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# An assessment on the status of pond fertilization, liming and fish production on fish zone of Sunsari district, Nepal

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**Abstract**

A study was conducted to analyze the status of pond fertilization, liming and fish production on fish zone of Sunsari District, Nepal in 2019. Three different study sites, namely, Barahakshetra Municipality, Ramdhuni Municipality and Koshi Rural Municipality of Sunsari were selected purposively. A total of 120 households, 40 from each site were selected randomly and were interviewed by preparing pre-tested semi-structured questionnaire. The collected data were analyzed using MS excel 2010 and SPSS 25 software. The average amount of FYM use was 3005.64 kg/ha (2.07 times a year). Similarly, other organic fertilizers use was Mustard cake, Goat manure, Poultry manure, Pig manure and Compost with average use 85.62, 141.33, 125.56, 59.17 and 24.75 kg per ha with frequency use of 2.24, 0.48, 0.17, 0.07 and 0.08 times a year respectively. Similarly, the average amount of urea use was 44.56 kg per ha (0.95 times a year) and that of DAP and MOP use was 42.41 and 0.79 kg per ha with frequency use of 0.92 and 0.02 times a year respectively. The average use of lime was 163.59 kg per ha (1.43 times a year). The average fish production was 2109 kg per ha. The average variable cost, gross return and gross profit realized per ha were NRs 140332, NRs 236202 and NRs 95869 respectively. The B/C ratio for the study site was found to be 1.83. About 92.5 percent of households believed that pond fertilization and liming is useful. Predators' problem and Lack of quality fish seeds and feed were major production problems.

**Keywords:** Fish, fertilizers, production, amount, frequency

## Introduction

Fisheries and aquaculture remain important sources of food, nutrition, income and livelihoods for hundreds of millions of people around the world (FAO, 2016) [6]. The most recent estimates indicate that 59.6 million people were engaged in the primary sector of capture fisheries and aquaculture in 2016 with 19.3 million people engaged in aquaculture and 40.3 million people engaged in fisheries (FAO, 2018) [7]. Fertilization and liming plays a crucial role for fish production. Fish ponds are fertilized to increase the natural food eventually cuts off the feed requirement needed for fish production (Shrestha & Pandit, 2017; Boyd & Snow, 1975) [11]. Similarly, liming improves the soil pH and makes the pond fit for stocking of fish and further fish production. Lime reacts with bottom muds, neutralizing acidity and increasing base saturation by exchanging basic for acidic ions on cation exchange site (Boyd C. E., 1974) [2].

Due to abundant water resources, there is a tremendous scope in aquaculture in Sunsari district. The sources of water in the district were boring water, water canal, rainfed, etc. In the buffer zone of Koshi Tappu Wildlife Reserve, the main source of pond water is seepage water from Koshi River. The total number of pond was 1175 during 2011/12 and increased up to 1858 in the year 2016/17. Similarly, the production of fish was 900 mt with productivity 3.6 mt/ha which is 5% less than the national fish productivity (3.8 mt/ha) during the year 2011/12 which was also increased up to about 2080 mt with productivity 4.963 mt/ha which is 1.28% more than the national fish productivity (4.9 mt/ha) in the fiscal year 2016/17. The production of fish was 2291.17 mt with productivity of 5.1 mt/ha in the year 2017/18 (MoAD, 2017; CFPCC, 2018) [8, 4].

Majority of fish farmers depend on natural food for the production of fish as a result the production and productivity of fish is too low as compared to other countries. Low and imbalanced use of manures and fertilizers, shortage in fish feed supply, inadequate supply of fertilizers and lime, minimum use of farm inputs, poor farm mechanization status, lack of knowledge of fish farming techniques, predatory problems (crocodile, fishing cat, otter, birds, snake) are the major limiting factors that hinders the commercial fish production in Sunsari district. Findings from this study will be useful for planners, policy makers, project implementers, farmers and donors to formulate

policy, strategy and plan, project implementation; and promote, adoption and dissemination of fish farming based technology.

The objectives of the study were to analyze the status of pond fertilization, liming and fish production on fish zone of Sunsari district of Nepal, identify the constraints for the production of fish, and analyze the farmers knowledge, attitude and perception towards the fish farming.

## Methodology

The study was conducted in Sunsari district. Three potential sites of Sunsari namely Ramdhuni Municipality, Barahakshetra Municipality and Koshi Rural Municipality, were purposively selected for the study based on the residence of most of the fish farmers and production potentiality in consultation with related stakeholders involved in fish production.

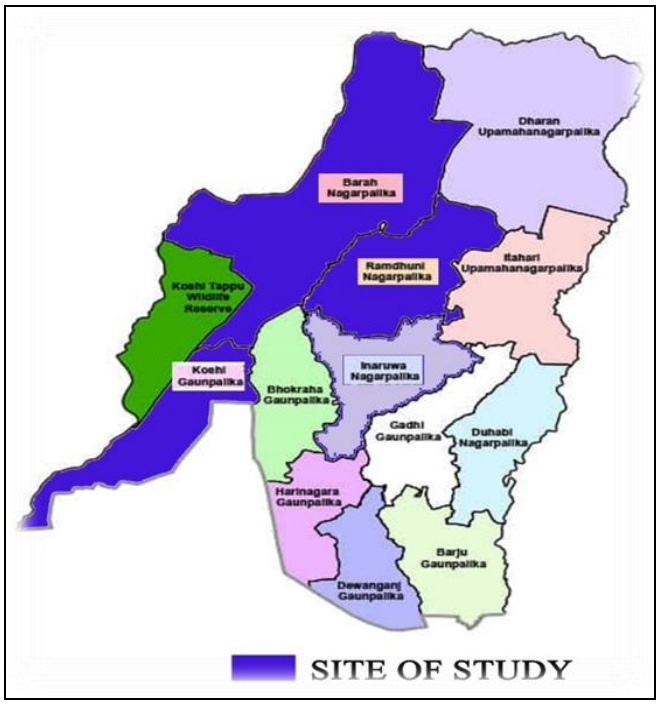


**Fig 1:** Map showing the study area

A total of 120 Households of fish farmers were randomly selected, 40 from each sites and were interviewed by using pre-tested semi structured questionnaire. Secondary data needed for the study were obtained from AKC, MoALD, NARC and other related organizations working on fisheries and aquaculture sector. Different articles, reports, journals, books and internet materials related to fish enterprise were consulted during the course of study. The information collected from study was coded, tabulated and analyzed using SPSS 25 and MS excel (2010).

The amount, type, frequency and method of application of different organic fertilizers used such as FYM, Mustard cake, Goat manure, Poultry manure, Pig manure and compost were analyzed. Similarly, in case of inorganic fertilizers and lime also.

In this study, the cost incurred for fish seeds, feed, manure and fertilizers, lime, energy and fuel, labour (including hired and family labor), repair and maintenance cost and miscellaneous cost were considered as variable cost. The ratio of gross return to gross cost i.e. B/C ratio is a relative measure which indicates the return per unit cost.

B/C ratio = Gross return/Total variable cost

Gross margin refers to the difference between the enterprise gross return and the variable cost incurred to that. It shows whether variable cost incurred in the production process is covered by the return obtained by selling the product. In this study the gross return and gross margin were calculated by using the formulae used by (Devkota, Dhakal, Dhakal, Dhakal, & Ojha, 2014) [5]

Gross margin = Gross return – Total variable cost

Gross return = Price * Total quantity sold

Total variable cost = Cost incurred for variable inputs

## Results and Discussions

### Socio-economic and demographic characteristics of respondents

The socio-economic and demographic characteristics include gender and age distribution, economically active population, education, occupation, caste/ethnicity, land holding size, migration, experience on fish farming.

Most of the respondents in the study area were males (84.2%) followed by females (15.8%). The most prominent ethnic groups were Janajati (37.50%) followed by Madhesi (35.83), Brahmin/Chhetri (21.67%), Dalit (2.50%) and Muslim (2.50%).

**Table 1:** Socio-demographic characteristics of respondents in the study area

| | | Mean Value | | |
|---|---|---|---|---|
| **Socio-demographic characteristics** | **Small farmers (n=78)** | **Large farmers (n=42)** | **Overall (N=120)** | **Chi-square /t-value** |
| Gender of respondent | | | | |
| i) Male (%) | 80.8 | 90.5 | 84.2 | 1.93 |
| ii) Female (%) | 19.2 | 9.5 | 15.8 | |
| Ethnicity | | | | |
| i) Brahmin/Chhetri (%) | 25.64 | 14.29 | 21.67 | |
| ii) Janajati (%) | 41.02 | 30.95 | 37.50 | |
| iii) Dalit (%) | 3.85 | 0 | 2.50 | 8.920 |
| iv) Madhesi (%) | 28.21 | 50 | 35.83 | |
| v) Muslim (%) | 1.28 | 4.76 | 2.50 | |
| Level of education | | | | |
| i) Illiterate (%) | 26.92 | 11.90 | 21.67 | |
| ii) Only read and write (%) | 3.85 | 4.76 | 4.17 | |
| iii) Primary level (%) | 6.41 | 7.14 | 6.67 | 11.829** |

| | | | | |
|---|---|---|---|---|
| iv) Secondary level (%) | 50 | 38.09 | 45.83 | |
| v) Higher secondary level (%) | 7.69 | 23.81 | 13.33 | |
| vi) University level (%) | 5.13 | 14.28 | 8.33 | |
| Experience (years) | | | | |
| i) 1-5 years (%) | 35.9 | 40.5 | 37.5 | |
| ii) 6-10 years (%) | 23.1 | 21.4 | 22.5 | 0.317 |
| iii) 11-15 years (%) | 6.4 | 7.1 | 6.7 | |
| iv) >15 (%) | 34.6 | 31 | 33.3 | |
| Size of household (no) | 6.79 | 6.64 | 6.74 | 0.231 |
| Age of respondents (years) | 47.09 | 47.86 | 47.36 | -0.33 |
| Economically active population (no) | 4.55 | 4.17 | 4.42 | 1.042 |
| Land holding size (ha) | | | | |
| i) Total owned land | 1.07 | 2.28 | 1.49 | -3.872*** |
| ii) Pond size | 0.24 | 0.99 | 0.50 | -11.817*** |

**Note:** ** and *** indicate significant difference at 5% and 1% level respectively.

The educational level of the respondent was categorized into six different groups. Illiterate are those who can neither read nor write. The respondents who can read and write without having attended any formal classes were categorized into only read and write group. Similarly, those who have attended school up to grade 5, 10 and 12 are grouped into primary level, secondary level and higher secondary level respectively. University level designates the formal education up to bachelor degree and above. Table 6 depicted that about 21.67% respondents were illiterate and remaining 78.33% were literate. The result showed that about 37.5 percent of the farmers have less than 5 years of experience and majority of farmers (33.3%) have more than 15 years of experience since the land around buffer zone wasn't suited for growing other crops. About 29.2% of the respondents have years of experience between 6 to 15 years. The average respondent household size was 6.74 members per household which was quite more than that of the national average household size i.e. 4.88 (CBS, 2017) [3]. Table 1 depicted that there were more economically active members (4.42). The average own land and pond size of the sampled household was 1.49 and 0.5 ha respectively. This was significant difference at 1% level (Table 1).

**Farmers' perception, attitude and knowledge towards pond fertilization, liming and fish production**

Farmers' knowledge, perception and attitudes affect the different practices adopted by them. About 20.8% fish farmers had knowledge about the integrated fish farming system. Similarly, 98.3% of fish farmers knew about the pond fertilization and liming. Likewise, 92.5% of respondents gave the answer that pond fertilization was useful. About 82.5% of fish farmers had the perception that pond fertilization and liming increased in fish production. Majority of the farmers (95.8%) knew about liming materials. Only 7.5% of respondent farmers knew about inorganic fertilizers and their constituents. About 80.8% farmers believed that fertilizers and lime don't have any undesirable effects on the pond (Table 2).

**Table 2:** Farmer's perception, attitude and knowledge towards pond fertilization, liming and fish production

| Descriptions (%) | Small farmers (n=78) | Large farmers (n=42) | Overall (N=120) | Chi-square value |
|---|---|---|---|---|
| i) Integrated fish farming system | 14.1 | 33.3 | 20.8 | 6.121** |
| ii) Pond fertilization and liming | 97.4 | 100 | 98.3 | 1.095 |
| iii) Pond fertilization and liming is useful | 89.7 | 97.6 | 92.5 | 2.441 |
| iv) Pond fertilization and liming increase in fish production | 78.2 | 90.5 | 82.5 | 2.847* |
| v) Know about liming materials | 94. | 97.6 | 95.8 | 0.516 |
| vi) Inorganic fertilizers and their constituents | 6.4 | 9.5 | 7.5 | 0.381 |
| vii) Fertilizers and liming don't have any undesirable effects on the pond | 74.4 | 92.9 | 80.8 | 6.030** |

**Note:** *and ** indicate significant difference at 10% and 5% level respectively.

**Amount and frequency of different fertilizers**

The average amount of FYM use was 3005.64 kg per ha with frequency 2.07 times a year. Similarly, the average amount of mustard cake, goat manure, poultry manure, pig manure and compost was 85.62, 141.33, 125.56, 59.17 and 24.75 kg per ha with frequency use of 2.24, 0.48, 0.17, 0.07 and 0.08 times a year respectively. The average amount of urea use was found to be 44.56 kg per ha with frequency use of 0.95 times a year. Likewise, The average amount of DAP and MOP use was 42.41 kg and 0.79 kg per ha with frequency use of 0.92 and 0.02 times a year respectively.

**Table 3:** Amount (kg per ha) and frequency of different type of fertilizers.

| Descriptions | Small farmers (n=78) | Large farmers (n=42) | Overall (N=120) | t-value |
|---|---|---|---|---|
| FYM | | | | |
| a. Amount | 2630.56 | 3702.23 | 3005.64 | -0.899 |
| b. Frequency | 2.06 | 2.09 | 2.07 | -0.04 |

| | | | | |
|---|---|---|---|---|
| Mustard cake | | | | |
| a. Amount | 63.37 | 126.95 | 85.62 | -0.849 |
| b. Frequency | 1.83 | 3 | 2.24 | -0.668 |
| Goat manure | | | | |
| a. Amount | 71.15 | 271.66 | 141.33 | -1.090 |
| b. Frequency | 0.10 | 1.19 | 0.48 | -1.408 |
| Poultry manure | | | | |
| a. Amount | 151.92 | 76.59 | 125.56 | 0.458 |
| b. Frequency | 0.09 | 0.31 | 0.17 | -1.367 |
| Pig manure | | | | |
| a. Amount | 91.03 | 0 | 59.17 | 1.637 |
| b. frequency | 0.11 | 0 | 0.07 | 1.582 |
| Compost | | | | |
| a. Amount | 25.25 | 23.81 | 24.75 | 0.060 |
| b. Frequency | 0.06 | 0.12 | 0.08 | -0.649 |
| Urea | | | | |
| a. Amount | 32.16 | 67.59 | 44.56 | -2.737*** |
| b. Frequency | 0.65 | 1.5 | 0.95 | -3.218*** |
| DAP | | | | |
| a. Amount | 30.64 | 64.28 | 42.41 | -2.605** |
| b. Frequency | 0.63 | 1.45 | 0.92 | -3.141*** |
| MOP | | | | |
| a. Amount | 0.58 | 1.19 | 0.79 | -0.524 |
| b. Frequency | 0.01 | 0.02 | 0.02 | -0.445 |

**Note:** ** and *** indicate significant difference at 5% and 1% level respectively.

**Type, amount (per ha), frequency and method of application of lime**

Majority of the respondent households (89.5%) used *ghar potne chun* type of lime might be due to its low cost followed by agricultural lime (5.3%) and fish lime (5.3%). About 85.1% of fish farmers used lime by dissolving in water and spraying all over the pond followed by broadcasting (14.9%) as shown in Table 21. The average amount of lime use in the study area was 163.59 kg per ha while that of small and large farmers used 144.45 and 199.14 kg per ha respectively. The average low amount of lime use could be due to the low use of fertilizers as the water quality doesn't get deteriorate. The average frequency of lime use was 1.43 times in a year.

**Table 4:** Type, amount (kg per ha), frequency and method of application of lime in the study area

| Descriptions | Small farmers (n=78) | Large farmers (n=42) | Overall (N=120) | Chi-square/ t-value |
|---|---|---|---|---|
| Type of lime | | | | |
| i) Ghar potne chun (%) | 90.7 | 87.2 | 89.5 | |
| ii) Agricultural lime (%) | 5.3 | 5.1 | 5.3 | 0.702 |
| iii) Fish lime (%) | 4 | 7.7 | 5.3 | |
| Total | 100 | 100 | 100 | |
| Method of application | | | | |
| i) Broadcasting (%) | 17.3 | 10.3 | 14.9 | |
| ii) Dissolve in water and spray all over the pond (%) | 82.7 | 89.7 | 85.1 | 1.013 |
| Total | 100 | 100 | 100 | |
| Amount | 144.45 | 199.14 | 163.59 | -1.796* |
| Frequency | 1.23 | 1.81 | 1.43 | -3.103*** |

**Note:** * and *** indicate significant difference at 10% and 1% level respectively.

**Cost and return per ha of pond area per year**

The average fish production in the study area was 2109 kg per ha. The total variable cost (TVC) of fish production per ha of the pond area was NRs 140332.36. It includes the cost in the fish production which constitutes the cost of fish seeds, feed, manures and fertilizers, lime, labour, repair and maintenance, fuel and energy and other miscellaneous cost. The total return/revenue from fish production was NRs 236201.60. The overall gross margin was NRs 95869.23 while that of small and large farmers were NRs 72669.77 and NRs 138953.96 per ha of pond area. This was significant difference at 5% level (Table 5). The result also showed that some farms have attained negative margin. It means that some of the farms of study area were in loss and maximum loss realized per ha was NRs. 630000. Sharma, et.al (2018) found NRs 585724.58 and NRs 1223934 as the variable cost and gross returns respectively. This showed that the both variable cost and gross return in the study area was found very low i.e. NRs 140332 and NRs 236202 respectively as indicated by low use of required inputs and subsistence type of fish farming.

**Benefit-cost (B/C) ratio**

Simply, the undiscounted B/C ratio is the ratio of gross return to the total variable cost incurred throughout the year. It gives the clear idea about recovery of total cost incurred during the production process by total return obtained from sell of product that same year. The B/C ratio was found to

be 1.83 while that of small and large farmers were 1.80 and 1.88 respectively. The average B/C ratio was found to be greater than unity. Thus, we can conclude that fish farming in the study area was somewhat profitable. Similar type of B/C ratio was found by Sharma, et.al 2018 in Chitwan, Nepal i.e. 1.63.

**Table 5:** Cost, Return, Profit and B/C ratio per ha of pond area

| Variables | Overall (N=120) | Small farmers (n=78) | Large farmers (n=42) | Mean difference | t-value |
|---|---|---|---|---|---|
| Production (kg) | 2109 | 2027.14 | 2260.78 | -233.64 | -0.657 |
| Cost (NRs.) | 140332.36 | 133108.93 | 153747.31 | -20638.38 | -0.986 |
| Return (NRs) | 236201.60 | 205778.70 | 292701.28 | -86922.58 | -1.871* |
| Gross margin | 95869.23 | 72669.77 | 138953.96 | -66284.19 | -2.025** |
| BC ratio | 1.83 | 1.80 | 1.88 | -0.7921 | -0.365 |

**Note:** * and ** indicate significant difference at 10% and 5% level.

**Constraints of fish production**

Various problems were encountered during the production process. In this regard, the major one was the problem of predators. The predators such as crocodile, birds, fishing cat, otter, snake, etc. fed on fish. The second most important problem was unavailability of quality fish, seeds and feed. The next major one was water shortage. The shifting of Koshi River towards the west resulted in decreased level of water in the pond since the main source of water was seepage. This created scarcity of water during the stocking of fish seeds. The fourth and fifth most important problems were unavailability of fertilizers and lime and poor managerial skill as indicated by index and rank (Table 6). Various inputs like fish seed, feed, manures and fertilizers were the important determinants of fish production in the study area. Such type of findings have also been made by Yadav (1990) [12], Mollah *et al*, (1991) [9] and Awoyemi *et al*, (2003) [1] while studying input-output relationship in fish production in Nepal, Bangladesh and Nigeria respectively.

**Table 6:** Ranking of major fish production problems encountered by farmers in the study area

| Problems | Index | Rank |
|---|---|---|
| Predator problems | 0.815 | I |
| Unavailability of fish seed and feed | 0.675 | II |
| Water shortage | 0.653333 | III |
| Unavailability of fertilizers and lime | 0.431667 | IV |
| Poor managerial skill | 0.425 | V |

**Conclusion**

Nepalese aquaculture is in growing stage and the amount of fish production is too low as compared to the world aquaculture production; however the progress achieved in recent years is really praiseworthy. The study was conducted among 120 fish farmers, who were randomly selected from three different sites i.e. Barahakshetra Municipality, Ramdhuni Municipality and Koshi Rural Municipality, 40 from each study site.

Farmers having large farm was found to have more sound knowledge, good perception and positive attitude towards pond fertilization, liming and fish production. Majority of the farmers used FYM and urea followed by other organic and inorganic fertilizers for pond fertilization but the quantity used was lower than the recommended (3000 kg well decomposed FYM, 120 kg urea and 90 kg DAP per ha as starter dose). Most of the farmers used *ghar potne chun* for liming in the ponds and the average amount was lower than the recommended (450 kg per ha initially and other amount based on water quality) since low use of fertilizers doesn't deteriorate pond water quality. Production of fish in large farms was more profitable than in smaller farm which was supported by higher B/C ratio among the fish farmers in large farm. In general, profitability could be increased by increasing expenditure on physical inputs namely seed, feed, lime, manure and fertilizer, and cutting down expenditure on hired human labor. In the study area, the major problem was attack of predator followed by lack of quality fish seeds and feed, water shortage, lack of fertilizers and lime and poor managerial skill.

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