Factors for converting hazelnut (*Corylus avellana L*) into black alder (*Alnus glutinosa Yalt.*) plantations

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Abstract: Hazelnut plantations, which are a major source of income for the villagers in the eastern Black sea region are not able to provide sufficient income to the villagers due to price fluctuations and sudden falls witnessed in recent years. Alternative investments in place of hazelnut cultivation are being investigated in order to prevent migration to urban areas and to increase the welfare of the rural population in the region. Black alder plantation investments have been assessed as one of the most essential alternative investment tools within the framework of the study. Assessment was carried out by comparing expected possible net present values (NPV). Although value increase occurs 12-18 years later, more income can be obtained through black alder than hazelnut plantation. In hazelnut plantations, the best NPV emerged in the lower zone. NPV was positive in the moderate zone but values were close to zero. In upper zone, positive NPV couldn't emerge. As a result, it was understood that black alder plantation investment is an effective alternative for hazelnut plantations.

Introduction

Alnus glutinosa, *Gaertn.subsp.barbata* (C.A.Mey.) which is a member of the Alnus species and part of the Betulaceae family comprising 36 species (Krstinic, 1994), is one of the most significant tree species of the Black sea region, and it is also a fast growing one. It provides products within a short period of time which are suitable for industry.

Due to an expansion of world population and the increasing variety of human needs, the demand for wood raw material is also increasing. It is possible to meet this demand in Turkey through plantations of fast growing domestic and exotic species especially with the calabrian pine, crimean pine, poplar and black alder, thus these species have been studied effectively (Misir *et al.,* 2007; Sevgi and Akkemik, 2007). Besides meeting the demand of factories that process materials of smaller diameters, black alder is invaluable for the region in terms of meeting traditional wood raw material needs, conservation of soil and prevention of erosion because of the high slopes in the region. More importantly, reducing the social pressure and consequently destruction of natural forests in the eastern Black sea region is one of the most crucial decisions (Ayan *et al.,* 1998).

Much research has been carried out on the botanic, anatomic, palinologic and technologic characteristics as well as expansion of silvicultural and ecologic demands of black alder (Gursu, 1967; Eyupoglu, 1975; Merev, 1983). As Ayan *et al.* (1999) have stated, the highest productivity was achieved in 3.2X2.8 plantation density. Atasoy and Kucuk (1986) and Ayan *et al.* (2006) indicated that

production of saplings through seeds is easier and cheaper as compared to the production of saplings through cutting. Guller and Ay (2001), analyzed the mechanical characteristics of black alder, and stated that it is suitable for plywood, particle board, packing, tool handles, and furniture. Ayan *et al.* (1998), defined the appropriate planting environments for provinces in the eastern and central Black sea regions. Ayan *et al.* (2001) compared hazelnut, tea and black alder cultivation and suggested hazelnut and tea cultivation are more appropriate for lower than 500 m and black alder is more appropriate for higher than 500 m.

Hazelnut (*Corylus avellana* L.) has been cultivated for its delicious nuts for years. It likes warm weather and needs good soil. It can be planted even at heights of 1700-1800 m among shrubs and in wet sites. It is cultivated along the Black sea coastal area and it also grows naturally. Due to the fact that hazelnuts have been an important source of income for the villagers in the eastern Black sea region, it has been a topic for research until to the present day. Uzun (1999) analyzed the socio-economic structure of the families engaged in hazelnut cultivation in Giresun Province. Kaya (1986) analyzed production techniques and assessed marketing strategies. Kaya (1993) defined the methods to be used in hazelnut yield estimations. Kaya and Caliskan (1999) searched the minimum business size in hazelnut agriculture and suggested that there needs to be a 2,4 ha plantation in lower zones, a 3,4 ha in moderate zones and a 5 ha in upper zones provided that it is supported by vegetable cultivation and husbandry. Reis and Yomral ioglu (2006) have detected current and potential hazelnut plantation areas using geographical information system (GIS).

Both the hazelnut and black alder develop best in areas with sufficient soil moisture, in Dafnetum and Castenatum forest zones (0-600 m). Hence the environments of the two species overlap, thus providing alternative cultivations.

Hazelnut is the major agricultural product in the eastern Black sea region and the population in this region subsists on it. The instability of hazelnut prices seen in recent years has made it necessary to search for alternative activities, which is the aim of the present study.

Materials and Methods

The development of stands and determination of black alder wood product types: Sample tree measurement values were used in defining single tree product types (Saracoglu, 2000) and also some additional measurements were taken. Sample trees were cut from 20 sample areas located within the hazelnut cultivation belt which is between 0-960 m in the coastal belt between Giresun and Artvin provinces. In order to determine the expansion of product types, 115 sample trees were cut from Site class I, and 172 sample trees were cut from Site class II and the necessary measurements were taken. The slope ranges between 0-53% and canopy closure ranges were between 0.7-1.1. Moreover, studies were made on the expansion of sample areas according to various aspects and field structures.

Plantation related expenses: Acquisition of the data about these expenses and values are given in Table 1. Periodic expenses were taken from valid market prices as referred by the General Directorate of Izmit Research Institute of Poplar and Fast Growing Forest Trees (Birler, 1996).

Plantation related price values: The income obtained from a plantation is the income acquired through the sale of cut wood raw material of middle yields and final yields. The values were taken from the average of 2007 auction sale prices of the General Directorates of Forestry in the eastern Black sea region. Black alder principally produces third class sawn logs and industrial wood. Neither 1st nor 2nd class logs nor the sale of mine-polls are seen in the sale data obtained from sale reports of General Directorate of Forestry (2007).

Income and expenses of hazelnuts and their financial values: Unit values of expenses and subsidiary incomes, are given below. Unit amounts were collected from publications of the Giresun Research Institute of Hazelnut and unit prices were collected from market values (Table 2).

The main income belonging to hazelnut is composed of annual sales of hazelnut. There is an important imbalance among the prices of hazelnut products on the market. The prices given by free market, and state institutions and autonomous institutions were analyzed and $3.5 per kg was seen consistent and this was taken as a basis in calculations. Hazelnut productivity in each decare changes according to altitude. The dissemination area of hazelnut was divided into three zones vertically by the Hazelnut Research Institute by taking into consideration approximately 300 m altitude differences. These were named as lower, moderate and upper zones. The average productivity

Table - 1: Plantation (black alder) related costs

Type of expense	Unit cost ($ ha⁻¹)	
	0-30 % slope	31-60 % slope
The expenses of plantation establishment	1717.25	1901.83
The expenses of maintenance	702.08	937.99
Periodical costs	26.58	31.41
Mid-yield (1st thinning)	855.41	959.79
Mid-yield (2nd thinning)	744.16	767.91
Final yield (Clear felling)	1895.62	2079.58

Table - 2: Unit values of expense items and subsidiary incomes, and also the amount of incomes and expenses (black alder)

Type of expense	Amount ($ ha⁻¹)
Breeding expenses	975
Yield expenses	1185.41
General management expenses (3% of breeding and yield expenses)	64.75
Subsidiary income of hazelnut product	
Wood income obtained from pruning	62.5
Hay income obtained in hazelnut grove clearing	100
Other income (Fruits *etc.*)	25

Table - 3: Hazelnut NPV in terms of altitude zones (4%) ($ ha⁻¹)

Years	Lower zone	Moderate zone	Upper zone
5	1507.35	79.39	-2099.03
10	2745.53	144.64	-3824.29
15	3763.57	198.28	-5242.32
20	4600.32	242.35	-6407.84
25	5288.07	278.59	-7365.81
30	5853.35	308.37	-8153.20

of hazelnuts is 1068 kg ha⁻¹ for lower zones, 733 kg ha⁻¹ for moderate zones and 487 kg ha⁻¹ for upper zones (Kaya, 1993).

It is necessary to choose an appropriate method since these two investment species will be compared according to their commercial profitability. In the commercial profitability analysis, the criteria of net present value, internal rate of return, net benefit cost ratio are commonly utilized (Price, 1988; Tunaka, 1991). Net present value criteria were utilized in our study.

Net present value (NPV): In this criterion which takes into consideration the time value of money, annual and periodical benefits and cost trends emerging during the economic life span of a project, are degraded into present values through a definite discount value. If NPV is positive, the project is in an acceptable state (Isguden, 1980; Davis and Johnson, 1987). NPV criterion can be defined with the following formula :

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

Benefit in *Ft* = t year, cost in *Mt*= t year, *n* = economic life span of the project, *dt* = discount factor.

Table - 4: The change of NPV(4%)($ ha^{-1}) according to the options of site, management period, way of intervention and slope groups

Management period	No thinning is carried out				Thinning is carried out			
	Site class I		Site class II		Site class I		Site class II	
	0-30%	31-60%	0-30%	31-60%	0-30%	31-60%	0-30%	31-60%
12	1455.93	779.18						
13	2549.53	1874.29	2533.19	1857.954				
14	3693.66	3019.88	3480.29	2806.518				
15	4856.70	4184.32	4746.95	4319.415	2682.51	1883.22	2880.53	2081.24
16	6060.10	5389.07	6013.60	5342.575	3285.60	2487.66	3394.60	2596.65
17	7281.38	6611.65	7042.59	6372.867	3896.90	3100.26	3911.70	3115.06
18	8512.69	7844.20	8061.05	7392.573	4512.61	3717.21	4423.16	3627.76
19	9746.90	9079.60	9076.51	8409.233	5129.33	4335.13	4932.67	4138.47
20	10980.03	10313.90	10081.18	9415.042	5745.03	4951.98	5436.38	4643.33
21	12201.41	11536.38	11066.38	10401.36	6354.50	5562.56	5930.20	5138.26
22	13400.53	12736.58	12033.82	11369.86	6952.69	6161.81	6414.81	5623.94
23	14588.89	13925.95	12976.03	12313.08	7545.17	6755.32	6886.65	6096.80
24	15756.28	15094.33	13899.60	13237.65	8127.01	7338.14	7349.02	6560.16
25	**16887.97**	**16226.97**	**14795.18**	**14134.18**	8690.95	7903.03	7797.25	7009.34
26					9244.45	8457.45	8230.57	7443.56
27					9777.59	8991.45	8652.23	7866.09
28					10294.48	9509.18	9058.13	8272.84
29					10796.11	10011.63	9446.06	8661.59
30					11275.76	10492.05	9819.16	9035.46
31					11734.98	10952.03	10173.58	9390.62
32					12174.84	11392.61	10512.33	9730.10
33					12594.11	11812.57	10836.02	10054.48
34					12992.53	12211.65	11141.10	10360.23
35					**13369.83**	**12589.59**	**11429.15**	**10648.91**

The project which has the highest NPV will be chosen among alternative projects provided that it is positive. A grading from highest to lowest is followed in accordance with the profitability of the choices.

Net present value criterion takes into consideration the time value of money by degrading net cash trends seen in different periods. It is very important to determine the discount rate or the degradation taken as data in a NPV calculation in an appropriate way. In commercial profitability analyses, a discount rate is the capital cost of the resources used in project financing or minimum profitability rate expected by the entrepreneur in the project. When the activities for the forestry investment assessment are analyzed, discount rates ranging between 3 and 9% are seen (Speidel, 1967; Price, 1988; Tunaka, 1991). The discount rate was taken as 4% in our study.

Results and Discussion

Determination of the amount of black alder wood product types: The number of single tree product types for Site class I and Site class II black alder stands were modeled through taken measurements. While determining the black alder single tree product types, the most important problem was that of trees belonging to the same site class with various diameters. This reflected the product types and caused coefficients of determination to be relatively low in regression analyses. The equations modeling the development of

black alder product types according to age in Site class I and Site class II.

Site class I

Whole tree: $y=0.001x^2-0.0074x+0.0315$, $R^2=0.85$

III class saw log: $y=0.0013x^2-0.0275x+0.299$, $R^2=0.87$

Industrial wood: $y=-0.0003x^2+0.0213x-0.1337$, $R^2=0.21$

Fuel wood: $y=0.000006x^2-0.0006x+0.0282$, $R^2=0.05$

Site class II

Whole tree: $y=0.0006x^2+0.0068x-0.0318$, $R^2=0.8$

III class saw log: $y=0.0002x^{2,3776}$, $R^2=0.62$

Industrial wood: $y=-0.0001x^2+0.0071x+0.0392$, $R^2=0.07$

Fuel wood: $y=0.000006x^2-0.0003x+0.0204$, $R^2=0.02$

Determination of NPV values in hazelnut groves: NPV calculations were carried out for 5-30 year period with a 4% discount rate for hazelnuts. These calculations were carried out in order to compare net incomes of black alder and hazelnut within the management period foreseen for black alder plantations. Both alternative investments were assessed in 1 ha areas. NPV of hazelnut were calculated separately for lower, moderate and upper zones due to their various production dynamic. These values are summarized below (Table 3).
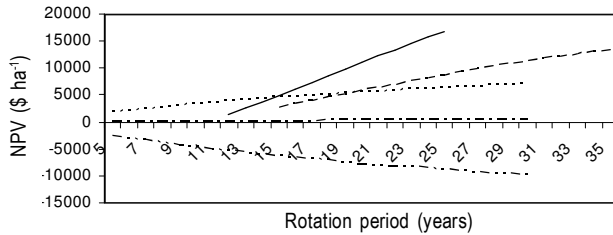
Fig. 1: Site class I, the comparisons of NPV expected from hazelnut and black alder plantations in 0-30% slope group
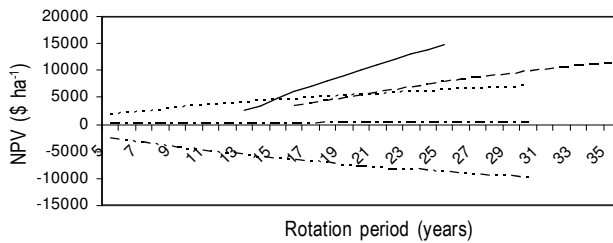
Fig. 3: Site class I, the comparison of NPV expected to be obtained from black alder and hazelnut plantations in 31-60% slope group

Fig. 2: Site class II, the comparisons of NPV expected to be obtained in hazelnut and black alder plantations in 0-30% slope group
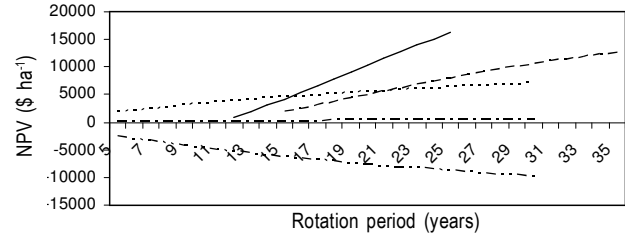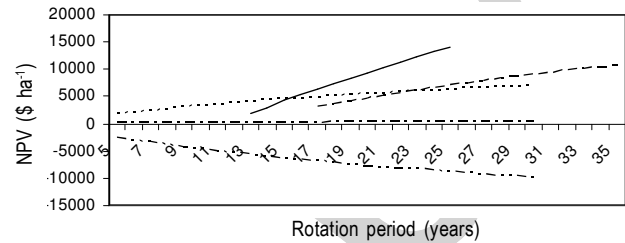
Fig. 4: Site class II, the comparison of NPV expected to be obtained from black alder and hazelnut plantations in 31-60% slope group
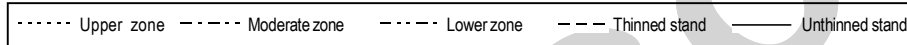
⋯⋯ Upper zone   — — Moderate zone   — ⋅ — Lower zone   — — Thinned stand   —— Unthinned stand

Determination of NPV values of black alder plantations: NPV calculations were made for the 12-25 years age range with a 4% discount rate for the option with no thinning. Calculations were carried out between the age when the trees to be able to give and the age when thinning was absolutely needed. Since thinning is absolutely necessary, especially in good sites after the age of 25 years, the ones which were older than 25 years were not calculated. Moreover, since wood from the sites where thinning was not carried out were only used as industrial wood, the quantity of logs and industrial wood were assessed as industrial wood. In the thinning option, the values were calculated from the age when each site class needs thinning to the age of 35 years. Two thinnings were foreseen for Site class I and Site class II between the age of 9 and 14 years with a 0.3 rate. It was thought that 1666 saplings were planted with a 3 m x 2 m distance within 1 ha. These thinnings were determined according to the procedure applied in plantations in Turkey. The change of NPV according to the options of site, management period, way of intervention and slope groups are given below.

In the beginning, the costs of hazelnuts were calculated for the management periods of black alder. Calculations were carried out separately for three altitude groups, the productivities of which vary. Relatively better, NPV emerged in the lower zone. In spite of the fact that a positive NPV emerged in the moderate zone, these values were very close to zero. It basically means that hazelnut breeding is undertaken without any income. There are negative NPV in the upper zone and growing hazelnuts in this zone means losing money. These outputs are similar to results from Ayan *et al.* (2001) that hazelnut cultivation are more appropriate for lower than 500 m and black alder is more appropriate for higher than 500 m.

When compared with hazelnut trees, more income can be obtained through black alder breeding in the same environment. However, this value increase occurs 12-18 years later. The net incomes obtained from hazelnut and black alder growing comparisons are given below in graphics (Fig. 1,2,3 and 4).

The net discounted income of black alder afforestation in Site class I and Site class II belonging to 0-30% slope and having no thinning is higher than the lower zone incomes providing the highest income at the age of 15 years for hazelnut trees. After that it increases gradually. The net discounted income of black alder afforestation in Site class I and Site class II belonging to 0-30% slope group is higher than the lower zone incomes which provide the highest income at the age of 20 years in hazelnuts. After that, it increases gradually.

The net discounted incomes of black alder afforestation in Site class I and Site class II belonging to 31-60% slope group and having no thinning are higher than the lower zone incomes providing the highest income at the age of 16 years in hazelnuts. After that it increases gradually. The net discounted incomes of black alder afforestation in Site class I belonging to 31-60% slope group and having thinning are higher than the lower zone incomes at the age of 22 years in hazelnuts. Also the net discounted incomes of black alder afforestation in Site class II are higher than the lower zones at the age of 24 years in hazelnuts. After this it increases gradually.

Once the hazelnut groves and black alder investments are compared, it is seen that black alder investments are more satisfying than hazelnut plantations. However, the benefit expected to be acquired from black alder emerges after a definite period of time. Namely, 10-30 years are needed in order to get the first income. This is the most important barrier faced by the villagers subsisting

on hazelnut when choosing black alder investments. Black alder is one of the most important options after the hazelnut, provided that this problem is overcome with various alternatives. Becoming a cooperative may be seen as an alternative on the way to solving this problem, and upcoming studies must be carried out in this respect.

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