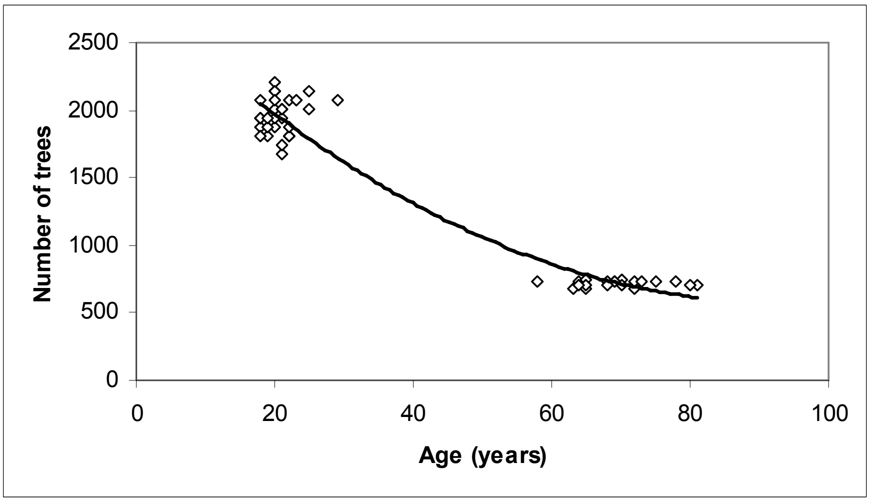

Figure 2. Age-number of trees relationship.

$$y = 0.2636x^2 - 48.874x + 2843.6,\ R^2 = 0.9467 \tag{4}$$

Stem volumes in hectare with respect to age has been found by multiplying the number of trees by volume found from age-single tree stem volume equation. The age-stem volume values from stem analysis have been modeled by fitting into the coordinate system. The equation showing the relationship is given below. The development of single tree green-volume is shown on Figure 3.

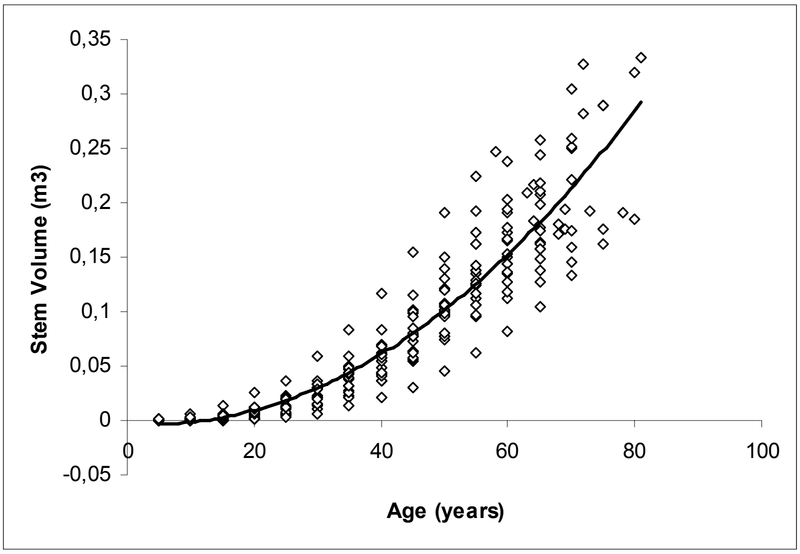

Figure 3. The age-stem volume relationship

$$y = 5E\text{-}05x^2 - 0.0004x - 0.0021,\ R^2 = 0.8738 \quad (5)$$

Wood production in coppices and sprout-origin high forest stands and net revenues: The comparison of coppices and high forest stands have been carried out by comparing the amounts of wood produced in a certain period and net present values obtained in various rotation lengths. The probable product amounts for each alternative have been compared for 200 years which is the rotation length for oak and this comparison has been stated in terms of wood production function. Intermediate and final yield amounts have been taken from yield table prepared for sprout-origin oak stands by Eraslan-Evcimen (1967). Four different rotation lengths have been prescribed for coppice stands. The comparison made is given in Table 2.

Table 2. Expected total amount of products in 200-year period(m^3/ha).

High Forest			**Coppices**			
Rotation Length (RL) = 200 years			**Final Yield (m^3)**			
Years	**Maintenance Yields (m^3)**	**Final Yield (m^3)**	**RL=20 years**	**RL=30 years**	**RL=40 years**	**RL=50 years**
20	8.00		19.51			
30	17.50			49.89		
40	27.00		19.51		81.11	
50	22.00					108.96
60	17.00		19.51	49.89		
70	19.00					
80	21.00		19.51		81.11	
90	21.50			49.89		
100	22.00		19.51			108.96
110	20.75					
120	19.50		19.51	49.89	81.11	
130	16.00					
140	12.50		19.51			
150	11.75			49.89		108.96
160	11.00		19.51		81.11	
170	9.75					
180	8.50		19.51	49.89		
190	7.25					
200	6.00	420.5	19.51	19.51	81.11	108.96
	298.00	**420.50**				
TOTAL	**718.50**		**195.10**	**318.86**	**405.50**	**435.84**

Then both alternatives have been compared for a period of 100 years in terms of product range, total amount of production and net present values. Four different rotation lengths have been prescribed for coppice stands. The comparison of both alternatives is given in Table 3.

Table 3. Total amount of production (m^3/ha) and net present values expected ($/ha) in 100-year period.

COPPICES												HIGH FOREST				
Rotation Length=20 years			Rotation Length=30 years			Rotation Length=40 years			Rotation Length=50 years			Rotation Length=100 years				
													Maintenance Yields		Final Yield	
Years	Fire wood	Indust. wood	Years	Fire wood	Indust. wood	Years	Fire wood	Indust. wood	Years	Fire wood	Indust. wood	Years	Fire wood	Indust. wood	Fire wood	Indust. wood
20	19.51		20			20			20			20	8			
30			30	49.89		30			30			30	17.5			
40	19.51		40			40	23.98	57.13	40			40	8.1	8		
50			50			50			50	19.00	89.95	50	3.7	17.5		
60	19.51		60	49.89		60			60			60	1.5	8.1		
70			70			70			70			70	0.9	3.7		
80	19.51		80			80	23.98	57.13	80			80	0.4	1.5		
90			90	49.89		90			90			90	0.6	0.9		
100	19.51		100			100	19.51		100	19.00	89.95	100			20	380
Total	97.55			149.67			67.67	114.26		38.00	179.90		40.7	112.3	20	380
PNV i:0.04	530.36			716.93			1107.00			1013.05			1531.21			
PNV i:0.07	224.32			250.01			313.35			221.52			347.61			

4. DISCUSSION

The principle aim of the coppices having a significant role in forest area of Turkey has been to reduce negative effects of people living in and/or near to forest area on forest ecosystem and make it focus on certain areas. Because of the industrialization and the migration to big cities to increase life quality rural population has been being decreased significantly. The coppices got rid of negative effects of forest villagers have turned into high forest stands without any interference. This has reinforced the opinion about converting the coppices into high forests. The working area covers an abandoned area.

As seen in Figure 1, in a sprout-origin oak stands of IVth site class there has been no saw log formation in a rotation length of 100 years. It can be observed that industrial wood has no formation before 40 years. Fuel wood shows increase until the age of 40 and then has a tendency to reduce after that age. No commercial saw log formation has been observed until the age of 100 among the measured trees in the sample plot.

When the rotation length is increases total wood product efficiency also increases as seen in Table 2. It can be seen that the highest wood product efficiency is in high forest stands. While a total of 718.50 m^3 product can be provided from a high forest stand within a 200-year rotation length, this amount is 195.10 m^3 from a coppice having 20-year rotation length, 318.86 m^3 from a coppice having 30-year rotation length, 405.50 m^3 from a coppice having 40-year rotation length and 435.84 m^3 for a coppice having 50-year rotation length. High forest stand has a production capacity 282.66 m^3 more than the coppice having 50-year rotation length for the same period. Furthermore, in a 100-year period high forest stand has much more wood production capacity than coppice alternatives.

Net Present Values (NPV) at the end of 100-year rotation have been calculated separately over two different discount rates (4 % and 7 %) by using expenditures and income data during that time. At the end of the calculations made by a discount rate of 4 % it has been seen that a discounted net revenue of 1531.21 $ from high forest stand, 530.36$ from coppice having 20-year rotation length, 716.93 $ from coppice having 30-year rotation length, 1107.00 $ for coppice having 40-year rotation length and 1013.05 $ from coppice having 50-year rotation length can be provided. When the calculation is made for a discount rate of 7 % it can be seen that a discounted net revenue of 347.61 $ from high forest stand, 224.32 $ from coppice having 20-year rotation length, 250.01 $ from coppice having 30-year rotation length, 313.35 $ for coppice having 40-year rotation length and 221.52 $ from coppice having 52-year rotation length can be provided. It can be observed that 40-year rotation length alternative has the highest profitability among coppices.

It has been concluded that high forest stands are far more effective than coppice stands in the aspect of both wood production and net revenue obtained. It can be expected that this effectiveness would increase at better site classes. As the efficiency increases increase in effectiveness can be expected. By converting coppices into high forests, significant amount of increases can be provided in revenue and atmospheric carbon amount kept.

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