

Influence of Rotation Length on the Economic Productivity of *Vachellia nilotica* (Kikar)

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SUMMARY

This study was performed in Tehsil Jaranwala, District Faisalabad, Pakistan in the year 2021. The purpose of this study was to assess the potential of increasing farmer's income by changing the rotation of farm grown *Vachellia nilotica* trees. Five hundred and ten trees aged one to six years were selected randomly from fifteen villages in Jaranwala. The age and price of the trees were inquired from the farmers. The prices of *V. nilotica* trees for ages 1 to 3 years were found to be Rs. 360.53 and 1270 respectively, while the prices for ages 4 to 6 years were Rs. 2280, 2650 and 2980, respectively. Discounting was carried out at a nine percent interest rate. Various rotations of *V. nilotica* trees were tested, namely 6 years, 3+3, 2+4 and 4+2 years, all with a total lifespan of 6 years. Net present worth was used to assess the most profitable rotation of the trees. The NPW of trees at 6-year rotation was found to be Rs.1768.08, while it was Rs. 1723.7 at a rotation of 3+3=6 years. The NPW at rotations of 2+4=6 years and 4+2=6 years was Rs.1790.964 and Rs. 1916.92, respectively. The last rotation option (4+2=6 years) was found to be the most profitable and beneficial. Therefore, farmers in Jaranwala are recommended to grow *V. nilotica* trees using this rotation to maximize economic returns from this particular tree species.

Keywords: farmer, *Vachellia nilotica*, rotation, net present worth, profit.

INTRODUCTION

Vachellia nilotica is a commonly grown tree in arid and semi-arid regions of Pakistan. It is a xerophytic plant, thus it grows with less irrigation water. It is a good farm forestry tree and it can be seen growing frequently in Punjab, including Jaranwala, alongside farm crops. It is a leguminous tree and fixes nitrogen, thus increasing the fertility of the farmlands. Its wood is used for making furniture, carts, tool handles and boats, etc. Its fuel wood is considered the best in Pakistan. Farmers usually grow trees without any specific rotation. They harvest their farm trees and sell them when needed. The literature indicates that changing the rotation of farm trees may affect economic returns (Sheikh, 1993).

Limited research has yet been carried out on calculating the economic rotation of *Vachellia* in Pakistan along with other broad-leaved tree species. Therefore, the present study was designed to determine whether changing the rotation of this tree can increase farmer's income. Before going forward, let's see what type of research work has been carried out on the economics of various tree species in developing countries of the world. For example, Roy *et al.* (2021) carried out an economic evaluation of a

plantation of *Vachellia* trees. At an 11-year rotation, economic returns were 1,017,430 Bangladeshi Tikkas. The income decreased to 915,687 B.T. when the rotation was increased to 22 years.

Nigussie *et al.* (2020) conducted an economic evaluation of *Vachellia nilotica* in sole cultivation and in combination with teff crop. The net present worth of the sole plantation of *V. nilotica* was 68,089 ETB per hectare, while the NPW of *Vachellia* in combination with the teff crop was found to be 57,005 ETB. Sembajju (1999) conducted an economic appraisal of a *Eucalyptus* plantation in Uganda. Economic returns were 8,000,000 and 3,703,500 Shillings per hectare, at a rotation of 4 and 3 year, respectively. Yadav *et al.* (2014) carried out an economic appraisal of a *V. nilotica* plantation. The NPW was found to be Rs. 1.88 lakhs ha⁻¹, while the BCR was 2.37 and the IRR was 24.70%. Silva *et al.* (2020) reported an NPW of 1,925 Brazilian Reals per hectare, a BCR of 1.31, and an IRR of 16% for a *Eucalyptus* plantation in Brazil at a rotation of 7 years.

Virgens *et al.* (2016) conducted an economic evaluation of a *Eucalyptus* plantation in Brazil. The BCR, NPW, and IRR were found to be 1.20, 1,279 Brazilian Reals, and 9.2%, respectively. Ebretsadik (2013) found that the volume of a hardwood plantation was 12.88 cubic meters per hectare at the age of 14 years and the NPW was also maximum at 14 years of age. Roja *et al.* (2005) carried out an economic analysis of a plantation of *Cordia myxa*. The NPW was 102 Pesos (Mexican currency) at a 40-year rotation and increased to 265 Pesos when the rotation was extended to 60 years age.

Elazaki and Gang (2019) subjected a *V. nilotica* natural plantation in Sudan to economic analysis. The NPW for honey production from the forest was 868 Dollars, while for fuel wood production, it was 156 US Dollars. The collective NPW for honey and fuel wood production was 712 Dollars per hectare. Khattabi (1999) described that 48% of timber production in Morocco is provided by *Eucalyptus camaldulensis* plantations. This business generates an economic activity of 13.5 million Dollars each year.

Foroughbakh *et al.* (2017) reported that in North Eastern Mexico, *Eucalyptus* is grown on a large scale and gives maximum economic output at a rotation of 20 years. Cuong *et al.* (2020) performed an economic evaluation of two plantations, namely *Acacia mangium* and *Eucalyptus camaldulensis* in Vietnam. The NPW was found to be 33 and 37 million Dollars per hectare for *Acacia mangium* and *Eucalyptus camaldulensis* plantations, respectively.

It is clear from the above discussion that a limited research work has been carried out in Pakistan on calculating the economic rotation of various tree species growing in agro forestry landscape of Pakistan. Most of the research on this topic has been carried out in other countries. So, it is the need of the time to calculate economic rotations of farm trees growing under various agro forestry systems in Pakistan.

As *Vachellia nilotica* is an important agro forestry tree of Punjab, Pakistan. So, it was decided to collect data and determine the best rotation of this important farm tree. The objective of the current study was to determine the best age of *Vachellia* trees at which farmers can get maximum income by selling their trees. This study was conducted in Jaranwala, District Faisalabad but it can provide a base for determining

rotations of *Vachellia* as well as other tree species in other areas of Punjab, Pakistan, so that farmers can earn maximum money in shortest period of time.

MATERIALS AND METHODS

This research was performed in Tehsil Jaranwala of District Faisalabad in 2021. The aim of this study was to determine whether farmers can earn more money by changing the rotation of *V. nilotica* trees. Three villages from each of Jhang Raod, Satiyana Road, Sargogha Road, Samundri Road and Amin pur Road were selected at random. 34 trees of different ages were selected from each village. A total of Five hundred and ten trees of *V. nilotica* were selected randomly from these 15 villages of Jaranwala (District Faisalabad). The data was collected during March and April 2021 through a questionnaire. The data was collected on the age and price of standing trees. The age and price of standing trees were inquired from the farmers. The trees growing there were aged one to six years. Net present worth was used as an economic tool in this study. Net Present Worth was used to make a comparison between incomes from trees at various rotations.

$NPW = PW \text{ of gross returns} - PW \text{ of expenditures}$

All the values of cost and benefit streams were discounted at a 9% interest rate. Then net present worth was calculated using the formula mentioned earlier. Micro Soft Excel was used to calculate discount factor, present worth of gross returns and expenditures. Net present worth was also calculated by using the same software

RESULTS AND DISCUSSION

The price of trees of various ages is shown in Table 1. The prices of 1, 3, and 6-year-old trees were found to be Rs. 360, 127 and 2980, respectively. The costs and benefits of *V. nilotica* at a single rotation of 6 years are shown in Table 2. The present worth of costs was Rs. 8 only, while that of benefits was Rs. 1776.08. The net present worth was Rs. 1768.08. The costs and benefits of *V. nilotica* at a rotation of 3+3=6 years are shown in Table 3. The present worth of costs was found to be only Rs. 13.664, while that of benefits was Rs. 1737.36. The net present worth was calculated as Rs. 1723.7. The costs and benefits of *V. nilotica* at a rotation of 2+4=6 years are shown in Table 4. The present worth of costs was found to be only Rs. 14.176, while the present worth of benefits was Rs. 1805.14. The net present worth was found to be Rs. 1790.964. The costs and benefits of *V. nilotica* at a rotation of 4+2=6 years are shown in Table 5. The present worth of costs was found to be Rs. 13.2 only, while the present worth of benefits was Rs. 1930.12. The net present worth was found to be Rs. 1916.92. The comparison of net present worth for various rotations of *V. nilotica* is shown in Table 6. The minimum net present worth (Rs. 1723.70) was found at a rotation of 3+3=6 years, while the maximum net present worth (Rs. 1916.92) was found at a rotation of 4+2=6 years.

The results of the present study are in line with the revelations of Roy *et al.* (2019), who described that at a shorter rotation (11 years), the income from *Vachellianilotica* plantation (Bangladeshi Tikkas 1,017,430) was higher compared to a longer rotation (22 years), which was Bangladeshi Tikkas 915,687. The comparison of both studies makes it clear that by decreasing the rotation of *Vachellia* trees, income can be increased. The results of this study are in disagreement with the findings of Roja *et. al.* (2005) who reported that NPW from a broad-leaved plantation was Mexican

Pesos 265 at a rotation of 60 years. When the rotation was decreased to 40 years, NPW decreased to 102 Pesos. The NPW in this case decreased because of the high discount rate (18%) used in this study.

Table 1: Price of trees of various ages of *Vachellia nilotica*

Age (years)	Price per Tree (Rupees)
1	360
2	530
3	1270
4	2280
5	2650
6	2980

Table 2: Costs and benefits of *Vachellia nilotica* at a single rotation of 6 years

Age Years	Cost (Rupees)	Benefits (Rupees)	D.F. @ 9% Discount rate	PW cost (Rupees)	PW Benefits (Rupees)
0	8	0	1	8	0
1	0	0	0.917	0	0
2	0	0	0.842	0	0
3	0	0	0.772	0	0
4	0	0	0.708	0	0
5	0	0	0.65	0	0
6	0	2980	0.596	0	1776.08
			Total1	8	1776.08
			Net Present Worth Rs.	1768.08	

Table3: Costs and Benefits of *Vachellia nilotica* at two rotations (3+3 years) of 6 years life span

Age (years)	Cost (Rupee)	Benefits (Rupee)	D.F. @ 9% Disc0unt rate	PW cost (Rupee)	PW Benefits (Rupee)
0	8	0	1	8	0
1	0	0	0.917	0	0
2	0	0	0.842	0	0
3	0	1270	0.772	0	980.44
4	8	0	0.708	5.664	0
5	0	0	0.65	0	0
6	0	1270	0.596	0	756.92
			Total1	13.664	1737.36
			Net Present Worth Rs.	1723.7	

Table 4: Costs and Benefits of *Vachellia nilotica* at two rotations (2+4 years) of total 6 years life span

age (years)	Cost (Rupee)	Profits (Rupee)	d.f. @ 9% Discount rate	PW cost (Rupee)	PW Benefits (Rupee)
0	8	0	1	8	0
1	0	0	0.917	0	0
2	0	530	0.842	0	446.26
3	8	0	0.772	6.176	0
4	0	0	0.708	0	0
5	0	0	0.653	0	0
6	0	2280	0.596	0	1358.88
			Total1	14.176	1805.14
			Net Present Worth Rs.	1790.964	

Table 5: Costs and Benefits of *Vachellia nilotica* at two rotations (4+2 years) of total 6 years life span

Age (years)	Cost (Rupee)	Benefits (Rupee)	D.F. @ 9% Discount rate	PW cost (Rupee)	PW Profits (Rupee)
0	8	0	1	8	0
1	0	0	0.917	0	0
2	0	0	0.842	0	0
3	0	0	0.772	0	0
4	0	2280	0.708	0	1614.24
5	8	0	0.65	5.2	0
6	0	530	0.596	0	315.88
			Total1	13.2	1930.12
			Net Present Worth Rs.	1916.92	

Table 6: Comparison of various rotations of *Vachellia nilotica*

Rotation (years)	Net present worth (Rs.)
6	1768.08
3+3=6	1723.7
2+4=6	1790.964
4+2=6	1916.92

CONCLUSION

The net present worth of *Vachellianilotica* trees was found to be positive in all rotation options. However, it was maximum (Rs.1916.92) at a rotation of 4+2 = 6 years, followed by the rotation of 2+4 = 6 years (Rs. 1790.964), 6 years (Rs. 1768.08), and 3+3 = 6 years

(Rs. 1723.7). Therefore, the farmers of Jaranwala are recommended to grow trees at a rotation of $4+2=6$ years to achieve maximum profit.

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