S. Dahal et al. (2023) Int. J. Appl. Sci. Biotechnol. Vol 11(2): 106-115.
DOI: 10.3126/ijasbt.v11i2.55093

ISSN (Online): 2091-2609
DOI Prefix: 10.3126/ijasbt

International Journal of Applied Sciences and Biotechnology (IJASBT)

Research Article

Economic Analysis of Mandarin *(Citrus reticulata)* Production in Salyan District of Nepal

Shishir Dahal[1*], Bijaya Dangi[1], Raman Kumar Dangi[1], Prakash Bista[1], Ashmita Sharma Upadhyaya[1], Sunita Bharati[1], Sunil Dulal[2]

[1] Institute of agriculture and animal sciences (IAAS), Tribhuvan University Nepal.
[2] International maize and wheat improvement centre (CIMMYT) Nepal.

Article Information

Received: 22 May 2023.
Revised version received: 19 June 2023.
Accepted: 21 June 2021.
Published: 29 June 2023.

Cite this article as:
S. Dahal et al. (2023) Int. J. Appl. Sci. Biotechnol. Vol 11(2): 106-115. DOI: 10.3126/ijasbt.v11i2.55093

***Corresponding author**
Shishir Dahal,
Institute of agriculture and animal sciences (IAAS), Tribhuvan University, Nepal
Email: ag.dahalshishir@gmail.com

Peer reviewed under authority of IJASBT

Abstract

Mandarin (*Citrus reticulata*) is the major sub-tropical fruit popularly grown in slopy terraces of mid-hills which has high domestic and foreign market potentialities. Scientific studies are hardly carried out to assess the socio-economic aspects of mandarin production in this area. So, this research was aimed to assess the production and profitability of mandarin production in Salyan district. For this, 61 respondents of Baghchaur municipality and 59 of Chhatreshwari rural municipality were selected using random sampling procedure which makes altogether 120 respondents in the study area. Pretested semi structured questionnaire were asked with farm decision makers for primary data collection. Collected data were encoded in MS excel version 2021, and required inferences on socio-economic and demographic characteristics, BC ratio, cobb-douglas production function and problem ranking were made by using SPSS version 26. Independent t test was used to compare the means between two municipalities. The results revealed that the annual mandarin production was 3560.58 Kgs per household with productivity of 14.60 tons per hectare. Average annual variable cost of production and revenue were NRs 227309.41 and NRs 988963.52 per hectare respectively. BC ratio was 5.07 indicating it as profitable business with the benefit of NRs 4.07 per rupee invested. Among the various determinants, cost of organic manure, human labor and plant protection materials had significantly increased while cost of irrigation had decreased the returns from the enterprise at different significance levels. The return of scale was 0.936 indicating decreasing rate of return of mandarin production.

Keywords: Mandarin; Benefit cost ratio; profitability; cobb-douglas production function.

Introduction

Mandarin (*Citrus reticulata*) is one of the major subtropical, perennial citrus species grown throughout the mid-hills of the country. It is favored for its superior taste, higher nutritional reserves including vitamin C and mostly eaten as fresh fruit but can also be consumed as processed food items such as marmalade (Shrestha, 1996). Fresh fruits contain considerable amount of sugar, organic acids, vitamins, dietary fiber, phenols, flavonoids, carotenoids and so on (Patil *et al.*, 2006). Vitamin C is biosynthesis of connective tissue, neurotransmitters, when deficit causes illness or even death (Goldenberg *et al.*, 2018) while flavonoids, phenols and carotenoids act as anticancer agents (Silalahi, 2002). The peels of mandarin consist of different phytochemicals (Singh *et al.*, 2020) which can be used as natural flavoring agents, cosmetics and even for the cure of lifestyle-based

diseases (Mahato *et al*., 2018). Mandarin is cultivated in 27,002 hectares (ha) of land area with annual production and productivity of 198,406 metric tons (mt) and 10.80 mt per hectare respectively which contributes almost 0.85% in AGDP (MOALD, 2021). Salyan district is also well known for commercial production of high-quality mandarins due to climatic suitability, soil conditions and market demand. It covers 1,405 hectares of land in the district with annual production of 1,305 metric tons and productivity of 10 tons per hectare (MOALD, 2021) which is still less than the national mean productivity. Mandarin covers about 67% of area and 64% of citrus production in the country due to its long-term higher profitability over cereals and oilseeds (NCRP, 2016). Even there is sufficient availability of agricultural labor force, suitable topography, unique climatic conditions and higher market demand, the area of production and productivity is not satisfactory. Small per capita land holdings (0.68 ha), unavailability of high yielding and resistant cultivars, quality planting materials, lack of efficient and sustainable soil and pest management measures, land fragmentation, lack of proper storage facilities and reliable market information system are key determinants of mandarin production. Policy level intervention is of utmost importance to transform the subsistence type mandarin cultivation into commercialized scale. Unfortunately, plans and policies are formulated but limited to the paper work (Sapkota *et al*., 2017). Therefore, this study was conducted to understand the present scenario of mandarin production, productivity and profitability in the district along with the prevailed constraints.

Materials and Methods

Site Selection

The study was carried out in Chhatreshwari rural municipality (28.3241°N, 82.2313°E) Baghchaur municipality (28.4511^{0}N, 82.2851°E) of Salyan district of Karnali province, Nepal. Both of the study sites are located in the mid-hills of Nepal with sub-tropical climatic conditions. These sites were selected on the basis of production and productivity of mandarin oranges (Fig. 1).

Data Collection

For this study, 61 respondents out of 780 mandarin growers of Baghchaur and 59 out of 468 of Chhatreshwari rural municipality were selected using random selection procedure which makes altogether 120 respondents in the study area. The household heads or their spouse who are involved in production, expenditure and sales were considered to be the decision maker, and selected as respondent. Survey was conducted voluntarily and all of the respondents were agreed to provide information without any justification. Semi-structured questionnaire was prepared and pretested in order to find out the farmers' understanding, relevancy and time taken for interview before conducting survey and essential corrections were made. Various socio-demographic characteristics such as age, gender, years of schooling, family size and years of experience, land holdings, sources of income, cost of production, revenue generated and problems were asked to obtain the required information from respondents. Secondary data were collected from various sources such as government reports, research articles, books and websites.

Data Analysis

Collected data were coded in spreadsheet using MS-Excel 2021. Required statistical inference were made by using statistical software SPSS version 26 and MS-Excel 2021.

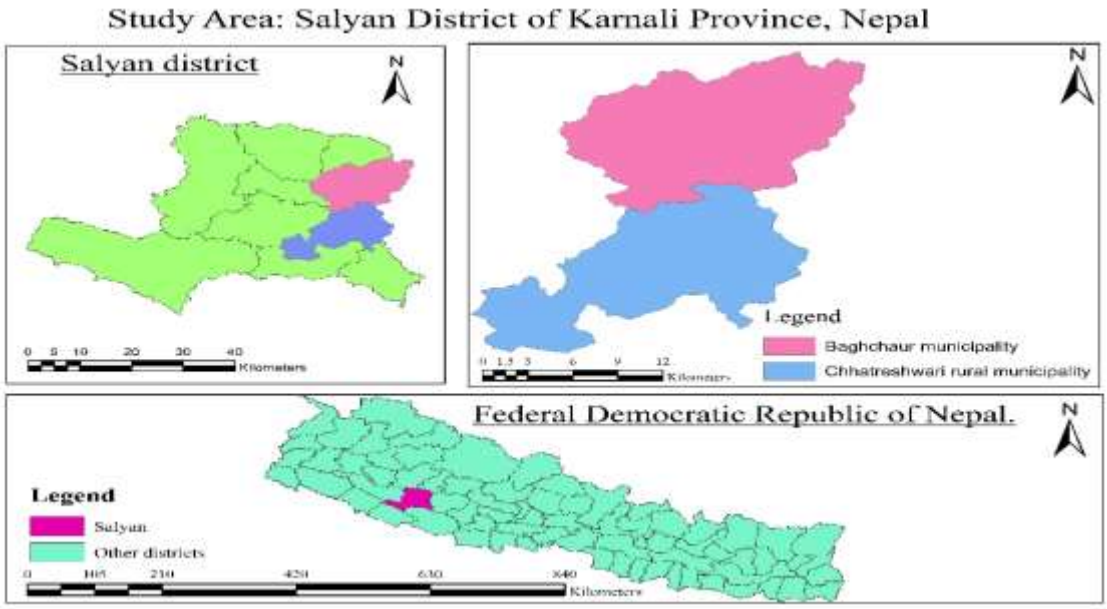

Fig. 1: Map of Nepal representing Salyan district and study area.

Gross Margin

Gross margin was calculated as:
Gross margin = Gross Return−Total variable cost
where Gross Return = Price of mandarin orange × Total mandarin production.
Total variable cost = Summation of all variable costs
Variable costs = Cost of saplings, organic manure, fertilizers, human labor, pesticides, transportation cost and other costs.

Benefit Cost Ratio

Benefit cost ratio of mandarin production was computed by using following formula.

$$Benefit\ cost\ ratio = \frac{Gross\ return}{Total\ variable\ cost}$$

Decision rule:

BCR > 1: positive net present value

BCR< 1: negative net present value

Production Function Analysis

Cobb-Douglas production function is most widely used linear regression model, which is used to determine the relationship between inputs used for the production of commodity and its output produced. The regression coefficients of CDPF indicates how the elasticity of each inputs changes the output of the production process. The following linear regression model was used to determine the technological relationship between inputs and output of the production process.

$$Y = aX_1^{b_1}X_2^{b_2}X_3^{b_3}X_4^{b_4}X_5^{b_5}X_6^{b_6}X_7^{b_7}X_8^{b_8}X_9^{b_9}e^u$$

where, Y is the total revenue generated by mandarin production in NRs. X_1 is the cost of saplings of mandarin orange, X_2 cost of organic manure, X_3 cost of fertilizers, X_4 cost of human labor, X_5 cost of transportation, X_6 cost of plant protection materials, X_7 cost of irrigation management, X_8 cost of agricultural tools, X_9 cost of depreciation, e is the error term and b_1, b_2, b_3.....b_9 represents the coefficients of respective inputs to be calculated.

Logarithmic transformation was done to obtain the data in normal distribution form which changes the above equation into following linearized equation.

$$ln\ Y = a + b_1 ln\ X_1 + b_2 ln\ X_2 + b_3 ln\ X_3 + b_4 ln\ X_4 + b_5 ln\ X_5 + b_6 ln\ X_6 + b_7 ln\ X_7 + b_8 ln\ X_8 + b_9 ln\ X_9 + u$$

where, ln is the natural logarithmic, a is the constant and u is the random distribution term.

Return to Scale Analysis

Return to scale is the economical tool to determine the response of output due to changes on inputs. It is computed by summing up the coefficients of inputs included in the regression model.

Return to scale = Summation of coefficients ($b_1 + b_2 + b_3 + ... + b_9$).

Decision rule:

RTS > 1: Increasing rate of return.

RTS = 1: Constant rate of return.

RTS < 1: Decreasing rate of return.

Garrett Ranking Technique

Garrett ranking technique was employed to rank the production and marketing problems faced by farmers in the study area as recommended by Dhanavandan S 2016. Farmers were asked to rank the different production and marketing problems according to their experience and mean garrett score was computed by using following procedure.

Computation of percentage position:

Percentage position = 100 (R_{ij} – 0.5)/N_j

Then, the garrett value was estimated by using garrett value chart and percentage position. Now the mean garrett score was obtained by dividing total garrett score by total numbers of respondents. Ranking was done on the basis of descending mean garrett score.

Results and Discussion

Demographic Characteristics

The mean age of the household head in the study area was found to be 47.73 years which ranged from 20 to 93 years (Table 1). Average age of household head in Chhatreshwari (49.10 years) and Baghchaur (46.41 years) were found to be statistically non-significant. Similarly, the average schooling years of the household head was recorded to be 5.94 years which was quite similar in Chattreshwari (6.25 years) and Baghchaur (5.64 years). About 83.33% of the households were headed by male household head while female headed households were about 16.67% in the study area. Male headed households were comparatively higher in Chhatreshwari (84.75%) than in Baghchaur (81.97%). Similarly, about 59.17% of the households were nuclear type of family with only two generations living together while 40.83% of the households were joint families where more than two generations live together. Chattreshwari had lager portion of nuclear family (67.80%) than joint type (32.20%), however households of Baghchaur were equally distributed as nuclear (50.82%) and joint (49.18%). The average family size in the study area was estimated to be 6.79 members per household with average male and female members of 3.43 and 3.37 per household respectively. The size of the family in Baghchaur was significantly higher (8.48 members HH^{-1}, p = 0.00) than that of Chhatreshwari (5.05 members HH^{-1}).

Table 1: Socio-economic and demographic characteristics of mandarin (*C. reticulata*) producing farmers in Salyan Nepal

Variables	Mean (n=120)	Chhatreshwari (n=59)	Baghchaur (n=61)	Mean difference	t-value	p-value
Age of household head	47.73(1.44)	49.10(1.87)	46.41(2.17)	2.69	0.94	0.35
Schooling years	5.94(0.46)	6.25(0.66)	5.64(0.66)	0.61	0.66	0.51
Male members	3.43(0.16)	2.56(0.17)	4.26(0.24)	-1.70***	-5.90	0.00
Female members	3.37(0.16)	2.49(0.16)	4.21(0.24)	-1.72***	-6.02	0.00
Total members	6.79(0.28)	5.05(0.26)	8.48(0.39)	-3.42***	-7.28	0.00
Economically active males	1.80(0.08)	1.75(0.11)	1.85(0.12)	-0.11	-0.65	0.52
Economically active females	1.76(0.08)	1.79(0.11)	1.74(0.10)	0.06	0.37	0.72
Total economically active members	3.55(0.13)	3.51(0.18)	3.59(0.18)	-0.08	-0.32	0.75
Dependency ratio	0.98(0.06)	0.53(0.08)	1.41(0.07)	-0.89***	-8.70	0.00
Upland area in hectare	0.44(0.04)	0.48(0.05)	0.41(0.06)	0.07	0.84	0.40
Low land in hectare	0.07(0.01)	0.07(0.02)	0.07(0.02)	0.00	-0.01	0.99
Total area in hectare	0.51(0.05)	0.54(0.06)	0.48(0.07)	0.07	0.74	0.46
Irrigated land in hectare	0.28(0.04)	0.42(0.05)	0.15(0.04)	0.26***	3.88	0.00
Unirrigated land in hectare	0.23(0.03)	0.13(0.03)	0.33(0.05)	-0.20***	-3.15	0.00
Experience years	10.31(0.68)	9.95(0.93)	10.66(0.99)	-0.71	-0.52	0.61
Production area in hectare	0.31(0.03)	0.30(0.04)	0.31(0.04)	-0.01	-0.17	0.87
Production trees	115.12(13.91)	94.75(11.51)	134.82(24.86)	-40.07	-1.46	0.15

Note: '***' indicates significance at 1% level; Values in parentheses are standard errors.

Larger family size in Chhatreshwari as compared to Baghchaur was formed due to larger numbers of male (4.26 members HH-1 vs 2.56 members H-1, p = 0.00) and female members (4.21 members HH-1 vs 2.49 members HH-1, p = 0.00) with statistically significant mean difference. Average numbers of independent family members in the study area were recorded to be 3.55 per household (male: 1.80 HH^{-1} & female: 1.76 HH^{-1}). Chhatreshwari and Baghchaur municipalities was found to have similar range of independent age group of members i.e., 3.51 (male: 1.75 members HH^{-1} & female: 1.79 members HH^{-1}) and 3.59 (male: 1.85 members HH^{-1} & female: 1.74 members HH^{-1}) respectively, however statistically non-significant. The dependency ratio prevailed in the family was estimated to be 0.98 in the district. Such ratio was found to be higher in Baghchaur (1.41) than Chhatreshwari (0.53) with statistically significant mean difference (0.89, p = 0.00). Total land holdings of the household in the overall study area were 0.51 hectare per household (Upland: 0.44 Ha HH^{-1} & Lowland: 0.07 Ha HH^{-1}). Mean land holdings of household in Chattreshwari was 0.54 hectare per household (Upland: 0.48 Ha HH^{-1} & Lowland: 0.07 Ha HH^{-1}) being in par with Baghchaur 0.48 hectare per household (Upland: 0.41 Ha HH^{-1} & Lowland: 0.07 Ha HH^{-1}). Out of the total land holdings of the household, mean land area under mandarin production in the study area was 0.31 hectare per household. Area under mandarin production in Chhatreshwari (0.30 Ha HH^{-1}) and Baghchaur (0.31 Ha HH^{-1}) were found to be statistically non-significant. Each household in the study area were found to have on an average of 0.28 hectare of irrigated land while remaining 0.23 hectare being deprived of irrigation facility. Average irrigated land area was found to be significantly higher in Chhatreshwari (0.54 Ha HH^{-1}) as compared to that of Baghchaur (0.15 Ha HH^{-1}) with statistically significant mean difference (0.26 Ha HH^{-1}, p = 0.00). In contrast, Baghchaur was found to have significantly higher unirrigated land size (0.33 Ha HH^{-1}, p = 0.00) than Chhatreshwari (0.13 Ha HH^{-1}). Mandarin producing farmers of Salyan district were found to have mean experience of 10.31 years which was found to be 9.95 years in Chhatreshwari and 10.66 years in Baghchaur municipality, however this was statistically non-significant. Similarly, average numbers of fruiting trees were found to be 115.21 per orchard in the study area. Farmers of Chhatreshwari had on an average of 94.75 fruiting trees in their orchard while farmers of Baghchaur had 134.82 fruiting trees in their orchard but found to be statistically non-significant.

Table 2. Cost of production of mandarin (*C. reticulata)*

Variable	Mean (n=120)	Chhatreshwori (n=59)	Baghchaur (n=61)	Mean difference	t value	p value
Variable cost in NRs Ha^{-1}						
Saplings	11463.57(1895.84)	9233.05(1563.61)	13620.95(3402.89)	-4387.90	-1.17	0.25
Organic manure	61315.81(4986.84)	60157.15(6052.16)	62436.48(7920.78)	-2279.33	-0.23	0.82
Fertilizers	41669.98(5334.86)	43252.34(6352.69)	40139.50(8557.56)	3112.84	0.29	0.77
Irrigation	749.34(656.07)	1332.88(1332.88)	184.93(86.78)	1147.952	0.86	0.39
Plant protection	51449.90(6162.77)	47071.45(7703.83)	55684.80(9596.12)	-8613.35	-0.70	0.49
Transportation	24397.25(7595.02)	33372.15(14681.49)	15716.61(4580.33)	17655.54	1.15	0.26
Human labor	53567.17(5428.84)	46318.47(6727.53)	60578.22(8426.60)	-14259.80	-1.32	0.19
Total variable cost	227309.41(19270.10)	206876.58(24711.81)	247072.31(29404.40)	-40195.70	-1.05	0.30
Fixed costs NRs Ha^{-1}						
Annual interest	629.12(629.12)	0.00(0.00)	1237.61(1237.61)	-1237.61	-1.00	0.32
Agricultural tools	9643.23(2744.00)	2207.58(1406.80)	16835.08(5076.79)	-14627.50	-2.78**	0.01
Depreciation	482.16(137.20)	110.38(70.34)	841.75(253.84)	-731.37	-2.78**	0.01
Total fixed costs	10754.51(2930.88)	2317.96(1477.14)	18914.45(5405.37)	-16596.50	-2.96***	0.00
Total costs NRs Ha^{-1}	238063.92(20928.18)	209194.54(24826.27)	265986.76(33259.29)	-56792.20	-1.37	0.17

Note: '***' & '**' indicate significance at 1% & 5% levels respectively; Values in parentheses are standard errors.

Cost of Production

Various costs of variable and fixed nature were estimated to figure out the total cost of production (Table 2). The average total cost of mandarin production in Salyan district was estimated to be NRs 238063.92 per hectare. Total cost of production of Chhattreshwari (NRs 209194.54 Ha^{-1}) and Baghchaur (NRs 265986.76 Ha^{-1}) was found to be statistically non-significant. Out of the total cost incurred for orange production, majority (95.48%) of the cost were spent for purchase of variable inputs (Fig 2). The mean total variable cost was estimated to be NRs 227309.41 per hectare in the district. Average total variable cost in Chhatreshwari (NRs 206876.58 Ha^{-1}) was in par with that of Baghchaur (NRs 247072.31 Ha^{-1}) with statistically non-significant mean difference. Among the expenses on various kinds of variable inputs, organic manure was found to hold the majority (26.97%) share of the total variable cost. Organic manure is the major variable input required for production of horticultural crops (Bajracharya & Sapkota, 2017). This might be due to higher price and requirement of bulky organic manure like FYM and compost. Average expenditure organic manure was calculated to be NRs 61315.81 per hectare which was similar in Chhatreshwari (NRs 60157.15 Ha^{-1}) and Baghchaur (NRs 62436.48 Ha^{-1}) with statistically non-significant mean difference (NRs 2279.33 Ha^{-1}, p = 0.82). Following this, human labor cost ranked in second major variable input (23.57%) during the mandarin production with NRs 53567.17 per hectare. Average labor cost incurred in Chhatreshwari (NRs 46318.47 Ha^{-1}) and Baghchaur (NRs 60578.22 Ha^{-1}), but found to be statistically non-significant. However, Baral *et al*., 2021 estimated that labor cost as the first major input holding almost 43.82% of variable cost during orange production which might be due to variation in cost of inputs at different regions of the nation. Furthermore, average expenses on plant protection materials were estimated to be NRs 5144.90 per hectare in the district which was found to be third major variable input (22.63%). Both Chhatreshwari (NRs 47071.45 Ha^{-1}) and Baghchaur (NRs 55684.80 Ha^{-1}) municipalities were found to have similar range of expenses on pesticides and other agrochemicals. The fourth major variable cost was incurred by fertilizer cost (18.33%) with average annual cost of NRs 41669.98 per hectare in the overall study area. Average annual expense on fertilizers in Chhatreshwari (43252.34 Ha^{-1}) and Baghchaur (NRs 401339.50 Ha^{-1}) were found to have statistically non-significant mean difference. Likewise, cost of transportation (10.73%) in the study area was found to be NRs 24397.25 per hectare on an average which ranges as similar as in Chhatreshwari (NRs 33372.15 Ha^{-1}) and Baghchaur (NRs 15716.61 Ha^{-1}). The mean cost of saplings (5.04%) was estimated to be NRs 11463.57 per hectare in the district, however there was no significant difference between mean sapling cost of Chhatreshwari (NRs 9233.05 Ha^{-1}) and Baghchaur (NRs 13620.95 Ha^{-1}). Average annual expense on irrigation was NRs 749.34 per hectare in the study area with similar range of expenditure in Chhatreshwari (NRs 1332.88 Ha^{-1}) and Baghchaur (NRs 184.93 Ha^{-1}). However, none of the variable cost were found to have statistically significant mean difference. The average total fixed cost was estimated to be NRs 10754.51 per hectare in Salyan district. Average annual fixed cost was found to be significantly higher in Baghchaur (NRs18914.45 Ha^{-1}, p = 0.00) than that of Chhatreshwari (NRs 2317.96 Ha^{-1}). Mean expense on annual interest was estimated to be NRs 629.12 per hectare in the district. Expenditure on annual interest in Baghchaur was higher (NRs 1237.61 Ha^{-1}) than Chhatreshwari (NRs 0.00 Ha^{-1}),

however mean difference was statistically non-significant. Similarly, average expenditure on purchase of agricultural tools was found to be NRs 9463.23 per hectare in the study area. The mean expense on agricultural tools in Baghchaur (NRs 16835.08 Ha^{-1}, $p = 0.00$) was found to be significantly higher than Chhatreshwari (NRs 2207.58 Ha^{-1}). Furthermore, depreciation cost of agricultural tools was calculated to be NRs 482.16 per hectare in the overall study area with significantly higher expenditure in Baghchaur (NRs 841.75 Ha^{-1}, $p = 0.00$) than in Chhatreshwari (NRs110.38 Ha^{-1}).

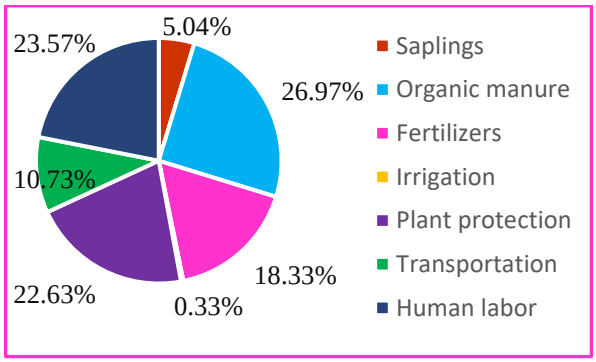

Fig 2: Percentage share of different inputs required for mandarin production.

Production, Productivity and Profitability of Mandarin Production

The average annual production of orange per household was 3560.58 Kgs in Salyan district (Table 3). The total production of mandarin oranges in Chhatreshwari and Baghchaur were 3597.08 Kgs and 3525.28 Kgs per household respectively with statistically non-significant mean difference. Similarly, the productivity of mandarin orange was estimated to be 14.60 tons per hectare (41.71 Kgs $tree^{-1}$) in the study area which was estimated to be 14.91 tons per hectare (46.38 Kgs $tree^{-1}$) in Chhatreshwari and 14.30 tons per hectare (37.18 Kgs $tree^{-1}$) in Baghchaur municipality with statistically non-significant mean difference. Average gross revenue generated by household in the district was estimated to NRs 248235.41 per year (NRs 988963.52 Ha^{-1} $year^{-1}$). Gross revenue in Chhatreshwari (NRs 281950.07 HH^{-1} $year^{-1}$ or NRs 1117491.78 Ha^{-1} $year^{-1}$) than Baghcahur (NRs 215626.15 HH^{-1} $tree^{-1}$ or NRs 864649.31 Ha^{-1} $year^{-1}$) with statistically non-significant mean difference.

Benefit Cost Analysis

The mean cost of production per kilogram of orange was estimated to be NRs 21.53, while price per kilogram was recorded to be NRs 63.18 which shows profit of NRs 41.66 per kilogram of the orange in the study area. The unit cost of production in Baghchaur (NRs 25.19, $p = 0.07$) was significantly higher than that of Chhatreshwari (NRs 17.74). Average market price of orange in Chhatreshwari and Baghchaur was NRs 71.32 per kilogram and NRs 55.31 per kilogram leading to average profit of NRs 53.58 and NRs 30.12 per kilogram respectively. The differences across the municipalities were statistically significant at 1% level of significance. The benefit cost ratio of mandarin orange production in Salyan district was estimated to be 5.07 indicating orange cultivation as profitable business with average revenue return of NRs 5.07 (NRs 4.07 benefit) per each NRs 1 invested. Baral *et al*., 2021 in their study also found that orange production as profitable agribusiness with the mean BC ratio of 3.29 and 2.58 in Parbat and Baglung district respectively. Similarly, Regmi *et al*., 2020 and Gautam *et al*., 2020 also revealed the similar findings with BCR of 1.62 in Dailekh and 1.90 in Gulmi district of Nepal. Also, Parajulee *et al*., 2021 got the BCR of 2.81 in their study on sweet orange in Sindhli district. BC ratio of Chattreshwari was found to be 6.21 while that of Baghchaur was estimated to be 3.96. This difference across two municipalities was statistically significant (2.25, $p = 0.00$).

Table 3: Production, profitability and BC ratio of mandarin *(C. reticulata)* production in Salyan Nepal.

Particulars	Mean (n=120)	Chhatreshwari (n=59)	Baghchaur (n=61)	Mean difference	t-value	p-value
Production Kgs HH^{-1}	3560.58(319.79)	3597.08(399.03)	3525.28(500.08)	71.81	0.11	0.91
Productivity tons Ha^{-1}	14.60(1.14)	14.91(1.81)	14.30(1.40)	0.61	0.27	0.79
Productivity Kgs $tree^{-1}$	41.71(2.90)	46.38(4.48)	37.18(3.64)	9.20	1.59	0.11
Total Revenue HH^{-1}	248235.41(25415.63)	281950.07(36537.68)	215626.15(35157.41)	66323.92	1.31	0.19
Revenue Ha^{-1}	988963.52(94666.25)	1117491.78(160924.87)	864649.31(101136.74)	252842.46	1.33	0.19
Cost NRs Kg^{-1}	21.53(2.03)	17.74(2.57)	25.19(3.08)	-7.45*	-1.86	0.07
Price NRs Kg^{-1}	63.18(1.72)	71.32(2.71)	55.31(1.58)	16.01***	5.10	0.00
Profit NRs Kg^{-1}	41.66(2.86)	53.58(3.74)	30.12(3.78)	23.46***	4.41	0.00
Benefit Cost Ratio	5.07(0.37)	6.21(0.62)	3.96(0.37)	2.25***	3.10	0.00

Note: '***', '**', '*' indicate significant at 1%, 5% and 10% levels respectively. Values in parentheses are standard errors.

Production Function Analysis

The F statistic (37.130) of the model was statistically significant at 1% level of significance indicating the higher explanatory power of the model (Table 4). The R^2 value of the model was estimated to be 0.699 (Adjusted R^2: 0.680) indicating that 69.9% of variations in the dependent variable were explained by independent variables included in the linear regression model.

Other variables keeping constant, increasing expense on sapling cost by 1% would increase the return from orange by 0.086% however, this was statistically non-significant. But the result was in contrast with (Gautam *et al*., 2020) who found that increased seedling cost would negatively influence the return. The result shown that increase of organic manure cost by unit percentage would increase the return from orange production by 0.212% which was statistically significant (p = 0.002). On the other hand, when expense on fertilizers were increased by 1%, it would result into increased return from the enterprise by 0.012%, but the relationship was statistically non-significant. Similarly, human labor cost when increased by 1% would increase the return by 0.656%, this increment was also statistically significant (p = 0.000). This finding was in line with (Baral *et al*., 2021) and (Gautam *et al*., 2020) who found that the increment in plant nutrients and human labor cost would significantly increase the return from orange production. Furthermore, the regression coefficient of transportation cost indicated that the increasing the cost by 1% would increase the return from orange production by 0.016%, however this increment was statistically non-significant. The coefficient of plant protection materials costs indicates that increasing the expense on pesticide by 1% would rise the return by 0.055%, which was statistically significant (p = 0.060). The cost of irrigation management in orange orchard if increased by 1%, it was evident to impact negatively or decrease the return would decrease by 0.100%. Such decrement in return was statistically significant at 5% level of significance.

Return to Scale Analysis

The summation of coefficients of the regression was estimated to be 0.936 which indicate the decreasing rate of return in the mandarin production. This shows that additional input cost incurred in the production of mandarin will generate lesser and lesser return due to lesser additional output generated as compared to additional inputs supplied. Bajracharya & Sapkota, 2017 also reported the return of scale below the unity in potato cultivation in Baglung district. However, our finding was in contrast to Baral *et al*., 2021 who estimated return of scale to be more than unity (1.097).

Problems of Mandarin Production

Various production and marketing problems faced by the farmers were studied by using Garrett ranking model technique. Problems encountered during the production process of orange were included as: lack of technical service, lack of quality saplings, incidence of disease and pest, lack of high yielding cultivars, lack of sufficient irrigation and Lack of adequate manure an fertilizers as "production problems" while marketing issues such as lack of marketing knowledge, influences of middlemen, lack of storage facilities, lack of safe transportation facilities, high post-harvest losses and lack of post-harvest handling knowledge were categorized as "marketing problems".

Table 4: Cobb-Douglas production function of mandarin *(C. reticulata)* production in Salyan, Nepal.

Explanatory variables	Coefficient	Standard error	t value	p value
Log sapling cost	0.086	0.065	1.330	0.188
Log organic manure cost	0.212***	0.067	1.380	0.002
Log fertilizer cost	0.012	0.018	0.660	0.511
Log human labor cost	0.656***	0.087	7.520	0.000
Log transportation cost	0.016	0.019	0.850	0.398
Log plan protection cost	0.055*	0.029	1.900	0.060
Log irrigation management cost	-0.100**	0.047	-2.140	0.035
Constant	1.240***	0.300	4.130	0.000
Number of observations	120			
F statistic	37.130***			
R square	0.699			
Adjusted R square	0.680			
Return of scale	0.936			

Note: '***', '**' & '*' indicate significance at 1%, 5% and 10% levels respectively;Values in parentheses are standard errors.

Production Problems

The result revealed that the first major issue of mandarin production in the study area was ranked to be "Incidences of diseases and pests" in Salyan district including both of the municipalities (Table 5). Second major production problem was found to be lack of technical services in the entire study area with similar results in Chhatreshwari. However, farmers of Baghchaur ranked lack of quality saplings as second major issue of mandarin production. Similarly, lack of quality saplings was considered to be the third major production constraint faced by farmers of the district inluding Chhatreshwari but third rank was given to lack of technical services in the case of Baghchaur municipality. Coming to the fourth rank, the respondents of overall study area ranked lack of irrigation as fourth major constraint. However, the comparison responses between two municipalities shown that farmers of Chhatreshwari and Baghchaur ranked lack of manures and fertilizers and lack of sufficient irrigation as their fourth major production constraints. Lack of manures and fertilizers and lack of high yielding cultivars was ranked as fifth and sixth major production constraints in the district. In contrary, in Chhatreshwari "lack of manures and fertilizers" and "lack of high yielding cultivars were ranked as fifth and sixth major problems respectively. Furthermore, farmers of Baghchaur municipality ranked "lack of high yielding cultivars" as fifth and "lack of manures and fertilizers" as sixth major issue of mandarin production.

Marketing Problems

"Influence of middlemen" during the marketing of orange was found to be the major marketing issue in Salyan district with first rank position (Table 6). After this, second rank was given to "lack of marketing knowledge" in overall study area including Chhatreshwari rural municipality. Rural farmers do not have easy access to marketing information and are unable to make market-oriented farm decisions. Farmers of Baghchaur municipality ranked "lack of storage facilities" as second major constraint which was ranked as third issue faced by farmers in Chhatreshwari and overall district. As orange is the perishable commodity, it has to be stored under controlled environmental condition in order to enhance its shelf life. Proper storage facilities also help farmers to get higher price of the commodity during lean period if surplus is stored well. Lack of safe transportation facility was ranked as fourth major marketing problem of orange production in the study area. Proper road conditions, well equipped vehicles and carets are needed to ensure the safe transportation of fresh and perishable commodities. High post-harvest loss was ranked to be fifth major marketing problem, as rough harvesting, handling, transportation and storage conditions may result into higher post-harvest loss of the fruits. Furthermore, lack of post-harvest handling techniques was ranked as sixth major problem faced by the orange producing farmers in Salyan district. There were no variations in ranks of fourth, fifth and sixth major marketing constraints between Chhatreshwari rural municipality and Baghchaur municipality.

Table 5: Production problems of mandarin *(C. reticulata)* in Salyan, Nepal

Problems	**Mean score (n=120)**	**Rank**	**Chhatreshwari (n=59)**	**Rank**	**Baghchaur (n=61)**	**Rank**
PP Technician	57.96	II	61.15	II	54.87	III
PP Quality Seedling	55.83	III	55.22	III	56.43	II
PP Pest/Disease	71.91	I	70.47	I	73.30	I
PP Varieties	32.57	VI	32.92	VI	32.25	V
PP Irrigation	42.64	IV	37.00	V	48.10	IV
PP Manure	34.91	V	37.90	IV	32.02	VI

Table 6: Marketing problems of mandarin *(C. reticulata)* in Salyan, Nepal

Problems	**Mean score (n=120)**	**Rank**	**Chhatreshwari (n=59)**	**Rank**	**Baghchaur (n=61)**	**Rank**
MP MK	58.30	II	60.44	II	56.18	III
MP Middleman	69.26	I	69.73	I	68.75	I
MP Storage	57.27	III	57.88	III	56.57	II
MP transportation	45.07	IV	43.95	IV	45.75	IV
MP Post harvest loss	39.47	V	37.93	V	40.23	V
MP post-harvest training	31.45	VI	29.86	VI	32.39	VI

Conclusion

Majority of the households were headed by male family members. Average age and schooling were 47.73 and 5.94 years respectively. Total numbers of economically active age group were 3.55 per household with the dependency ratio of 0.98 in the study area. Total land holdings of orange growing household was 0.51 hectare out of which 0.31 hectare was under orange cultivation. Agricultural land of each household was partially irrigated i.e., 0.28 hectare remaining 0.23 hectare was unirrigated. Total cost of production of mandarin orange was NRs 238063.92 per hectare out of which variable cost incurred NRs 227309.41 per hectare (95.48%). Highest portion of cost was spent for organic manure (26.97%) which was immediately followed by human labor (23.57%), plant protection materials (22.67%), fertilizers (18.33%), transportation (10.73%), saplings (5.04%) and irrigation management (0.33%). The total production of mandarin oranges in Salyan district was 3560.58 Kgs per household with productivity of 14.60 tons per hectare and 41.71 Kgs per tree. The BC ratio of orange production in the district was 5.07 indicating as profitable business with almost 4.07 rupees of benefit from the investment of NRs 1. Increasing the investment in organic manure, human labor and plant protection materials would significantly increase the return by 0.212%, 0.656% and 0.055% respectively. Similarly, increased investment on saplings, fertilizers and transportation by 1% would increase the return by 0.086%, 0.012% and 0.016% respectively. And irrigation cost when increased at same percentage would significantly decrease the income by 0.100%. The return to scale was 0.936 representing decreasing rate of return from orange production in the district. Incidences of pest and diseases was found to be the major production constraint of mandarin production in Salyan district which was followed by lack of technical services, lack of quality planting materials, lack of sufficient irrigation, lack of manures or fertilizers and lack of high yielding resistant cultivars. Similarly, influence of middlemen, lack of marketing knowledge, lack of storage facilities, lack of safe transportation, high post-harvest loss and lack of scientific post-harvest handling measures were the major marketing issues sequentially. Results show that there is immense need of technological interventions such as high yielding resistant cultivars, efficient pest control measures, quality enhancement of organic manures, modern orchard management strategies so that the production, productivity and quality of mandarin oranges increase. Storage facilities are of utmost importance in the district so the surplus produce is stored safely until the market demand and price is desirable, this would help farmers to bare unexpected market failures. Furthermore, policy level intervention is also recommended to overcome the monopolistic price determination by middlemen, for ease access to agricultural credits and quick dissemination of technological supports.

Authors' Contribution

S Dahal & B Dangi designed the research plan; S Dahal, B Dangi, P Bista, AS Upadhyaya, S Bharati performed experimental works & collected the required data. S Dahal & S Dulal analysed the data; S Dahal prepared the manuscript. All authors critically revised and finalized the manuscript. Final form of manuscript was approved by all authors.

Conflict of Interest

The authors declare that there is no conflict of interest with present publication.

References

Bajracharya M & Sapkota M (2017) Profitability and productivity of potato (*Solanum tuberosum*) in Baglung district, Nepal. *Agriculture and food security.* **6**(47): 1-8. DOI: 10.1186/s40066-017-0125-5

Baral S, Marahatta S & Shrestha A (2021) Economics of production and marketing of mandarin in Parbat and Baglung districts of Nepal. *International journal of agriculture, environment and food sciences.* **5**(3): 323-328. DOI: 10.31015/jaefs.2021.3.9

Dhanavandan S (2016) Application of garret ranking technique: practical approach. *International journal of library and information studies.* **6**(3): 135-140.

Gautam A, Bhattarai C Khadka, R Bhandari D & Regmi R (2020). Economics of production and marketing of mandarin in Gulmi, Nepal. *Food and agribusiness management.* **1**(1): 1-4. DOI: 10.26480/fabm.01.2020.01.04

Goldenberg L, Yaniv Y, Porat R & Carmi N (2018). Mandarin fruit quality: A review. *Journal of the science of food and agriculture.* **98**(1): 18-26. DOI: 10.1002/jsfa.8495

Mahato N, Sharma K, Sinha M & Cho HM (2018). Citrus waste derived nutra-/pharmaceuticals fir health benefits: Current trends and future prospectives. *Journal of functional foods.* **40**(1): 307-316. DOI: 10.1016/j.jff.2017.11.015

MOALD (2021). Statistical information on Nepalese agriculture. Agribusiness promotion and statistics division, ministry of agriculture and livestock development, government of Nepal.

NCRP. (2016) Annual Report. Dhankuta, Nepal: National Citrus Research Program,Nepal Agriculture Research Council

Parajulee D, Kandel A, Panta S & Devkota K (2021). Economic analysis of sweet orange in Sindhuli district of Nepal. *International journal of social sciences and management.* **8**(3): 396-400. DOI: 10.3126/ijssm.v8i3.38504

Patil SB, Brodbelt SJ, Miller GE & Turner GN (2002). Potential health benefits of citrus: An overview. *ACS symposium series, Americal chemical society.* 1-16. DOI: 10.1021/bk-2006-0936.ch001

Regmi R, Pandey RS & Regmi R (2020). Economics of mandarin (*Citrus reticulata* Blanco) production in Dailekh, Nepal. *Food and agribusiness management.* **1**(1): 10-15. DOI: 10.26480/fabm.01.2020.10.15

Sapkota M, Joshi PN, Kattel RR & Bajracharya M (2017). Determinants of maize seed income and adoption of foundation seed production: evidence from Palpa district of Nepal. *Agriculture and food security.* **6**(41): 1-10. DOI: 10.1186/s40066-017-0119-3

Shrestha K (1996) World Commercial Fruits at a Glance (1st ed.). Kathmandu, Nepal: Technica Concern.

Silalahi J (2002). Anticancer and health protective properties of citrus fruit components. *Asia pacific journal of clinical nutrition.* **11**(1): 79-84. DOI: 10.1046/j.1440-6047.2002.00271.x

Singh B, Singh PJ, Kaur A & Singh N (2020). Phenolic composition, antioxidant potential and health benefits of citrus peel. *Food research international.* **132**(1): 109-114. DOI: 10.1016/j.foodres.2020.109114