



RESEARCH ARTICLE

PROFITABILITY, PRODUCTIVITY AND MARKETING OF FISH IN DANG DISTRICT OF LUMBINI PROVINCE, NEPAL

Shishir Dahal^{a*}, Bijaya Dangi^a, Raman Kumar Dangi^a, Prajwal Adhikari^a, Prakash Bist^a, Aarjal Bhandari^a, Milan Bhattarai^b

^aInstitute of Agriculture and Animal Sciences (IAAS), Tribhuvan University, Nepal.

^bDepartment of Agriculture economics and social sciences, Institute of Agriculture and Animal Sciences (IAAS), Tribhuvan University, Nepal.

*Corresponding Author Email: ag.dahalshishir@gmail.com

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ABSTRACT

Fish is the rich source of various essential nutrients for wellbeing of human physical and mental health. Production of fish is one of the major enterprises preferred by farmers in Dang valley due to its suitability, profitability and higher market demand. Both of the lower and upper valleys of Dang district are considered to be feasible for high scale fish production. But due to lack of research works on production, productivity, profitability and marketing channels the potentiality is not explored at its utmost level. So, this research was aimed to assess the production, productivity and profitability in a comparative way using independent t test. For this study, two municipalities of each domain i.e., Lamahi municipality and Gadawa rural municipality of lower and Tulsipur and Ghorahi sub-metropolitan municipalities of upper dang valley were selected purposively. Pre tested semi-structured questionnaires were used for face-to-face interview with 27 and 23 randomly selected households (total samples n=50) of lower and upper valley respectively. Collected data was coded and required results such as socio-economic and demographic characteristics, profitability, BC ratio, production function analysis and problem indexing were obtained with the help of statistical software SPSS version 26 and MS-Excel. The average productivity and BC ratio of farms was estimated to be 10.65 tons⁻¹ ha and 2.12 in the study area. The cost of production per Kg of fish was found to be NRs 244.78 with average selling price of NRs 300.06. Increase in fingerling and feed expenditure each by 1% would significantly increase the income by 0.830% and 0.329% respectively. Similarly, expenditure on organic manure, chemical fertilizers and medicine when increased by unit percentage would increase the income by 0.084%, 0.015% and 0.011% respectively. The return of scale was found to be 0.028 representing decreasing rate of return. The lower productivity of farms is due to incidences of diseases and parasites, lack of technical know-how, lack of quality fingerlings, inadequate availability of manures and fertilizers and seasonal labor force. Lower farmgate price, unhealthy competition with Indian fish products, higher price gap between producers and consumers, long and lack of safe transportation are the issues causing detrimental effects during marketing of the fresh fishes in the study area.

KEYWORDS

Benefit-cost ratio, Production Function, Fish.

1. INTRODUCTION

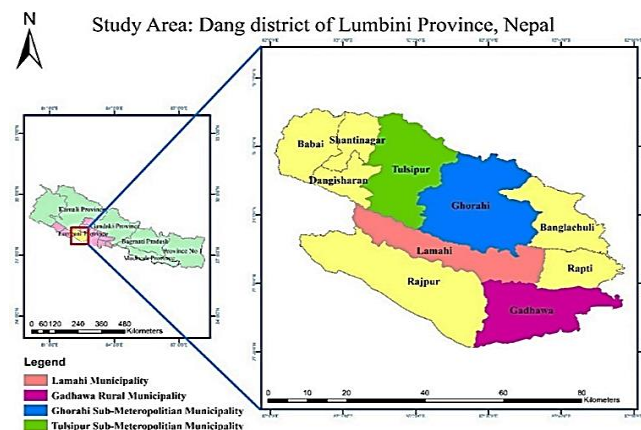


Figure 1: Map of Nepal representing Dang and study areas.

Fish is the major food source of humankind since ancient history (Tacon and Metian, 2013). Fish is super rich source of animal protein, omega fatty acids, folic acids, vitamins and other essential micro-nutrients which are crucial for better physical, mental and cardiac health (Limbu and Subba 2013; Swanson et al., 2012). Regular intake of fish or animal protein is recommended to be at least 30 gm per day per person by government of Nepal (DFQTC, 2017). However, per capita fish consumption is still under the recommended level ranging from 354 gm per year in far-western to 1730 gm per year in central development region of Nepal (Gurung, 2016). Approximately 36% of children under 5 years of age are stunted, 27% are underweight and 10% of the children are wasted due to acute malnutrition (WFP, 2022). People of rural areas such as Far-western and Karnali province are at the risk of extreme malnutrition and food insecurity. Nepal has tremendous opportunities of fish production via commercialization of cold as well as warm water fisheries. In recent days, fish production has considerable share in national GDP (1.13%) and AGDP (4.18%) with annual production of 73,693 mt and productivity of 5.3 mt⁻¹ ha (MOALD, 2021). Fishes are cultured over the varied agro-ecological zones in the country. Dang, is one of the major fish producing district with annual production of 906 metric tons. The cross-border policy between

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Nepal and India has influenced the socio-economic conditions of small enterprises in the border regions, this could bring considerable disturbances in price determination of Nepalese fishes resulting into economical loss to the small farmers (Paudel and Devkota, 2018). Huge interventions in input supply especially quality fingerlings and feeds are utmost important to reduce cost of production and rapid commercialization of fishery sub sectors. This study aims to find out the present scenario of fish production, productivity, profitability, constraints prevailing in the study area.

2. METHODOLOGY

Dang is the major fish producing district of the country. The district can be categorized two geographical domains as: Lower valley and upper valley. To study the economics of fish production in two different geographical domains two Lamahi municipality (27.8710°N, 82.5727°E and Gadhawa rural (27.7583°N, 82.5294°E) of lower Dang and Ghorahi (28.0588°N, 82.4861°E) and Tulsipur (28.1545°N, 82.3235°E) sub-metropolitan municipalities were selected purposively (Table 1). The study site is represented in Figure 1. Random sampling technique was employed and 50 out of 96 registered farms were selected for the study out of which 27 farms were selected from lower and 23 from upper valley. Primary data were collected by face-to-face interview with farmers using semi-structured and pre-tested questionnaires whereas secondary data were collected from reports, published articles or books of governmental and related organizations. Collected data were entered in MS excel and analysis was conducted by using statistical software SPSS version 26. Means were compared using independent t test.

2.1 Gross Margin Analysis

Gross margin was calculated by using following mathematical formula.

Gross margin = Gross return – Total variable cost. Where, gross return = Price of fish per Kg x Quantity of fish produced in Kgs and Total variable cost = Summation of all variable costs.

Variable costs = Cost incurred for fingerlings, feed, labor, energy, agriculture lime, medicines and technical assistance.

2.2 Benefit Cost Analysis

BC analysis was carried out via given formula.

$$BCR = \frac{\text{Gross return}}{\text{Total variable cost}}$$

2.3 Production Function Analysis

Cobb Douglas production function is considered to be the most widely used regression model to estimate the technological relationship between inputs used and output produced (Asamoah et al., 2012; Chiang et al., 2004). The coefficients represent the elasticity of respective inputs, and its summation provides the value of return to scale. The following form of CDPF was used:

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

where Y is the total income from fish production in hectare (NRs.), X_1 cost of fingerlings (NRs.), X_2 cost of feed (NRs.), X_3 expenditure on labor (NRs.), X_4 expenditure on organic manure (NRs.), X_5 expenditure on chemical fertilizers (NRs.), X_6 expenditure on agriculture lime, X_7 expenditure on energy, X_8 expenditure on medicine, X_9 expenditure on technical assistance, e error term and $b_1 \dots b_9$ are coefficients to be estimated. The CDPF in the form expressed above was linearized in a logarithmic function for the ease in computation. where \ln = natural logarithm, a = constant and u = random disturbance term. The CDPF in the form expressed above was linearized in a logarithmic function for the ease in computation.

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

where \ln = natural logarithm, a = constant and u = random disturbance term.

2.4 Return to Scale Analysis.

Return to scale is the economical tool that indicates the response of output due to overall proportional change in inputs allocated. It is computed through summation of coefficients obtained from Cobb Douglas production function (Bajracharya & Sapkota 2017).

$$\text{Return to scale} = (b_1 + b_2 + b_3 + \dots + b_9).$$

Decision rule:

Return to scale > 1: Increasing rate of return

Return to scale = 1: Constant rate of return

Return to scale < 1: Decreasing rate of return

2.5 Problems Indexing/Scaling.

The importance of production and marketing problems were estimated on the basis of perception of farmers towards them. The production and marketing problems were ranked from 1 to 5 and 1 to 6 respectively on the basis of their higher to lower severity. These problems were compared between lower and upper valley of the district. The index of importance was calculated by using following formula. $\text{Iimp} = \frac{\sum(S_i f_i)}{N}$ where,

Iimp = Index of importance

S_i = Scale value

f_i = frequency of importance given by the respondents

N = Total numbers of respondent

3. RESULTS AND DISCUSSION

3.1 Socio-Economic and Demographic Characters.

Various socio-economic and demographic characteristics were studied in order to find out the present scenario of the farming community (Table 1). The age of respondents was found to ranges between 16 years to 76 years with mean average of 47.82 years in the study area which was 45.89 years and 50.09 years in lower and upper dang respectively however the mean difference (4.20 years) was found not to be statistically significant. The average years of schooling of household head was found to be 8.86 in the selected study area. Numbers of schooling years of household were found to be similar in lower valley (9.67) and upper valley (7.91), mean difference being statistically non-significant. Study area was found to be dominated by male house hold heads (92.00%) as compared to female household head (8.00%). Male dominance in house hold head was

found to be 85.18% in lower valley with only 4.15% of female household heads. But upper valley was found to fully dominated by male household heads i.e., 100%. Overall, Chhetri (44.00%) was found to be the major ethnicity of the studied area which was followed by Janajati (26.00%), Bhramin (24.00%), Dalit (4.00%) and other ethnical groups (2.00%). Average family size of the studied area was found to be 5.86 which was ranged from 3 and 14 numbers of family members. Family size of lower valley (5.52) and upper valley (6.26) was found statistically non-significant. Dependency ratio is the ratio of dependent family members (below 15 and above 60) to the economically active members. The higher dependency ratio supports less household saving and investment leading to increased probability of poverty and food insecurity (Maharjan and Joshi, 2011). Average dependency ratio of the families belonging to the area was observed to be 0.30 with total economically active members being 3.89 (male: 2.12 and female: 1.88). Both lower and upper valleys were found to be similar with dependency ratio 0.29 (male: 1.93 and female 1.81) and 0.30 (male: 2.35 and 1.96) respectively with statistically non-significant mean difference. Average land holdings of respondents were found to be 2.13 ha in the study area with no significant difference between lower (2.40 ha, $p = 0.29$) and upper (1.80 ha) dang valley. Mean unirrigated land per household was found to be 0.20 which was found to be significantly higher in upper dang valley (0.43 ha per HH) than lower valley (0.00 ha per HH) with mean difference of 7.91 ha per HH ($p = 0.00$). Similarly, mean irrigated land holdings was found to be 1.89 ha per HH with significant difference between lower valley (2.34 ha per HH, $p = 0.07$) and upper valley (1.37 ha per HH). In contrast, privately owned land was found to be 1.23 ha per HH in study area with no significant difference ($p = 0.22$) between lower valley (1.42 ha per HH) and upper valley (3.35 ha per HH). Holdings of leased land was found to be 0.85 ha per HH in the study area. Lower valley and upper valley exhibited 0.90 ha per HH and 2.91 ha per HH of leased land holdings with no statistically significant difference ($p = 0.81$). Average numbers of fish ponds were found to be 5.32 in the study area. The farmers of lower valley found to own significantly higher numbers of fish ponds lower valley (6.85) and upper valley (6.26) with mean difference of 3.33 ($p = 0.03$). Furthermore, average land area used for fisheries was found to be 1.47 ha per HH but had found to be statistically significant between lower valley (1.85 ha per HH, $p = 0.08$) and upper valley (2.35 ha per HH). The farmers of lower valley were found to be more experienced with mean years of experience of 11.70 years than farmers of upper dang valley with mean experience of 1.96 years ($p = 0.00$). Stocking density is the numbers of fishes stocked per unit water space. The

optimum stocking density is of prime importance for enhanced feed efficiency and higher fish growth (K. R. Sharma et al., 1999) The mean stocking density was recorded to be 17.67 per square meter in the study

area. Lower and upper valleys also had similar range of stocking densities i.e., 2.61 and 29.50 per square meter no statistically significant difference (p = 0.25).

Table 1: Socioeconomic and Demographic Characteristics.						
Variables	Total Mean (n=50)	Lower Dang (n=27)	Upper Dang (n=23)	Mean difference	t value	p-value
Age of respondent	47.82 (12.80)	45.89 (12.30)	50.09 (13.27)	-4.20	-1.16	0.25
Schooling of HH (years)	8.86 (4.20)	9.67 (3.84)	7.91 (4.496)	1.75	1.49	0.14
Number of male family members	3.08 (1.47)	2.85 (1.26)	3.35 (1.67)	-0.50	-1.20	0.24
Number of female members	2.84 (1.93)	2.78 (1.81)	2.91 (2.11)	-0.14	-0.24	0.81
Total number of family members	5.86 (2.84)	5.52 (2.24)	6.26 (3.43)	-0.74	-0.92	0.36
Economically active male members	2.12 (1.08)	1.93 (0.83)	2.35 (1.30)	-0.42	-1.39	0.17
Economically active female members	1.88 (1.00)	1.81 (0.68)	1.96 (1.30)	-0.14	-0.49	0.62
Total economically active members	3.98 (1.86)	3.70 (1.27)	4.30 (2.36)	-0.60	-1.14	0.26
Dependency ratio	0.30 (0.20)	0.29 (0.22)	0.30 (0.19)	-0.01	-0.16	0.87
Total land holdings in Hectare	2.13 (1.96)	2.40 (2.28)	1.80 (1.48)	0.59	1.07	0.29
Irrigated land in Hectare	1.89 (1.85)	2.34 (2.30)	1.37 (0.93)	0.96*	1.88	0.07
Unirrigated land in Hectare	0.20 (0.49)	0.00 (0.00)	0.43 (0.65)	-0.43***	-3.45	0.00
Private land holdings in Hectare	1.23 (1.17)	1.42 (1.37)	3.35 (1.67)	0.41	1.26	0.22
Leased land holdings in Hectare	0.85 (1.66)	0.90 (1.66)	2.91 (2.11)	0.12	0.25	0.81
Number of fish ponds	5.32 (5.53)	6.85 (6.91)	6.26 (3.43)	3.33**	2.20	0.03
Land area used for fisheries in Hectare	1.47 (1.67)	1.85 (1.92)	2.35 (1.30)	0.82*	1.77	0.08
Farmer's experience (years)	8.66 (6.65)	11.70 (7.48)	1.96 (1.30)	6.62***	4.01	0.00
Stocking density	17.67 (81.87)	2.61 (2.67)	29.50 (108.76)	-26.89	-1.31	0.25

Note: Values in parenthesis are standard deviations. HH: Household head, "****", "***" and "*" represents significant at 1% (p<0.01), 5% (p<0.05) and 10% (p<0.1) level respectively

3.2 Fish Species Diversity

Nepal's fish biodiversity has extended to various 200 species of 114 genera belonging to 36 families and 11 orders (Sharma, 2008). Exotic fish species were found to be the major preferences of farmers (Figure 1) but native species are also cultured at commercial scale at limited extent. Out of 10 major fish species 17.65% of farmers preferred common carp for fishery which was immediately followed by indigenous species Rohu (16.91%). Grass carp was preferred by 15.44% of farmers while 13.97% of farmers had chosen silver carp. Similarly, Naini was favored by 12.50%, Bighead by 9.93%, Pangas by 8.09%, Katla by 3.68%, Tilapiya 1.47% and Rupchandra by 0.37% of farmers.

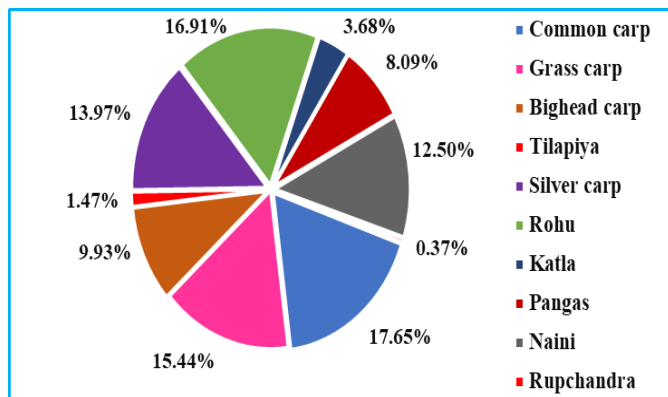


Figure 1: Diversity of fish species cultured in the study area.

3.3 Farming System

The farming system adopted by the farmers of the study area can be categorized on the basis of intensity of farming and species cultured. Similar type of farming systems was observed in lower and upper Dang valley. On the basis of intensity, three types of farming systems were found to be adopted (Figure 2). Almost 96% of the farmers has found to adopt semi-intensive type of farming system on which they culture their fishes under natural conditions i.e., water pond with artificial feeding and management. Only 2% of farmers were found to adopt intensive farming system under highly specialized artificial ponds at high stocking rate with continuous oxygen supply through aerator The semi-intensive fish culture

system enables farmers to reduce the cost of feed and other management expenditures, promotes polyculture system for higher feed efficiency, requires lesser technical know-how and less sophisticated technology (Tacon & de Silva, 1997). Integrated-fish farming was adopted by 2% of farmers where they integrate their fish enterprise with other sub enterprises such as pigs, cattle or poultry. Integration of fish enterprise with other possible components such as livestock or crops spread out the risks, enhance the employment opportunities, increase the food diversity and suppress the food insecurity (O, 2007), maintains the nutrient cycle and utilizes the wastes of one enterprise to produce another commodity there by promoting circular economy. Similarly, on the basis of fish species cultured, only two types of farming systems were recorded i.e., Polyculture and monoculture systems (Figure 3). Polyculture is complex system of fish farming in which various species of fishes with different feeding habits and ecological requirements which improves the feed efficiency hence, reduces the cost of production (Wang & Lu, 2016). In contrast, monoculture refers to the farming of single fish species in the water pond being comparatively less efficient due to higher feed loss, excess ammonia accumulation and reduced water quality and oxygen concentration (Wang and et al, 1998). Polyculture and monoculture system were found to be adopted by 86% and 14% of farmers respectively.

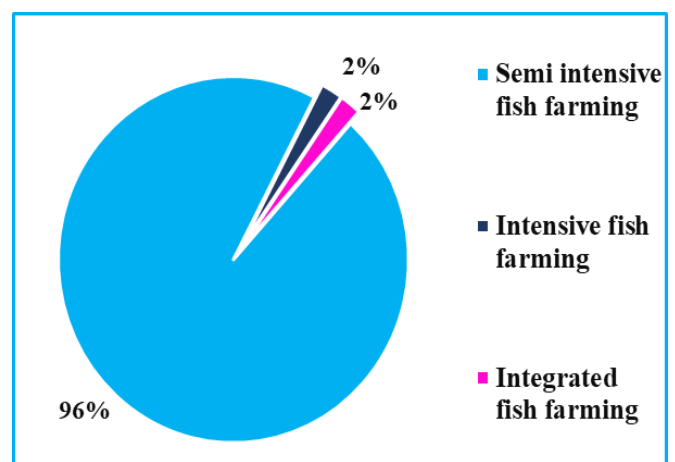


Figure 2: Farming system prevailed in the study area (on the basis of intensity)

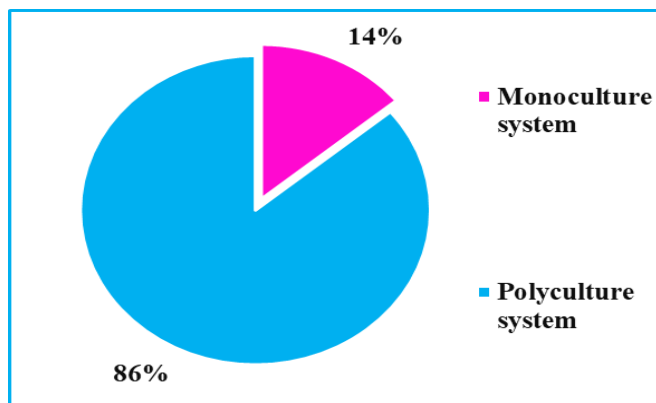


Figure 3: Farming system prevailed in the study area (on the basis of species)

hold the highest share (74.42%) of variable costs. Mean costs for feed was found to be NRs 1827206.47 which was found to be at similar range in lower valley (NRs 1220731.46) and upper valley (NRs 2539155.39) with no significant difference ($p = 0.20$) due to fixed priced determination by feed suppliers all over the district. Labor was found to be the second major input which accounts for 11.48% of total variable cost with mean labor cost of NRs 281911.09 per ha. However, there was no significant difference in mean labor cost between lower (NRs 270717.07 per ha) and upper (NRs 295051.89 per ha). This finding is similar with the results of (T. Sharma et al., 2018) as they also had reported feed and labor as major inputs required for fish production.

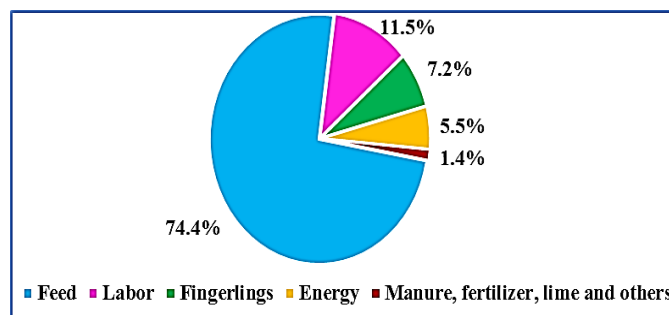


Figure 4: Percentage share of various inputs required for fish production.

3.4 Costs of Fish Production

Various kinds of variable and fixed costs incurred during fish farming were studied for economic analysis (Table 2). Mean total variable costs was estimated to be NRs 2455164.16 in the study area with no significant difference between lower (NRs 1812482.88, $p = 0.27$) and upper valley (NRs 3209616.10). Feed, the major input of fish enterprise has found to

Cost particulars	Total mean (n=50)	Lower Dang (n=27)	Upper Dang (n=23)	Mean difference	t value	p-value
Variable costs						
Fingerlings	177526.39 (818564.57)	243210.18 (1116672.12)	100419.34 (84810.87)	142790.84	0.61	0.54
Feed	1827206.47(4272817.44)	1220731.46(3078776.10)	2539155.39(5336631.96)	-1318423.93	-1.09	0.28
Labor	281911.09 (28746.54)	270717.07 (214319.39)	295051.89 (317599.81)	-24334.82	-0.32	0.75
Manure	19320.29 (28567.78)	26280.40 (36556.69)	11149.29 (11485.30)	15131.12**	2.13	0.04
Fertilizers	3511.85 (5997.47)	3129.19 (6325.20)	3961.07 (5695.70)	-831.88	-0.49	0.63
Agriculture lime	5847.17 (5524.55)	5710.37 (6885.17)	6007.75 (3450.09)	-297.37	-0.19	0.85
Energy	135939.63 (657936.85)	38560.75 (36256.04)	250253.97 (968137.79)	-211693.22	-1.14	0.26
Medicine	3807.77 (9582.12)	3995.30 (8264.16)	3587.62 (11121.77)	407.69	0.15	0.88
Technical assistance	93.70 (571.97)	148.15 (769.80)	29.78 (142.82)	118.37	0.73	0.47
TVC	2455164.16(4389079.15)	1812482.88(3272669.38)	3209616.10(5398752.72)	1397133.21	-1.12	0.27
Fixed costs						
Pond Maintenance	50082.27 (24458.50)	45964.12 (31488.49)	54916.62 (10739.94)	-8952.50	-1.30	0.20
Annual interest	34.12 (116.65)	9.48 (16.08)	63.05 (168.47)	-53.57	-1.65	0.11
Premium	1779.77 (6558.93)	1487.44 (4671.09)	2122.94 (8354.77)	-635.50	-0.34	0.74
Depreciation	15789.98 (3953.12)	13315.68 (3718.15)	18694.60 (1460.79)	-5378.91***	-6.52	0.00
Rent	45280.05 (100592.54)	27576.91 (47031.31)	66061.99 (138156.41)	-38485.07	-1.36	0.18
Total fixed cost	217133.77 (340477.84)	145913.57 (173094.66)	300740.10 (457443.69)	-154826.53	-1.63	0.11
Total cost	2672297.93 (4453603.59)	1958396.45 (3326157.42)	3510356.20 (5453663.10)	-1551959.75	-0.05	0.96

Note: Values in parenthesis are standard deviations. NRs: Nepalese Rupees. "***" represents significant at 5% ($p < 0.05$) level.

Third major share of variable cost was found to be hold by cost of fingerlings (7.23%). Average Fingerling cost was found to be NRs 177526.39 per ha in the study area. Fingerling cost was found to be NRs 243210.18 per ha in lower and NRs 100419.34 per ha in upper dang valley with no statistical significance. This similarity might be due to similar wages distribution over the district. Furthermore, energy i.e., either fuels or electricity or both which are used in fish farms to operate pumps, motors, aerator and lights had accounted fourth major variable input (5.54%). Average cost for energy in the study area was found to be NRs 135939.63 per ha with no significant difference between lower valley (NRs 38560.75 per ha) and upper valley (NRs 250253.97 per ha). In contrast, organic manure cost which accounted 0.8% of total variable cost. The average cost for organic manure was found to be NRs 19320.29 in the study area. Manure cost was found to significantly lower in upper valley (NRs 11149.29 per ha) than in lower valley (NRs 26280.40 per ha) with mean difference of NRs 15131.12 per ha ($p = 0.04$). Similarly, mean cost for chemical fertilizers was found to be NRs 3511.85 per ha in the study area. Similar range of cost was incurred by chemical fertilizers in lower valley (NRs 3129.19 per ha) and upper valley (NRs 3961.07 per ha) which were statistically non-significant. Medicine for curing various disease and parasitic infestation also had considerable amount of cost during fish production. The average cost for medicine materials was NRs

3807.77 per ha in the study area. Both lower and upper valley had similar range of costs NRs 3995.30 per ha and NRs 3587.62 per ha respectively with no significant mean difference. Farmers found to be spent comparatively lesser amount of money for technical assistance with mean cost of NRs 93.70 per ha in the study area. Mean costs incurred for technical assistance was found not to be significantly difference between lower valley (NRs 148.15 per ha) and upper valley (NRs 3587.62 per ha). This might be due to efficient and cheap extension services being provided by governmental extension bodies, projects, suppliers and private agencies. Total fixed cost incurred for fish production was found to be NRs 217133.77 per ha per year. Lower valley and upper valley farmers had statistically similar range of total fixed costs 145913.57 NRS per ha and NRs 300740.10 per ha per year respectively with no significant difference. Average pond maintenance cost was estimated to be NRs 50082.27 per ha in the study area. Farmers of lower valley found to spend NRs 45964.12 per ha per year for pond maintenance while farmers of upper valley spend NRs 54916.62 per ha per year for the same operation which are statistically non-significant. This might be due to similar activities performed by farmers such as reconstruction of dikes, cleaning of pond surroundings, removal of excess mud and so on manually. Average annual interest per ha per year was found to be NRs 34.12 in the study area. Costs separated for annual interest by the lower valley farmers (NRs 9.48 per

ha) and upper valley farmers (NRs 63.05 per ha) found statistically non-significant. This might be due to poor accessibility of farmers to financial credits. Furthermore, annual premium for insurance was NRs 1779.77 per ha in the overall study area. Farmers of both valleys pay similar range of premium annually with no significant difference. However, costs for depreciation were found to be statistically minimum in case of lower valley (NRs 15789.98 per ha) than upper valley (NRs 13315.68 per ha) with mean difference of NRs 5378.92 per ha per year ($p = 0.00$). The mean cost for depreciation in the study area was found to be NRs 15789.98 per ha per year. Average land rent was found to be NRs 45280.05 per ha in the study area with no significant difference between than that of lower valley (NRs 27576.91 per ha) and upper valley (NRs 66061.99 per ha).

3.5 Production, Productivity, Profitability and Benefit Cost Analysis of Fish Production

The average production fish per household in the study area was found to be 12793.67 kgs (Table 3). There was no significant difference between average fish production per house hold in lower Dang (12275.23 kgs, $p = 0.84$) and upper Dang (13289.57 kgs). The average productivity was estimated to be 10653.60 kgs per ha in the study area. However,

productivity was significantly higher in upper Dang (13791.52 kgs per ha, $p = 0.09$) than in lower Dang (7373.05 kgs per ha). The average revenue generated by household in the study area was estimated to be NRs 3537414.51 with profit of NRs 1806166.17 per year. Both revenue and profit were found not to be statistically significant in lower Dang (Revenue: NRs 3319675.68, Profit: NRs 1899786.20) and upper Dang (Revenue: NRs 3745868.43, Profit: NRs 1716616.57). The average cost per kg of fish was found to be NRs 244.78 in the study area. Lower and upper valley farmers also had similar level of costs NRs 228.34 and NRs 260.51 per kg respectively however, they were not statistically significant ($p = 0.65$). Mean price per kg of fish was recorded to be NRs 300.06 in the area. The price of kg of fish was found similar over the two domains namely lower valley (NRs 293.05) and upper valley (NRs 306.77) with no statistically significant difference ($p = 0.38$). The BC ratio of fish enterprise was estimated to be 2.12 on an average in the study area indicating that one rupee spent in fish farming yield 1.12 rupees of benefits on an average. The BC ratio of lower valley and upper valley was found to be 1.97 and 2.26 with no significant mean difference ($p = 0.55$). (Sharma et al., 2018) and (Magar et al., 2022) had also reported fish farming as profitable enterprise in Chitwan and Siraha district of Nepal respectively.

Table 3: Production, Productivity, Profitability and BC Ratio of Fish Production in Dang, Nepal.

Particulars	Mean (n=50)	Lower Dang (n=27)	Upper Dang (n=23)	Mean difference	t value	p-value
Production in kgs per HH	12793.67(16626.84)	12275.23(14600.56)	13289.57(18678.64)	-1014.34	-0.20	0.84
Productivity Kgs per Ha	10653.60(12828.71)	7373.05(7629.47)	13791.52(15891.27)	-6418.47*	-1.71	0.09
Annual revenue in NRs per HH	3537414.51 (4368544.03)	3319675.68(3817241.66)	3745686.43(4915953.05)	-426010.75	-0.32	0.75
Profit	1806166.17(3124847.31)	1899786.20(2810218.82)	1716616.57(3460322.65)	183169.64	0.19	0.85
Cost per Kg (NRs)	244.78(230.69)	228.34(157.56)	260.51(286.73)	-32.16	-0.46	0.65
Price per Kg (NRs)	300.06(52.19)	293.05(46.12)	306.77(57.62)	-13.72	-0.88	0.38
Benefit cost ratio	2.12(1.56)	1.97(1.30)	2.26(1.78)	-0.28	-0.61	0.55

Note: Values in parenthesis are standard deviations. NRs: Nepalese Rupees. "*" represents significant at 1% ($p < 0.1$)

3.6 Production Function Analysis of Fish Production

F statistic of the production function was found to be statistically significant ($p = 0.00$) showing higher degree of explanatory power of the model (Table 4). It was found that 73.8% of variations in dependent variable were explained by independent or explanatory variables in the model ($R^2 = 0.738$, Adjusted $R^2 = 0.679$). Other factors being constant, 1% increment in fingerling expenses can increase the income from the fish by almost 0.830% which was statistically significant ($p = 0.00$). Similarly, it is evident that 1% increase in feed expenses can increase the income by 0.329% which also was found to be statistically significant ($p = 0.034$).

Furthermore, increase expenses of labor by unit percentage can decrease the income by 0.064% but found not to significant statistically ($p = 0.813$). Expenditure for organic manure and chemical fertilizers when each increased by 1% will results in positive increments in income by 0.084% ($p = 0.111$) and 0.015% ($p = 0.762$) respectively, however both of them were found to be statistically non-significant. In contrast, expenditure on agriculture lime, energy and technical assistance when increased by 1% would result into decreased income by 0.038% ($p = 0.612$), 1.118% ($p = 0.211$) and 0.021% ($p = 0.879$) respectively but found to be statistically non-significant.

Table 4: Cobb Douglas Production Function of Fish Production.

Explanatory variables	Coefficient	Standard Error	t value	p-value
Log Fingerling expenses	0.830***	0.153	5.427	0.000
Log Feed expenses	0.329**	0.150	2.195	0.034
Log Labor expenses	-0.064	0.270	-0.238	0.813
Log Organic manure expenses	0.084	0.051	1.629	0.111
Log Chemical fertilizer expenses	0.015	0.051	0.304	0.762
Log agriculture lime expenses	-0.038	0.074	-0.512	0.612
Log Energy expenses	-1.118	0.093	-1.270	0.211
Log Medicine expenses	0.011	0.060	0.189	0.851
Log Technical assistance expenses	-0.021	0.153	-0.153	0.879
Constant	-4.564***	1.301	-3.509	0.001
R ² value	0.738			
Adjusted R ² value	0.679			
F value	12.511 ***			
Return to scale	0.028			

Note: Values in parenthesis are standard deviations. "****" and "***" represent significant at 1% ($p < 0.01$) and 5% ($p < 0.05$) respectively.

However, increase in medicine expenses by 1% can increase the income from fish by 0.011% which was also found not to be statistically significant ($p = 0.851$). The summation of coefficients obtained from CDPF was estimated to be 0.028 which indicates decreasing return to scale in fish production. This represents that increase in expenses on variable inputs will return lesser amount of income from fish production i.e., additional output will be lesser than additional portion of inputs under this condition. However, the return to scale of fish production was found to be 1.78% in eastern terai region of Nepal (D. Poudel & N.P. Pandit, 2020). Such difference might be due to easier accessibility of farmers of that region to

Indian market for variable inputs such as fingerlings, feeds, lime and medicines.

3.7 Production Problems

Problems faced by fish growers were ranked from higher to lower severity (Table 5). The major problem faced by farmers during production was recognized to be incidence of diseases and parasites (index: 0.85) in the studied area which was followed by lack of technical know-how (index:0.84), lack of quality fingerlings (index: 0.65),

Table 5: Production Problems of Fish Farmers in the Study Area.

Problems	Total (n=50)		Lower Dang (n=27)		Upper Dang (n=23)	
	Index	Rank	Index	Rank	Index	Rank
Lack of knowledge	0.84	II	0.84	I	0.81	II
Lack of quality fingerlings	0.65	III	0.59	III	0.73	III
Lack of manures and fertilizers	0.42	IV	0.45	IV	0.42	IV
Lack of labor	0.24	V	0.33	V	0.23	V
Incidence of diseases and parasites	0.85	I	0.79	II	0.82	I

lack of manures and fertilizers (index: 0.42) and lack of labor (index: 0.24) as second, third, fourth and fifth major problems respectively. Similar scenario was responded by the fish farmers of upper dang valley. However, farmers of lower dang valley responded lack of technical know-how (index: 0.84) as the first major problem of lower production while they ranked incidence of diseases and parasites as second problematic issue (index: 0.79) remaining problems were ranked as similar to the farmers of upper valley.

3.8 Marketing Problems

Marketing issues faced by fish producers in the study area were also ranked from higher to lower severity (Table 6). Farmers ranked lower

farm gate price of fish (index: 0.84) as their first, unhealthy competition with Indian fishes as second (0.78), high price gap between producer and consumer as third (0.74), lack of marketing knowledge as fourth (0.56), long market distance as fifth (index: 0.30) and lack of transportation as sixth major problem (index: 0.29). Farmers of both lower and upper valleys ranked low farm gate price as first major problem with indices of 0.83 and 0.85 respectively. Farmers of lower valley responded unhealthy competition with Indian fishes as second major problem (index: 0.70) while farmers of upper valley ranked higher price gap as second major problem (index:0.80). Third major problem was ranked to be higher price gap by farmers of lower valley (index: 0.70) but unhealthy competition was ranked at third position (index: 0.68) by and long-distance market was ranked at the same position upper valley farmers (index: 0.30).

Table 6: Marketing Problems of Fish Farmers in the Study Area

Problems	Total (n=50)		Lower Dang (n=27)		Upper Dang (n=23)	
	Index	Rank	Index	Rank	Index	Rank
Low farm gate price	0.84	I	0.83	I	0.85	I
Lack of marketing knowledge	0.56	IV	0.53	IV	0.59	IV
Higher price gap between producer and consumer	0.74	III	0.70	III	0.80	II
Lack of transportation	0.29	VI	0.29	V	0.29	VI
Long market distance	0.30	V	0.27	VI	0.30	V
Unhealthy competition with domestic and Indian products	0.78	II	0.70	II	0.68	III

For sixth rank, lower valley famers responded long market distance (index: 0.27) while upper valley farmers responded lack of transportation (index: 0.29). with indices of 0.53 and 0.59 respectively. However, lack of

transportation was ranked as fifth by lower valley (index: 0.29) farmers of upper valley while lack of marketing knowledge was ranked as fourth major problem by famers of both of the valleys.

3.9 Marketing Channel

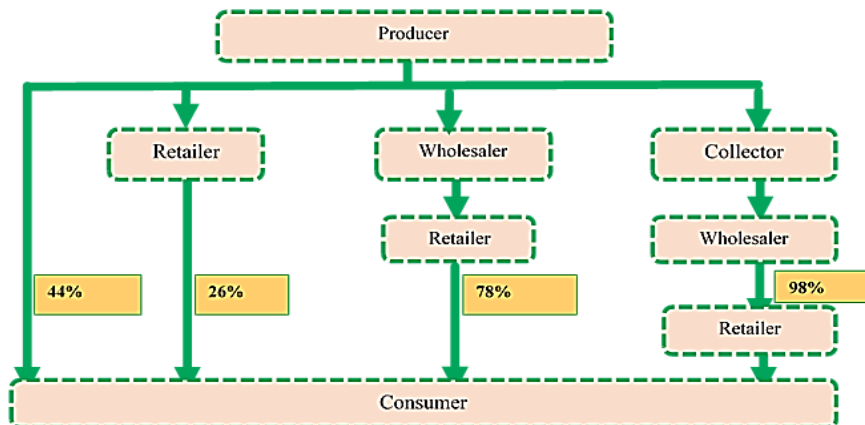


Figure 5: Marketing channels of fish prevailed in the study area.

Mainly, four types of marketing channels were prevailed in the study area (Figure 5). The most commonly practiced marketing channel was found to be "producer to collector to wholesaler to retailer to consumer", which was adopted by 98% of farmers. Similarly, second longest pathway being practiced was "producer to wholesaler to retailer to consumers" which was practiced by 78% of farmers in the study area. The shortest channel of selling was found to be directly "producer to consumers", this channel was practiced by 44% of farmers in the study area while 26% of farmers found to practice "producer to retailer to consumer" pathway of marketing.

4. ACCESS TO SUBSIDY

Majority (56%) of fish farmers responded that they never had access to subsidies or subsidized loan for the extension of their enterprise while remaining 44% of farmers had either subsidies or subsidized credits (Figure 6). Equal percentage (16%) of farmers had received subsidies from local and provincial government. Furthermore, 8% of farmers were benefited by subsidies from related projects and remaining 4% got subsidized loan from financial institutions or commercial bank.

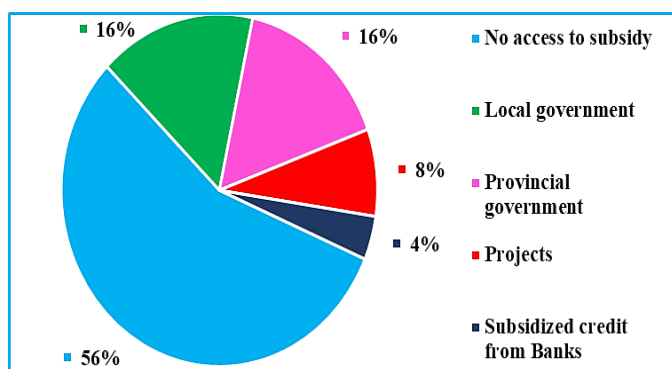


Figure 6: Percentage of farmers benefited by subsidies of various sources.

5. CONCLUSION

Majority of the fish farms were dominated by male household heads. The economically active male and female members were found to be 2.12 and 1.88 on an average with total active family members of 3.98 per household and dependency ratio of 0.30. Average landholdings per household was recorded to be 2.13 ha-1 household out of which 1.89 ha was found to be irrigated and 0.20 ha unirrigated per household. Lower valley was found to be well irrigated as compared to upper valley with average irrigated land of 2.34 ha and 1.37 ha per household. Farmers of lower valley were found to have significantly higher years of experiences (11.70 years) than upper valley (1.96 years). Similarly, farmers of lower valley had found to own significantly higher numbers of fish ponds (6.85) per household than upper valley (6.26). Out of 10 major fish species, 7 were found to be exotic species due to their higher feed conversion ratio and accessibility to fry and fingerlings. Majority of the households followed semi-intensive fish farming (96%), while intensive (2%) and integrated farming (2%) was adopted by minority of households. Polyculture system was found to be preferred by almost 86% of farmers while rest of 14% farmers followed monoculture system. The average cost of fish production was found to be NRs 2455164.16 out of which feed incurred almost three fourth (74.4%) of total variable cost which was followed by labor (11.5%) and fingerlings cost (7.2%). The total cost was estimated to be NRs 2672297.93 per household. In case of general farms, average fish production was found to be 12793.67 Kgs with productivity of 10.65 tons-1 ha and BC ratio of 2.12. An increase in fingerling and feed expenses by 1% would significantly increase income by 0.830% and 0.329% respectively. Similarly, expenditure of organic manure, fertilizers and medicine when increased by unit percentage would rise income by 0.084%, 0.015% and 0.011% respectively. Incidences of diseases and parasites, lack of technical know-how, inadequate supply of manures and fertilizers and lack of seasonal labor availability were found as major production limiting issues being faced by the farmers. Furthermore, lower farmgate price, intervention by Indian fish products and higher price gap between producer and consumers were the issues rendering the efficient marketing of fishes. It was revealed that there is need of on time supply of inputs specially feed and fingerlings. Technical assistance is also needed to upgrade the knowledge and skills of farmers. Similarly, large intervention in policy level to maintain the transparent marketing and price determination, improve the productivity of quality fishes is needed to compete with foreign fish products.

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