Analysis of Resource Use Efficiency of Areca Nut (*Areca catechu*) in Jhapa, Nepal

.

ABSTRACT

|  |
| --- |
| **Aims:** The study aimed to assess the resource use efficiency of Areca nut production in Jhapa, Nepal**Methods and Duration of Research:** The study was conducted in Jhapa, Nepal, in May-June 2019 to appraise the efficiency of resources used in areca nut farming. Three municipalities of Jhapa were purposively selected. A total of 90 areca nut growers were sampled using a simple random sampling technique. Data analysis was carried out using descriptive statistics and production function analysis.**Results:** The average gross margin per ha was found to be NRs. 251,232 and Benefit- Cost (BC) ratio was 2.15. Production function analysis showed that inputs such as nutrients, irrigation and labour significantly influenced gross income. The return to scale for areca nut production was found to be 1.041, indicating increasing return to scale. Additionally, it was found that resources like nutrients, irrigations, labour were underutilized. **Conclusion:** The efficiency of areca nut production can be enhanced by optimizing resources use. It is recommended to increase the application of inputs such as manure, fertilizer, and micronutrients and to improve irrigation facilities to maximize returns for farmers.  |

***Keywords:*** *Areca nut; efficiency; farmers; production; resources.*

INTRODUCTION

Areca nut (*Areca catechu*), a tropical fruit from piperaceae family, is believed to originated from Philippines and is cultivated in Asian countries like India, Nepal, Sri Lanka, and Bangladesh (6, 19). It is a commodity of conventional, commercial and economic importance, primarily grown for its seeds, which contain intoxicating alkaloids and are also used for interior landscaping (15, 19). It is commercially used for the preparation of sweet supari, pan masala, and gutkha, while fresh and fermented areca nuts are consumed locally (12). It is the fourth most commonly used addictive and psychoactive substance in the world, after nicotine, ethanol and caffeine, and is consumed by approximately 10% of the world's population (1, 2, 20). It is commonly consumed in countries such as India, Bangladesh, Srilanka, Maldives, Pakistan, Myanmar, Taiwan, Thailand, Indonesia, Cambodia, Vietnam, Philippines, Laos and China (10). Areca nut has both positive and negative effects on human health. The negative effect include several health hazards, leading to cancer of mouth and oesophgous (11). It is believed to be helpful for the digestive system and has mild euphoric effects (1). In additions, it is a key ingredient in several religious and social ceremonies, symbolizing the community’s culture and emphasizing its cultural significance (1, 19).

According to Food and Agriculture Organization (FAO), the total area covered by areca nut was 1,310,919 ha with the productivity of 1.74 mt/ha. India is the largest producers of areca nut and share about 60% of global production. The total areca under areca nut cultivation in Nepal was 4030 ha and total production was 14803 mt which contributes 2% of global production (5). Eastern region of Nepal is the basket for the areca nut production which contributes 99% of total production (3). Among these, Jhapa district is the largest producer of areca nut. According to data of fiscal year 2022/23, area under areca nut cultivation was 2770 ha and production was 10370 mt which contributes 70% of the total production of Nepal (14).

The nature of the areca nut plant, which offers various benefits and serves as an industrial raw material with significant potential, gives it high economic value, making it a global export commodity. With the rising demand for areca nut in Nepal, particularly due to the increasing number of Gutkha factories, there is a growing concern over the ability of growers to meet this demand. The national demand for areca nut is also expanding, creating pressure on production. To satisfy this increasing demand, either the cultivated area must be expanded or productivity must be enhanced. However, since it takes about six years for areca nut plants to begin bearing fruit (11), improving resource use efficiency in existing plantations is critical for sustaining and boosting production levels in Nepal. This study assessed the resource use efficiency of areca nut cultivation in Jhapa, Nepal, and examined the factors influencing the economic benefits of its production. By exploring these factors, the study aims to provide valuable insights for optimizing resource use and improving the overall profitability of areca nut farming.

material and methods

**Study area and sampling design**

This study was conducted in Jhapa district, Nepal which has a favorable climate for areca nut production. The district lies in the 26.200 to 26.500 north latitude and 87.390 to 88.120N longitude. The average annual temperature ranges from 3ºC to 37ºC. The district is situated at 58 meters to 380 meters from the mean sea level. Three local bodies of the northern part of Jhapa district namely Budhasanti rural municipality, Arjundhara municipality, and Mechinagar municipality were purposively selected for the study. Altogether 90 samples were collected from three local bodies, 30 from each by simple random technique.

**Data collection and analysis**

Primary data was collected by the use of structured and semi-structure questionnaire in May-June, 2019 by face-to-face interviews. Focus group discussion (FGD) and key informant interviews (KII) were carried out for additional information. Secondary data was collected from district profile, journals, research articles, thesis and various websites. The collected information was coded, entered and analyzed using SPSS, MS-Excel and Stata software.

**Cost and benefit analysis**

The total variable cost of areca nut cultivation was calculated by considering all the variable inputs like manures, fertilizer, micronutrients, irrigation, pesticides, and labour cost for manure, fertilizer applications, and weeding.

Total variable cost = C nutrients + C irrigation + C pesticide + C nutrients applications + C weeding

The establishment cost is amortized using the formula of amortization. An amortization schedule normally shows us how much interest and principle we are paying each period. The formula for calculation of amortized cost per year of establishment cost was

 Amortized Cost= TEC {(1+i) AL\*i/ (1+i) AL-1} …….(13)

Where,

TEC=Total establishment cost

i =interest rate of 12 % is taken

AL= Average life span of areca nut which is taken to be 30 years.

Total cost incurred per annum was calculated as

C per annum = total variable cost + amortized cost + rental value of land

Similarly, gross return was calculated as

Gross return=Quantity sell × Price per kg+ Revenue from byproduct (leaf sheath)

Benefit-cost ratio was estimated by the following formula

Benefit cost ratio = Gross Return/ Total Cost

Gross margin was calculated as

Gross margin = Gross return –Total variable cost………..(16)

**Production function analysis**

Cobb-Douglas production function was used to determine the contribution and efficiency of different variables inputs on areca nut production (7). The Cobb-Douglas production function for resource productivity was as follows:

Y= aX1b1 X2b2 X3b3 X4b4 eu

Transformation to linear form for ease in computation

lnY = lna + b1lnX1+ b2lnX2 + b3lnX3 + b4lnX4 + u

Where,

Y= Gross return (NRs. / ha)

X1 =Manure, fertilizer and micronutrients cost (NRs. / ha)

X2 = Irrigation cost (NRs. / ha)

X3 = Manure applications cost (NRs. / ha)

X4 =Weeding cost (NRs. / ha)

a = constant

e = Base of natural logarithm

u = Error term

ln = Natural logarithm

b1, b2, b3 and b4 are coefficient of X1, X2, X3, X4 variables respectively

**Return to scale (RTS) analysis**

The return to scale was calculated as follows:

RTS = ∑ bi

Where, bi=Coefficient of explanatory variables from Cobb-Douglas production function

Decision rule:

RTS = 1; Constant return to scale i.e. percentage change in output is equal to percentage change in input

RTS < 1; Decreasing return to scale i.e. percentage change in output is less than percentage change in input

RTS > 1; Increasing return to scale i.e. percentage change in output is more than percentage change in input

**Resource use efficiency**

The efficiency of resource use in the production of areca nut was determined by the ratio of marginal value product (MVP) to Marginal Factor Cost (MFC) of variable inputs based on the estimated regression coefficients. The formula for resource use efficiency is given as

r = MVP/MFC

` Where, r = efficiency ratio

 MVP = Marginal Value Product

 MFC = Marginal Factor Cost

The decision rule for efficiency analysis was as:

 r = 1; efficient use of resource

 r > 1; underutilization of resource

 r < 1; overutilization of resource

**Marginal value products (MVP)**

Marginal value products (MVP) were estimated using the regression coefficients of input and price of output and cost of inputs.

MVP= bi Y̅/X̅

 Where bi = regression coefficients of the variables

 Y̅ = Geometric mean of output

 X̅ = Geometric mean of inputs

**Marginal value product (MVP) adjustment**

The relative percentage change in MVP of each resource required to obtain resource allocation that is r = 1 or MVP = MFC was estimated using the formula:

 D = (1-MFC/MVP) \*100

 Where D = absolute value of percentage change in MVP of each resource

results and discussion

**Cost of production**

Two types of costs are involved in the production of areca nuts, namely establishment costs and maintenance costs. Establishment cost means all the cost incurred up to the start of the bearing whereas maintenance cost are cost of all the variable cost incurred per year. The establishment cost per ha were found to be NRs. 3, 67,260 and maintenance cost per ha were found to be NRs. 74,022. Details of the cost is shown in the table 1. The amortized value of establishment cost per year was NRs. 44,922 and rental value of land per ha was found to be NRs. 30,000 per year in the study area.

**Table 1. Average establishment cost of areca nut per ha of land in study area**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Items** | **I****year** | **II****year** | **III year** | **IV Year** | **V year** | **VI year** |
| A | **Material cost** |  |  |  |  |  |  |
| 1 | Planting material | 53600 | 2000 |  |  |  |  |
| 2 | Manures and fertilizer | 22500 |  |  |  |  |  |
| 3 | Laying of irrigation | 100000 | 10000 | 10000 | 10000 | 10000 | 10000 |
| 4 | Insecticide | 1200 |  |  |  |  |  |
|  | Total material cost | 177300 | 12000 | 10000 | 10000 | 10000 | 10000 |
| **B** | **Labour cost** |  |  |  |  |  |  |
| 1 | Land preparation | 5000 |  |  |  |  |  |
| 2 | Pit digging | 31680 | 1200 |  |  |  |  |
| 3 | Manure and fertilizer application | 15840 | 600 |  |  |  |  |
| 4 | Planting  | 15840 | 600 |  |  |  |  |
| 5 | Weeding |  | 12000 | 12000 | 12000 | 12000 | 12000 |
| 6 | Pesticide applications cost | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 |
|  | Total labour cost | 69560 | 15600 | 13200 | 13200 | 13200 | 13200 |
|  | Total cost | 246860 | 27600 | 23200 | 23200 | 23200 | 23200 |
|  | **Total establishment cost** | **367260** |  |  |  |  |  |

**Table 2. Average cost of areca nut production per annum (NRs. /ha) in producing areca nut orchard**

|  |  |  |
| --- | --- | --- |
| Particulars | Costs (NRs. /ha) | Share on total cost (%) |
| Manures, fertilizers and micronutrients | 27719 | 18.61 |
| Irrigation | 11095 | 7.45 |
| Pesticide | 1675 | 1.12 |
| Manures application | 18410 | 12.36 |
| Weeding | 15123 | 10.15 |
| Total variable cost | 74022 | 49.70 |
| Rental value of land | 30000 | 20.14 |
| Amortized value of establishment cost | 44922 | 30.16 |
| Total cost per annum | 148944 | 100 |

**Return from areca nut production**

The gross margin was calculated by considering only variable costs. The gross margin per ha was found to be NRs. 251,232. Total cost per annum includes all the variable cost per year, rental value of land and amortized value of establishment cost.

**Table 3. Gross margin and BC ratio of areca nut cultivation per ha in the study area**

|  |  |
| --- | --- |
| Variable cost per year | NRs. 74,022 |
| Total Cost per annum | NRs. 148,944 |
| Gross return per year | NRs. 325,254 |
| Gross margin per year | NRs. 251,232 |
| BC ratio | 2.18 |

The BC ratio was calculated as 2.18, which is higher than unity. Thus areca nut plantation is financially feasible in the study area. This result aligns with the findings of similar studies conducted in various states of India by (4, 8, 17 and 18).

**Production function analysis**

The estimated value of the coefficients and related statistics of Cobb-Douglas production function are shown in table 3. The value of the coefficients of determination (R2) was 0.647. This implies that 64.70 % variation in dependent variables is explained by the independent variable fitted in the model. The measure of the overall significance of the estimated regression F value was 38.94, which was significant at a 1% level of significance so that we can say the model is the best fit. Out of four independent variables included in the regression analysis, manures, fertilizer & micronutrients cost and weeding cost were found significant at 1% level of significance while manures application cost and irrigation cost were found significant at 5% level of significance.

The regression coefficient for manure, fertilizer and micronutrients was 0.536 which indicates that with unit increase in this, gross return could increase by 0.536. Similarly, with the unit increase in irrigation cost, manure application cost and weeding cost, gross return could increase by 0.020, 0.255 and 0.231 respectively. The sum of all the regression function turned out to be 1.041 which indicates that the production functions exhibited increasing return to scale. This implies that if all the inputs specified in the production function are increased by unity, the gross return will increase by 1.041. The return to scale was similar to the finding of Dahal (2012) who reported 1.07 return to scale (3).

**Table 4. Regression estimates for factors affecting gross income from areca nut**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Estimated coefficients** | **Standard error** | **t-value** |
| Constant | 2.486 | 0.581 | 4.27  |
| Manures, fertilizers and micro nutrients | 0.536\*\*\* | 0.087 | 6.19 |
| Irrigation | 0.020\*\* | 0.009 | 2.35 |
| Manure and fertilizer applications | 0.255\*\* | 0.115 | 2.22 |
| Weeding | 0.231\*\*\* | 0.087 | 2.66 |
| F-value | 38.94 |  |  |
| R square | 0.647 |  |  |
| Return to scale | 1.041 |  |  |

*\*\* and \*\*\* indicate 5% and 1% level of significance respectively.*

**Resource use efficiency**

Resource use efficiency was calculated from the elasticity of Cobb-Douglas production function analysis. The table 5 estimates the resource use level and utilization of the inputs used in the areca nut cultivations in Jhapa, Nepal. From the study, it is revealed that all the resources used were underutilized in areca nut cultivations.

**Table 5. Estimated resource use efficiency in areca nut production in Jhapa, Nepal**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Farm inputs** | **Coefficient** | **MVP** | **MFC** | **R** | **Remarks** |
| Manures, fertilizers and micronutrients | 0.536 | 6.343 | 1.00 | 6.343 | Under utilized |
| Irrigation | 0.020 | 11.829 | 1.00 | 11.829 | Under utilized |
| Manures application | 0.255 | 4.322 | 1.00 | 4.322 | Under utilized |
| Weeding | 0.231 | 4.919 | 1.00 | 4.919 | Under utilized |

*MVP means marginal value products, MFC means marginal factor cost.*

The table 6 shows percentage adjustment in the marginal value products for optimum utilization of inputs. For optimum utilization of resources the marginal value of products should be equal to marginal factor cost i.e. MVP = MFC. This shows that 84.23% adjustment is required for optimum utilization in manure, fertilizer, and micronutrients, 91.55% is required for irrigation, 76.86% is required for manure applications, and 79.67% is required for weeding. This indicates that a lot needs to be done to bridge the gap of optimum use of the resources in the study area. This required efforts of government and non-governmental organization working for the promotion of areca nut plantation.

**Table 6. Marginal value product (MVP) adjustment**

|  |  |
| --- | --- |
| **Variable inputs** | **Percentage adjustment required (%)** |
| Manures, fertilizer and micronutrients | 84.23 |
| Irrigation | 91.55 |
| Manures applications | 76.86 |
| Weeding | 79.67 |

Conclusion

This study concluded that areca nut cultivation is profitable enterprise. Farmers realized an average gross margin of NRs. 2, 51,232 from cultivating areca nut in one hectare land. The BC ratio was found 2.18 which is financially feasible. Thus areca nut cultivation being profitable farm enterprise should be promoted in the study area. The return to scale of areca nut enterprise was found to be 1.041, an increasing return to scale. Resources such as manures, fertilizers and micronutrients, irrigations, labour were found underutilized. There is enough room to get optimum profit by efficiently utilizing resources. It is recommended that the use of inputs such as manure, fertilizer, and micronutrients should be increased, and irrigation facilities should be improved. Appropriate extension services should be provided to farmers for proper and efficient utilization of resources.

AcknowledgEments

We sincerely extend our heartfelt gratitude to the farmers of Jhapa, Nepal for their participation as well as staff of Prime Minister Agriculture Modernization Project (PMAMP) Office, Jhapa for their invaluable support and contributions in completing this study.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare that no generative AI technologies and text-to-image generators have been used during the writing or editing of this manuscript.

References

1. Boucher BJ and Mannan N (2002) Metabolic effects of the consumption of Areca catechu. Addiction Biology, 7(1), 103–110. <https://doi.org/10.1080/13556210120095392>
2. Croucher, R., & Islam, S. (2002). Socio-economic aspects of areca nut use. Addiction Biology, 7(1), 139-146. https://doi.org/10.1080/13556210120091518
3. Dahal BP (2012) Production and marketing of areca nut in Jhapa district of Nepal (Doctoral dissertation). Institute of Agricultural and Animal Science, Tribhuvan University.
4. Deorukhakar A, Nikam M and Rane A (2007) Economics of areca nut cultivation in Ratnagiri district of Maharashtra state. Journal of Maharashtra Agricultural Universities, 32(2), 254–258.
5. FAO (2023) Food and Agriculture organization. Retrieved from http://www.fao.org
6. Garg A, Chaturvedi P and Gupta PC (2014) A review of the systemic adverse effects of areca nut or betel nut. Indian Journal of Medical and Paediatric Oncology, 35(1), 3–9. https://doi.org/10.4103/0971-5851.131378
7. Gujarati DN (2009) Basic econometrics (4th ed.). Tata McGraw-Hill Education.
8. Hassan H (2010) An economic analysis of arecanut production in Malappuram district of Kerala (M.Sc.Ag. thesis). Acharya N.G. Ranga Agricultural University, Tirupati, India.
9. Hegde SA and Deal J (2014) Areca nut farming in Southern India: A case study. International Journal of Business and Social Science, 5(10), 40–45.
10. Hossain MF, Anwar M, Akhtar, S and Numan SM (2015) Adverse effects on health posed by consumption of areca nut (*Areca Catechu* L., Family: Palmaceae). International Journal of Community Medicine and Public Health, 2(4), 357-360. Https://Doi.Org/10.18203/2394-6040.Ijcmph20151028
11. IARC working group on the evaluation of carcinogenic risks to humans (2004) Betel-quid and areca-nut chewing and some areca-nut derived nitrosamines. IARC monographs on the evaluation of carcinogenic risks to humans, 85, 1-334. https://doi.org/10.1002/pmid:15635762
12. ILRT (2019) *Arecanut subsector in Meghalaya: A Review.* Lower Lachumiere near Kripa Foundation,: Meghalaya Basin Development Authority (MBDA)
13. Merritt C (2013) Basic amortization formula. Demand Media. http://homeguides.sfgate.com/basic-amortization-formula-2782.html
14. Ministry of Agricultural and Livestock Development (MoALD) (2023). Statistical information on Nepalese agriculture 2023. Kathmandu, Nepal: MoALD.
15. Naagarajan R and Meenakshi R (2016) Analysis of Areca nut production and export in India. International Journal of Applied Social Science, 3(3 & 4), 67–81.
16. Olukosi JO, Isitor SU and Ode MO (2006) Introduction to agricultural marketing and prices: Principles and application. American Journal of Agriculture and Forestry, 2(4), 199–205.
17. Remdor D, Singh R, Feroze SM, Singh RJ and Aheibam M (2016) Profitability analysis of areca nut orchard in Meghalaya. The Indian Forester, 142(4), 405–413.
18. Rudragouda BP (2014) An economic analysis of production and marketing of organic spices in Uttar Kannada district.
19. Shambhavi A (2016) An analysis of marketing and processing of arecanut in Shivamogga district of Karnataka state (Master's thesis). Rajendranagar,Hyderabad.
20. Shamim S and Khan M (2017) Phytochemical Screening by High Performance Liquid Chromatography (HPLC) and Antimicrobial Activity of Different Solvent Fractions of Areca Nuts against *Bacillus Subtilis* Biofilm. International Research Journal of Pharmacy, 8(10), 29-37. Https://Doi.Org/10.7897/2230-8407.0810178