FORESTRY

ECONOMIC ROTATION OF *DALBERGIA SISSOO* IN TEHSIL KHUSHAB

Khayyam Anjum, Ihsan Qadir, H. Masood Ahmad*, Madiha Saher, Shazia Afzal, Faiz Rasool**, Wasif Nouman***, Muhammad Talha Bin Yousaf** and Asif Ali****

*Lecturer, **Post graduate student, ****Research Assistant, Department of Forestry and Range Management, University of Agriculture, Faisalabad, Pakistan.
***Assistant Professor, College of Agriculture, Bahauddin Zakariya University, Multan, Pakistan.

ABSTRACT

This study was carried out in the Department of Forestry and Range Management, University of Agriculture, Faisalabad, Pakistan during the year 2014. Five villages of tehsil Khushab, Punjab were randomly selected. From each village, three trees having 1-15 years age each were randomly selected. Thus 45 trees were selected from each village making a total of 225 trees from 5 villages. Price of each standing tree was determined by the farmer and recorded through a short questionnaire. It was observed that trees of one year age were not salable, so the data regarding one year trees were omitted from the study. Remaining number of trees of all ages was 210. Three rotation options (15, 10+ 5 and 5+5+5) with the same life span (15 years) were tested using net present worth (NPW), benefit cost ratio (BCR) and return on investment (ROI) as economic tools. At a rotation of 15 years, NPW was Rs. 2039.05, BCR 449.59 and ROI, 44859.20 percent. At a rotation of 10+5 = 15 years, NPW was Rs. 2519.82, BCR 401.10 and ROI 40010.47 percent. At a rotation of 5+5+5 =15 years, NPW was Rs. 1578.92, BCR 401.10 and ROI 40010.47 percent. The rotation of 10+5 = 15 years was most profitable. So, farmers are advised to grow *Dalbergia sissoo* trees at a rotation of 10+5 =15 years on their farmlands.

KEYWORDS: *Dalbergia sissoo*; economic rotation; net present worth; benefit cost ratio; return on investment; Pakistan.

INTRODUCTION

In Pakistan, farmers grow trees on various rotations which are often economically unfit/less profitable. They usually fell the trees in accordance with their domestic needs. Impact of rotation on the net income received is usually not taken into account. Inflation, like other commodities affect the prices of trees significantly. Farmers, mostly being illiterate usually do not have the idea of economic rotation of trees, so they often face economic loss.

Ayazz *et al.* (4) studied two rotations of *Eucalyptus camaldulensis* using net present worth (NPW) as economic tool. At 21 years rotation NPW was found to be Rs. 5,211,669 per hectare. When a number of rotations were evaluated with total 21 years period, NPW jumped to Rs. 7,449,253 per hectare. It clearly showed that rotation has a significant impact on net income received from a tree or plantation. It may either increase or decrease with changing rotation period.

Jalota and Sangha (6) tested various rotations of *Paraserienthes* trees to find out best rotation for maximum net income. Three years rotation had NPW of -12000 Philippine Pesos while at six years rotation, NPW increased to 73320 Pesos. It is evident that at three years rotation, NPW was negative which became positive when rotation period was doubled (8).

Another study carried out on the economic rotation of *Eucalyptus camaldulensis* revealed that price per cubic foot of wood was Rs. 42.41 at a rotation of eight years. When rotation of six years was tested, NPW increased to Rs. 53.28 per cubic foot. It means that NPW increased when rotation period was decreased by 20 percent. Sometimes, net income increases when rotation is increased and sometimes when it is decreased.

Economic rotation of a hard wood forest was calculated in Queensland, United Kingdom (9). NPW was $ 2086 per hectare at a rotation of ten

years. At 20 years rotation, it declined to $ 860 per hectare. When rotation was set at 25 years, the cultivation of forest became more fruitful with NPW of $ 2300 per hectare.

A plantation of *Tectonagrandis* (teak) trees was subjected to economic analysis in Hawaii State of USA (3). NPW of $ 2713 on per acre basis was calculated for 35 years rotation period. Kamalia plantation was evaluated for economic purposes. The plantation was running in loss with a NPW of 0.014 million and return on investment 89.15 percent both with negative sign (1). In another study (7) *Cordia myxa* (Lasure) plantation was tested for various rotations. The plantation had NPW of 102.47 Mexican Pesos and benefit cost ratio 2.11 per hectare, at 40 years rotation period. The economic return increased at 60 years rotation. NPW jumped to 265 Mexican Pesos and BCR to 5.61. Similarly three rotations viz. 6 years, 3+3 years and 4+2 years were tested at tehsil and district Muzaffargarh, all with total span of 6 years. Single rotation of 6 years was found as the best with benefit cost ratio (BCR) of 295.89 and NPW of Rs. 1474.48 per tree (4).

For present study district Khushab was selected which comprises rainfed area and farmers grow mostly chickpea, maize, sorghum, etc. for income generation. Tree farming is also popular among the farmers as a source of secondary income. *Dalbergia sissoo* is popular tree species among the farmers for their farmlands. It is hard wood tree species which is used for making best quality furniture in addition to other uses. It is grown upto the age of 15 years in the area (5). Farmers are mostly unaware of the most profitable rotation of this most important hard wood species. Moreover, data on economic rotation of this timber plant is not available at tehsil level. Keeping in view this instantaneous need, present study was designed to test various rotations of *Dalbergia sissoo* to find out the most profitable rotation.

MATERIALS AND METHODS
This study was carried out in the Department of Forestry and Range Management, University of Agriculture, Faisalabad, Pakistan during the year 2014. Five villages of tehsil Khushab were randomly selected. Ten respondents/farmers having shisham trees on their farmlands were selected from each village through simple random sampling technique. Again three trees of each age ranging from 1-15 years were randomly selected from 10 respondents of each village. Thus 45 trees were selected from each village making a total of 225 trees from 5 villages/10 respondents. Data on age and price of each standing tree was determined / inquired from the farmer and recorded through a short questionnaire, as no other information was needed. The study was based on "profit maximization" from farm trees, so central object is "tree" while farmer is the profit/ money maker. In such farm tree "profit enhancing" projects, number of trees are more important than number of farmers. So, little number of farmers having more number of trees on their farm is considered to be the best respondents.

It is an established fact that farmers of Punjab province always sell standing trees. No doubt they often get a price less than the actual market value. They do not have necessary skill/expertise for harvesting and modifying wood into standard size logs/pieces/lumber that is necessary value addition for direct sale in market. So they have no way but to sell their trees in standing form. In addition, this process is time and resource consuming. Keeping these facts in mind, market price of trees was not recorded. It was observed that trees of one year age were not salable, so the data regarding one year trees was omitted from the study. Remaining number of trees of all ages was 210.

Average price of trees of each age from 1-15 years was calculated. Discounting was carried out at 10 percent interest/discount rate. Three rotation options (15, 10+ 5 and 5+5+5) with the same life span (15 years) were tested using NPW, BCR and return on investment (ROI) as economic tools (2) as described below.

Economic analysis

Discounting: Discounting was carried out to bring all values of cost and benefit stream at the same currency level. Discount factor was multiplied with the relevant values of cost and benefit stream to get present worth. Following formula was used to calculate discount factor for various years.

$$Discount\ factor = 1/(1+i)n$$

where

i = Discount rate
n = Number of year, for which discount factor is to be calculated (1 for 1st year, 2 for 2nd year and so on).

Net present worth (NPW) and benefit cost ratio (BCR): NPW was calculated using the following formula:

$$NPW = -C0 + C1 /1+r + C2/ (1+r)\ 2 +-------+$$
$$CT/ \quad (1+r)\ T$$

-C0   =   Initial investment
C   =   Cash flow
R   =   Discount rate
T   =   Time

The project with positive NPW was acceptable and vice versa.

BCR = Discounted benefits/Discounted costs

The project with BCR of 1 or more was acceptable and vice versa.

Return on investment:

ROI (%) = [(Gross benefits- total   cost)/total cost] x 100.

The project with positive ROI was acceptable and vice versa.

At the end, comparison of various rotation options was made to find out the best/most profitable rotation. Sensitivity analysis was also carried out by decreasing benefits/income by 10 and 20 percent, respectively. As the costs were very small, so sensitivity analysis by increasing costs was not carried out.

RESULTS AND DISCUSSION

The data (Table 1) showed that average price of tree of *Dalbergia sissoo* of 15 years of age was Rs.8536.67. Ten years old tree had average price of Rs. 5760.67 while 5 years tree had average price of Rs. 1274.66.

Present worth of benefits of *Dalbergia sissoo* at a rotation of 15 years was Rs.2043.61 while cost was Rs. 4.54 (Table 2). NPW was Rs. 2039.05, BCR 449.59 and ROI 44859.20 percent. The cultivation of *Dalbergia* trees at 15 years rotation is economically beneficial and acceptable as NPW is positive, BCR is more than 1 and ROI is also positive. These results are comparable with earlier findings (4) where cultivation of *Eucalyptus camaldulensis* at 21 years rotation was economically feasible with NPW of Rs. 5,211,669 per hectare. Although, two tree species and rotation are different but it is obvious that trees at 15 or more than 15 years rotation may have positive net present worth, a pre-requisite for the acceptance of an economic project.

Present worth of benefits of *Dalbergia sissoo* at a rotation of 10+5 =15 years was Rs.2526.13 while cost was Rs. 6.29 (Table 3). NPW was Rs. 2519.82, BCR 401.10 and ROI 40010.47 percent. It is evident that rotation of10+5=15 years is economically acceptable as NPW is positive, BCR is more than 1 and ROI is also positive. These results are comparable with earlier findings (9) where economic rotation of a hard wood forest in Queensland, United Kingdom was collected. NPW of $ 860 per hectare at a rotation of 20 years. Although was noted two studies differed in terms of tree species but both have positive NPW at the tested rotations.

Table 1.   Price of trees of various ages of *Dalbergia sissoo* (Rs.)

S. No.	Age (years)						
	2	**3**	**4**	**5**	**6**	**7**	**8**
1.	430	830	830	1230	1430	1540	1730
2.	400	900	990	1190	1600	1600	1600
3.	480	880	880	1180	1400	1700	1400
4.	880	980	980	980	1480	1650	1880
5.	800	990	1000	1000	1300	1600	1300
6.	790	890	1190	1290	1490	1500	1890
7.	900	1000	1000	1300	1590	1590	1890
8.	880	980	1100	1200	1700	1700	1800
9.	820	820	920	1320	1520	1520	1820
10.	980	980	980	1380	1480	1480	1880
11.	900	900	1120	1320	1320	1675	1920
12.	870	970	1170	1370	1670	1670	1870
13.	920	820	1190	1390	1790	1790	1900
14.	980	980	980	1480	1680	1680	1770
15.	890	990	1190	1490	1490	1490	1690
Average	794.66	927.33	1034.67	1274.66	1529.33	1612.33	1756.00
	9	**10**	**11**	**12**	**13**	**14**	**15**
1.	3230	6500	5700	7500	8430	8500	9430
2.	3100	5100	5100	5100	7100	7100	8100
3.	2900	5900	6900	6900	6900	6900	7900
4.	2880	6880	6880	7880	7880	7880	7880
5.	2300	5300	6300	6300	7300	7300	7300
6.	2890	4890	4890	6890	8890	8890	8890
7.	3890	5890	6890	6890	8890	7890	8890
8.	2800	6800	6800	6800	8000	8800	8200
9.	2820	4820	4820	7820	8020	8820	8620
10.	2880	6880	7880	7880	8080	8880	8480
11.	2920	5920	6920	6920	8920	8920	8820
12.	2870	4870	4870	6870	8070	8870	8670
13.	2900	4900	6900	6900	7900	8900	8900
14.	2770	6770	6770	7770	7070	7770	8070
15.	1990	4990	4990	7990	7900	7990	9900
Average	2876.00	5760.67	6294.00	7094.00	7956.67	8227.33	8536.67

Table 2.   Present worth of benefits, cost, net present worth, benefit cost ratio, and return on investment of *Dalbergia sissoo* at rotation of 15 years

Age	Costs (Rs.)	Benefits (Rs.)	D. F.	PW benefits (Rs.)	PW costs (Rs.)
1.	5	0	0.90	0	4.54
2.	0	0	0.82	0	0
3.	0	0	0.75	0	0
4.	0	0	0.68	0	0
5.	0	0	0.62	0	0
6.	0	0	0.56	0	0
7.	0	0	0.51	0	0
8.	0	0	0.46	0	0
9.	0	0	0.42	0	0
10	0	0	0.38	0	0
11.	0	0	0.35	0	0
12.	0	0	0.31	0	0
13.	0	0	0.28	0	0
14.	0	0	0.26	0	0
15.	0	8536.66	0.23	2043.61	0
Total		8536.66	-	2043.61	4.54
NPW (Rs.)	2039.05				
BCR	449.59				
ROI (%)	44859.20				

Table 3. Present worth of benefits, cost, net present worth, benefit cost ratio, and return on investment of *Dalbergiasissoo* at rotation of 10+5 = 15 years

Age	Costs (Rs.)	Benefits (Rs.)	D. F.	PW benefits (Rs.)	PW costs (Rs.)
1.	5	0	0.90	0	4.54
2.	0	0	0.82	0	0
3.	0	0	0.75	0	0
4.	0	0	0.68	0	0
5.	0	0	0.62	0	0
6.	0	0	0.56	0	0
7.	0	0	0.51	0	0
8.	0	0	0.46	0	0
9.	0	0	0.42	0	0
10.	0	5760.66	0.38	2220.98	0
11.	5	0	0.35	0	1.75
12.	0	0	0.31	0	0
13.	0	0	0.28	0	0
14.	0	0	0.26	0	0
15.	0	1274.66	0.23	305.15	0
Total			-	2526.13	6.29
NPW (Rs.)	2519.82				
BCR	401.10				
ROI (%)	40010.47				

Present worth of benefits of *Dalbergia sissoo* at a rotation of (5+5+5 =15 years) was Rs.1588.044 while cost was Rs.9.12 (Table-4). NPW was Rs. 1578.92, BCR 174.12 and ROI 17312.20 percent. This rotation is also found economically acceptable as NPW is positive, BCR is more than 1 and ROI is also positive. These results are comparable with previous findings (3) where a *Tectonagrandis* (teak) plantation was economically analyzed in Hawaii State of USA. NPW of $ 2713 on per acre basis for 35 years rotation period was noted.

Table 4. Present worth of benefits, cost, net present worth, benefit cost ratio, and return on investment of *Dalbergia sissoo* at rotation of 5+5+5 = 15 years

Age	Costs (Rs.)	Benefits (Rs.)	D. F.	PW benefits (Rs.)	PW costs (Rs.)
1.	5	0	0.90	0	4.54
2.	0	0	0.82	0	0
3.	0	0	0.75	0	0
4.	0	0	0.68	0	0
5.	0	1274.66	0.62	791.46	0
6.	5	0	0.56	0	2.82
7.	0	0	0.51	0	0
8.	0	0	0.46	0	0
9.	0	0	0.42	0	0
10.	0	1274.66	0.38	491.44	0
11.	5	0	0.35	0	1.75
12.	0	0	0.31	0	0
13.	0	0	0.28	0	0
14.	0	0	0.26	0	0
15.	0	1274.66	0.23	305.14	0
Total			-	1588.044	9.12
NPW (Rs.)	1578.92				
BCR	174.12				
ROI (%)	17312.20				

Economically, best rotation was found to be 10+5= 15 years with NPW Rs. 2519.82, BCR 401.10 and ROI 40010.47 percent per tree (Table-5). The rotation with minimum economic benefits was 5+5+5=15 years with NPW Rs. 1578.92, BCR 174.12 and ROI 17312.72 percent per tree. Many times, when a single rotation of trees is changed with multiple rotations, with same total

life span, the economic benefits are increased (2). These results are in line with previous findings (7) where economic rotation of *Cordia myxa* (Lasura) plantation was collected. The plantation had NPW of 265 Mexican Pesos and BCR 5.6 per hectare, at 60 years rotation. When rotation was reduced to 40 years, NPW decreased to 102.47 Mexican Pesos and benefit cost ratio to 2.11 per hectare.

Table 5.   Economic comparison of various rotation options of *Dalbergia sissoo*

Rotation	PW of benefits	PW of cost/expenditures	NPW	BCR	ROI
15	2043.61	4.54	2039.05	459.59	44859.20
10+5	2526.12	6.29	2519.82	401.10	40010.47
5+5+5	1588.04	9.12	1578.92	174.12	17312.72

Sensitivity analysis revealed that reduction in benefits by 10 and 20 percent did not make the NPW negative at any rotation option (Table-6). Similarly, BCR was also more than 1 and ROI was still positive for all rotation periods. In case the benefits/income was reduced by 10 percent NPW was Rs. 1834.71 and Rs. 1420.12 at a rotation

of 15 years and 5+5+5=15 years, respectively. Similarly, when benefits/income were reduced by 20 percent, NPW was Rs. 1630.35 and Rs. 1261.31 at a rotation of 15 years and 5+5+5=15 years, respectively. It means that NPW, BCR and ROI are not economically sensitive to decrease in prices of tree upto 20 percent.

Table 6.   Sensitivity analysis for the cultivation of *Dalbergia sissoo* at various rotations

Rotation	Gross income	Cost/expenditures	NPW	BCR	ROI
Decreasing benefits by 10%					
15	1839.25	4.54	1834.71	405.12	40412.11
10+5	2273.51	6.29	2267.22	361.45	36044.83
5+5+5	1429.24	9.12	1420.12	156.71	15571.49
Decreasing benefits by 20%					
15	1634.89	4.54	1630.35	360.11	35910.79
10+5	2020.89	6.29	2014.60	321.29	32028.62
5+5+5	1270.43	9.12	1261.31	139.30	13830.25

CONCLUSION
It is concluded that although all the economic indicators were positive and acceptable for all tested rotations but a rotation of 10 years followed by another short rotation of 5 years with total span of 15 years proved as the most profitable. It is recommended that the farmers of tehsil Khushab should grow *Dalbergia sissoo* trees at a rotation of 10+5=15 years for earning maximum profit.

REFERENCES
1. Anjum, K., G. S. Khan, M. Afzal and Z. H. Khan. 2011. Economic comparison of agriculture with agroforestry in tehsil Kamalia, district Toba Tek Singh, Pakistan. J. Agric. Res. 49(4):551-561.

2. Anjum, K., I. Qadir, M. F. Azhar and S. Hafeez. 2013. Economic evaluation of irrigated plantation in Kamalia, Punjab, Pakistan. J. Agric. Res. 51(2):189-202.
3. Anon. 1988. An Economic Training Handbook. Economic Programme, CIMMYT, Mexico.
4. Ayyaz, F., K. Anjum, I. Qadir, W. Nouman, S. Afzal and M. Asif. 2014. Best economic rotation of farm trees in tehsil Muzaffargarh. J. Agric. Res. 52(4): 569-579.
5. Friday, J.B., C. Cabal and J. Yanagida. 2000. Financial Analysis for Tree Farming in Hawaii. Resource Management Booklet. Cooperation Extension Service, University of Hawaii. p. 1-7.

6. Jalota, R. K. and K. K. Sangha. 2005. Value of ecological services of exotic *Eucalyptus tereticornis* and native *Dalbergia sissoo* tree plantations of north-western India. Conservation and Society. 3(1):92-109.

7. Malik, T. J. 2009. Pre-investment Study of District Khushab. Director of industries, Multan Road, Lahore.

8. Nissen, T. M., D. J. Midmore and A. G. Keeler. 2001. Biophysical and economic trade of intercropping timber with food crops in the Philippine uplands. Agric. System. 67:49-69.

9. Roja, T., T. Holm and M. Zeller. 2005. Economic Evaluation of Timber and Non-Timber Forest Products of *Cordia dodecandra* Tree in the Southern of Mexico. Conference of Peruvian Science, Lima, Peru.

10. Tanvir, M. A., M. T. Siddiqui and A. H. Shah. 2002. Growth and price trend of *Eucalyptus camaldulensis* in Central Punjab. Int. J. Agri. Biol. 4 (3):344-46.

10. Venn, T. J. 2005. Financial and economic performance of long rotation hardwood plantation investments in Queensland, Australia. For. Pol. Eco. 7(3):437-54.

CONTRIBUTION OF AURHORS

Khayyam Anjum	**Presented the idea of research, designed and supervised the whole research work, collected and reviewed the literature**
Ihsan Qadir	**Made the calculations, wrote introduction and methodology**
Madiha Saher	**Wrote abstract, helped in calculations**
Shazia Afzal	**Helped in collection and review of literature, data organization and tabulation**
Faiz Rasool	**Contributed in results and discussion**
Wasif Nouman	**Contributed in results and discussion**
Muhammad Talha Bin Yousaf	**Tree measurements and data collection**
Muhammad Sohail Yousaf	**Tree measurements and data collection**
Asif Ali	**Proof reading, wrote the references**