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Estimation of small-scale fisheries production development trend in Nepal

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Abstract

Nepal is a landlocked country with enormous natural diversity ranges from the world's highest peak, Mt. Everest to the Tarai area. Nepalese aquaculture is still in its early stages, and fish production is still insufficient in comparison to global levels. Fish is a popular cuisine in Nepal, and it is enjoyed by people of all ages, genders, and religions. The total national fish production is currently 77,000 m.t., with 28 percent coming from catch fisheries and 72 percent from aquaculture. Aquaculture and open-water capture fisheries account for around 2% of agricultural gross domestic product; this little share of the fisheries sector is promising, with an annual growth rate of 8–9%. Total fisheries production in Nepal was reported at 81070 metric tons in 2018, according to the World Bank assortment of development indicators, compiled from officially recognized bases. Small-scale fishermen's catch production and secondary data in Nepal's Chitwan District, Bagmati Province, from 2010 to 2019. Regression estimates model and multivariate regression analysis of time series data, the Cobb-Douglas production function equation rational technique is applied. Changes in the number of fish caught have an impact on the home economics and spending. The length of the river, outboard engine power, and regional differences in area were found to have a positive impact on small-scale fishermen's catch production, whereas gasoline, schooling, and family dependents had a negative impact, though fishing gear, kerosene, and fishermen's age had no considerable impact.

Keywords: Cobb-Douglas, Employment, Pond Productivity, River, Weather

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Introduction

Natural water resources are plentiful in Nepal. The principal sources of fresh water in Nepal are rivers, lakes, reservoirs, wetlands, and lowland irrigated paddy crops. From the world's highest peak, Mt. Everest, to the Tarai area, Nepal is a landlocked country with enormous natural diversity. With an annual growth rate of around 6% in the last decade, finfish aquaculture is Asia's fastest growing aquaculture sub-sector. Nepalese aqua farming is known for having a diverse agriculture system. Nepal is landlocked; thus, it relies solely on inland aquaculture and finfish cultivation. Climatological circumstances favor the cultivation of both cold and warm - water species. When compared to worldwide aquaculture production, Aquaculture in Nepal is still in its infancy, with only a few fish being produced. It is one of Nepal's fastest growing agricultural subsectors. Between 1981 and 2017, total annual fish production in the country climbed from 3530 tons to 86544 tones, while yearly per capita fish production increased from 0.33 kg in 1982 to 3.01 kg in 2017/18 (CFPCC, 2018). Fish supply for human consumption has increased by 3.2 percent over the last five decades, beating population growth by 1.11%, resulting in average per capita obtainability of fish exceeding 20 kg (FAO, 2016) (Pauly & Zeller, 2017).

The rise in fish consumption hasn't been uniform or sufficient in all areas. Mt. Everest, the world's tallest peak, is found in Nepal, which is primarily hilly. People in mountain and plain locations were known to have a high prevalence rate of goiter disorders, which were thought to be a symptom of a lack of animal origin foods and an iodine shortage in human diet. Small scale fisheries provide livelihood, food security, and revenue to millions of coastal societies around the world (Teh & Sumaila, 2013). Aquaculture employs 90% of fisheries workers and accounts for 2/3 of worldwide fish harvests meant for direct human consumption. Many SSFs are self-employed and provide fish directly to their families. Poverty reduction is a strategy of improving small-scale fisheries resilience. Because of its importance in both fish production and job creation, capture fisheries is a vital industry. Each man, woman, adolescent girl, and boy should consume at least 30 grams of fish or animal protein each day, according to the Nepalese government. There are more than 6000 rivers, fresh water resources suitable for fish farming in Nepal. 11 fish species, including 7 carp species, 1 perch (tilapia), 2 catfish, and 1 trout species, are being farmed commercially out of the 252 fish species that have been recorded in Nepal. Aquaculture contributed 4.18 % and 1.13%, respectively, of the nation's GDP and agriculture GDP (CFPCC, 2018/19).54, 237 households are active in fish farming, and 143,241 individuals work in this industry as a whole. Nepal produces 91832 metric tons of fish a year, of which 21000 metric tons come from inland capture fisheries and 70832 metric tons come from aquaculture (CFPCC, 2018/19).

The Fisheries Development Program was first introduced in 1956, when the Fisheries Section was established. The growth of fundamental infrastructures and human resources had positive effects (ADB, 1995). Fish farming is expected to develop in response to rising domestic and international demand. Fish is regarded as one of the most nutrient-dense foods available, as well as one of the least harmful to the environment. Nepal has abundant aquatic resources, which make up 5.5 percent of the country's total land area. Aquaculture and capture fisheries account for less than 2% of Nepal's estimated 8, 26,818-hectare water surface area. Modern aquaculture began in Nepal in the 1950 (Rajbansi, 1995). Aquaculture accounts for about 1% of Nepal's GDP, with pond aquaculture producing over 3.6 million tons per hectare (DoFD, 2007). Fish production, on the other hand, can range from a few hundred kilograms per hectare to 7.0 million tons per hectare, depending on farming and management methods. Agriculture was heavily reliant on the country's primary source of revenue. Based on these discussions, this study aims to evaluate the fish production and marketing and assess the fish production technology practiced by small, medium, and large-scale farmers in Chitwan district, and explore current state of fish farming in Nepal, as well as the amount of fish consumption in the country.

Methodology and materials

Study area

Carps, Pangas, Tilapia, catfish, and Rainbow trout are the most prevalent species cultivated. Small-scale catches of fishermen in Nepal's Chitwan District, Bagmati Province, vary year to year due to variations in the fishing period and starvation. Commercial fish farmers were regarded as the survey population and were therefore included in the sampling. 120 actively involved fish farmers were chosen by a straightforward random sample procedure out of the 200 fish farmers registered in the fish block in Chitwan. 13 traders were also chosen at random to participate in the survey. A survey was carried out in 2021.

Data collection

The Directorate of Fisheries Development (DoFD), Ministry of Agriculture, Land Management, and Collective's Department of Nepal government's annual publication provided annual data on fish production and water resources. We have gathered secondary data from journal articles, reports, and other pertinent publications, including those from the Agriculture Knowledge Centre, Agriculture Census, NARC, FAO, and CFPCC. To collect primary data, key informant interviews (KII), focus groups, and a semi-structured, pre- tested interview schedule were all used. To cross-verify data, KII was performed with representatives of local stakeholders, lead farmers, the head of a community-based organization, etc., and a FGD was held with a group of 10 progressive farmers during the checklist creation process.

Data analysis technique

STATA version 17 was used to conduct qualitative and quantitative analyses. Small-scale fishermen's catches are estimated using the Cobb-Douglas production function. The production function is a mathematical expression that explains the technical relationship between inputs and outputs (Debertin, 1986) which is as follows:

$$y = f(x) \qquad \text{... (1)}$$

Here, the output is y, and the input is *x*. The neoclassical production function, which existed before the Cobb-Douglas production function, was an equation or a function that described output as a function of two inputs, viz. labor and capital as shown below.

$$Q = f(K, L) \qquad \text{... (2)}$$

Here, Q stands for the amount of production generated over a given time period, K is the amount of capital, and L is the amount of labor. Paul Cobb and Charles Douglas introduced the Cobb-Douglas production function in a paper titled "A Theory of Production" in the American Economic Review 18 scientific magazine (Debertin, 1986) as follows:

$$Q = AK^2L^2 \qquad \text{... (3)}$$

As it assumes that the number of parameters in the Cobb-Douglas production function is unity, viz.$\beta + \alpha = 1$, it is a linear first-degree homogeneous production function.

If $\beta + \alpha = 1$, then $\beta = 1 - \alpha$ ... (4)

This implies that

$$Q = AK^{\alpha}L^{1-\alpha} \qquad \text{... (5)}$$

When the input is increased to become the original t*x* input, the output is also increased to become the original ty output, resulting in

$$Q = (tK, tL) = A\,(tK)(tL)^{1-\alpha} \qquad \text{... (6)}$$

$$= At^{\alpha}K^{\alpha}t^{1-\alpha}L^{1-\alpha} \qquad \text{... (7)}$$

$$= tAK^{\alpha}L^{1-\alpha} \qquad \text{... (8)}$$

$$= tQ\,(K, L) \qquad \text{... (9)}$$

The parameters α and β constant values indicate the output elasticity of each input that defines the Cobb-Douglas production function. If the Cobb-Douglas production function is incorporated in the profit model, the optimum cost will offer a constant elasticity of substitution with a value of one (σ =1).(Debertin ,1986). Log-log or natural logarithms (Ln) are used to express the Cobb-Douglas production function as:

$$LnQ = LnA + \alpha LnK + \beta LnL \qquad \text{... (10)}$$

If$\beta + \alpha = 1$ then β = 1- α ... (11)

This implies that

$$LnA = LnA + \alpha LnK + (1 - \alpha)\,LnL \qquad \text{... (12)}$$

$$LnQ = LnA + \alpha LnK - \alpha LnL + LnL \qquad \text{... (13)}$$

$$LnQ - LnL = LnA + (LnK - LnL) \qquad \text{... (14)}$$

$(Q/L) = LnA + (K/L)$ ...(15)

The average labor productivity (Q/L) is linked to the capital-labor ratio (K/L) in equation (15). If $\alpha + \beta = 1$, then the Cobb-Douglas production function becomes:

$Q = (tK, tL) = A\,(tK)(tL)$ ... (16)

$= At^{\alpha}K^{\alpha} \times t^{\beta}L^{\beta}$ ... (17)

$= t^{(\alpha+\beta)}AK^{\alpha}L^{\beta}$ ... (18)

$= t^{(\alpha+\beta)}Q(K,L)$ ... (19)

The results will be decreasing returns to scale, if $\beta + \alpha < 1$ and the results will be growing returns to scale, if $\beta + \alpha > 1$. The Cobb-Douglas mathematical function with two or more variables is a function or equation, which can be expressed as follows:

$Y = \alpha X_1\beta_1, X_2\beta_2, \ldots, X_i\beta_i, \ldots, X_n\beta_n u$ ... (20)

If Y and X represent the Cobb-Douglas production function, then equation (19) can be written as:

$Q = (X_{1,2}, \ldots, X_i, \ldots, X_n)$ ... (21)

Where X denotes the explanatory variable, Y denotes the dependent variable, e denotes natural logarithms α denotes the intercept, u denotes the disturbance term, and β denotes the regression coefficient. Equation can be converted to numerous linear forms to make estimate easier by applying pressure in the form of natural logarithm (Ln) as follows:

$LnY = Ln\alpha + \beta_1 LnX_1 + \beta_2 LnX_2 + ,\ldots, + \beta_i LnX_i +, \ldots, + \beta_n LnX_n + u$ ... (22)

With the following analysis method using on-linear regression with exponential functions or the Cobb-Douglas production function equation, an econometric approach of qualitative independent variable estimation is used for factor estimation of small-scale fishermen's catch production (Gujarati & Porter, 2009):

$QSCOMF_i = \beta_0\ QGsln_i^{\beta_1} QKrsn_i^{\beta_2} TFhsngF_i^{\beta_3}\ ExpF_i^{\beta_4} AgF_i^{\beta_5} EdF_i^{\beta_6} QFR_i^{\beta_7} \mu_1$ ... (23)

Using the natural logarithm method, the equation is transformed to multiple linear form to make it easier to calculate the equation model, as demonstrated below:

$LnQSCMF_i = Ln\beta_0 + \beta_1 LnQGsln_i + \beta_2 LnQKrsn_i + \beta_3 LnTFhsng_i + \beta_4 nExpF_i + \beta_5 LnAgF_i + \beta_6 LnEdF_i + \beta_7 Ln\mathrm{QFR} + \mu_1$ ... (24)

Where small-scale outboard motor fishermen catch production (kg) is abbreviated as QSCMF, β_0 and β_7 respectively.

The coefficients of independent variable regression are $\beta_1,\ldots,7$, and the coefficients of dummy variables are $\beta 1,\ldots, \beta 4$. QGsln is gasoline (liter), QKrsn is kerosene (liter), TFshngi is fishing time (hour), ExpF is experience as a fisherman (year), AgF is age of fisherman (year), QFR is family responsibility Dummy Regional differences in small-scale outboard motor fisherman, EdF is formal education (year); SdTR: 1 for Chitwan district; 0 for the other; SdB: 1 for Chitwan district; 0 for the other and μ_1 is the disturbance term. Similarly, secondary data analysis is performed by multivariate regression analysis.

Table 1
Fish production

S.N.	Year	Pond's No.	Total Fish production (Mt.)
1	2010/11	26036	26941
2	2011/12	29270	29999
3	2012/13	32020	31221
4	2013/14	34400	37427
5	2014/15	36666	41481
6	2015/16	39308	48543
7	2016/17	44725	55842
8	2017/18	45327	58433
9	2018/19	45936	62725
10	2019/20	48369	66906

Source: Central Bureau of Statistics (2018)

Figure 1
Distribution of number of ponds and fish productio0n (m.t.)

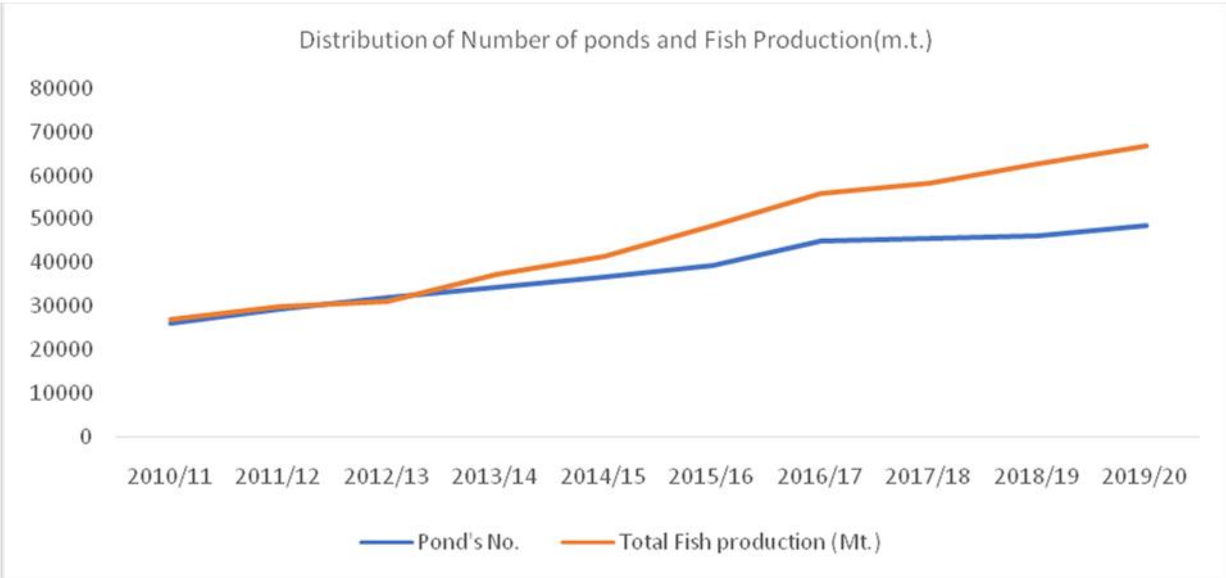

Table 2
Determinant estimation of small-scale fishermen catch production

Independent variables	ES.	i	t-test	VIF	Coefficient Park
Gasoline	+	-0.025***	-3.298	1.93	3.78
Kerosene	+	0.456 ^{ns}	1.312	8.234	5.044
Time of fishing	+	0.882***	4.540	6.782	2.86
Fisherman age	-	0.645^{ns}	1.282	4.321	0.000
Fisherman experience	+	-0.325^{ns}	-1.034	4.250	0.000
Fisherman education	+	-0.0423*	-1.632	1.243	-0.004
Responsibility	+	-0.321	-2.012	1.325	-0.003
Intercept					7.527
F-test					62.245
Adjusted R^2					0.862
N					50

****=significant on the level of 99%, * significant on the level of 90%, ns=not significant. Variable inflation factor (VIF) > 10 indicates multicollinearity, while VIF< 10 indicates non-multicollinearity. If the Park test results for the value of are not significant, heteroscedasticity was not present. Instead, heteroscedasticity existed if the value of employing the Park test was considerable.*

Results and discussion

Socioeconomic and demographic characterization

The majority of fish farmers were discovered to be men, with very few women in this field. Female members contributed to various tasks like feeding and marketing but did not take a full part in fish farming. The average age of farmers (52.11%) was between 31 and 40, with a maximum age of 58 and a minimum age of 24. Similarly, just 17.78% of farmers who responded to the survey had received no any formal education. While many others were literate, it was found that few farmers had gone on to earn higher educations. Fish farming made up 86.67% of fish farmers' jobs, with 13.33% of them working in other occupations like agriculture, poultry, small business, trading, and services. Fishermen had an average experience of 9.22 years, with a maximum experience of 30 years and a minimum experience of 1 year. The fish farmers in the surrounding district relied heavily on their income from fish farming. From a minimum of $2500 to a high of $52000, the farmers' annual income varied. In comparison to small-scale farmers with limited experience, it was discovered that large-scale farmers made more money.

Small-scale fishermen using outboard motors and long line fishing gear were estimated using a qualitative independent econometric technique employing the Cobb- Douglas production function on the west shore of Chitwan District. It also employs the adjusted R^2 model's accuracy measurement, the F and t tests to evaluate the hypothesis, and the variant inflation factor (VIF) and park test to test the classical assumptions of multicollinearity and heteroscedasticity. The F test results show the projected variables or factors that affect outboard motor catch production have a considerable impact on the 1% error rate. This implies that all independent variables have an impact on small-scale fishermen's catch production at the same time. The F test findings show that the estimated factors that affect the manufacture of outboard motor catches significantly affect the 1% rate. This can be taken to mean that all independent variables concurrently have a big impact on how many fish small-scale fishermen produce. The t-test is also used to determine the specific impact of each independent variable on the production of small-scale fishermen's catches.

A regression coefficient that has a negative and econometrically significant influence on a 1% level error exists between the variable uses of fuel oil as an input for the catching productivity per trip of small-scale fishermen. Outboard motor fishermen in the Chitawan district capture less fish per trip since the waters near their fishing area are primarily used by motorized. On a 1% level error the regression coefficient among the variable consumption of fuel oil as an input for catching production per trip of small-scale fishermen outboard motor has a negative and econometric significance effect. The time spent fishing on a small scale is usually restricted to one day. Because small-scale fisheries activities are linked to declining biomass, individual target fish size rich or fish resources (Wiyono, 2012), such conditions or behaviors will surely result in suboptimal catches and low income (Retnowati, 2011. Variations in the effect of each independent variable, such as gasoline, fishing time, and fisherman characteristics, such as age, experience as fishermen, length of time as fishermen, formal education of fishermen, and number of family dependents on fishing, must have explained the disparity in the production of catches from small-scale fishermen in each region of the Chitwan District area.

Employment generation by fisheries subsector

Many fishing villages rely on natural water, particularly rivers, and lakes, for their livelihood. Fisheries are actively and indirectly involved in about twelve ethnic communities (Gurung, 2005). These groups live near water and rely on fisheries and aquatic resources to survive. Capture fishing employs over 4.5 hundred thousand persons, 60 percent of whom are women. Females assist with the preparation of fishing gear, nets, and other equipment, as well as the sale of fish at marketplaces in capture fisheries. Aquaculture contributes significantly to the creation of jobs at various stages of the value chain.

The aquaculture value chain employs men and women of various ages. This sub-sector employs approximately 1.5 hundred thousand people, with men accounting for 68 percent of the workforce and women for only 32 percent. By providing adolescents with job possibilities in various fisheries and aquaculture-related activities, the Fisheries sub-sector can be an alternative to reducing youth migration. Remittances are crucial to Nepal's economy. As a result, such an economy is likely to be insecure, putting the economy in jeopardy.

Conclusion

Aquaculture is one of Nepal's most rapidly increasing agricultural subsectors. Long river fishing and outboard engine strength are positive influences in the Cobb-Douglas production function approach to estimating factors influencing small scale fisherman production per trip in Chitwan District, Bagmati Province, while fuel oil, number of family dependents, fishermen's education, and regional differences are negative influences, while fishing gear, kerosene, age of fishermen and time of fishing have no significance.

The development of Nepal's fisheries sector would be dependent on the construction of domestic fish markets. To ensure enhanced fish production, contemporary techniques for seed and feed production, as well as cooperative-based fisheries, must be introduced. The trend of live fish markets is growing and may be found in a few locations in cities. These markets should be expanded as much as feasible with government assistance. The government should put more emphasis on increasing domestic fish production.

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