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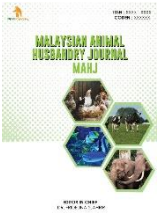

RESEARCH ARTICLE

ASSESSMENT OF PRODUCTION STATUS OF FISH IN FISH ZONE MAHOTARRI, NEPAL

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ABSTRACT

This study was conducted in June, 2020 to know the current status of production of fish subsector in fish zone, Mahottari district. For the study, the primary information was collected from 60 households via predetermined semi structured interview schedule. Simple random technique was used to select the respondents. Virtual interview was carried out to confirm the data collected from household as primary data. Different research journal, articles, reports, books, and the publication of national and international agency, government and non- government organization was consulted to collect secondary data. Collected data was verified and entered in Ms-Excel software for descriptive analysis. Problem indexing was done to rank the major problems. Study revealed socio economic preview with production. Majority of the respondents were found adopted fish farming as major source of income and majority of the respondents engaged in this subsector were from Madhesi community. However, it was found that the farmers were adopting traditional practices for fish production. Unavailability of quality seeds and feeds was found the major problems in the commercial fish farming. Farmers supplying traditional feeds (MOC) only were found dominant. Application of chemical fertilizer was less than the Nepal government's recommended quantity. Farmers were found applying more quantity of DAP than Urea. Argulosis and E.U.S were the most commonly found diseases in fish. Use of equipment like aerator, p^H meter, DO meter to maintain water quality was found very less by farmer. Total production of table fish was found to be 4158.09 qts whereas average production per household was found to be 70.47 qts. B/C ratio was found 1.43 which suggested fish farming was a profitable agricultural business in fish zone, Mahottari and was economically viable to run forward in future.

KEYWORDS

B/C ratio, descriptive analysis, dominant, economically viable.

1. INTRODUCTION

1.1 Background

Major population of Nepal is depending on agriculture to sustain their daily life which makes it the backbone of Nepalese economy. It has been estimated that about 27.7% of Nepal's gross domestic product (GDP) came from agriculture sector during 2019/20 (Economic survey, 2020) Out of various sub sectors of agriculture, fishery is related to raising or harvesting of fish. Food and Agricultural Organization (FAO) defined fishery as an activity leading to harvesting of fish. It may involve capture of wild fish or raising of fish through aquaculture. Aquaculture is an important food production sector in the world. Nepal is the richest country in terms of water resources which makes Nepal a country with potential fresh fish farming. Aquaculture has achieved the economy growth of 18.64% during 13th fifth year plan which accounted for 1.32% contribution to GDP and 4.22% to AGDP (DoFD, 2016). Despite of this growth, per capita production and consumption of fish in Nepal is only 2.75 kg which is far below than the world's average (19 kg) and average of least developed countries (11 kg) (DoFD, 2016).

Fish farming has been traditionally practiced by many tribes in Nepal from many years ago i.e. Tharu, Kewat, Das, Kahar, Malaha, Lodh, Gaud and Gaha etc. These tribes were usually dependent on capture fishery for theirs food sources and to run their livelihood, which is still a common practice across the country, but this is unorganized and done mostly at subsistence level (Rajbanshi, 2002). Having landlocked in nature, Nepal depends only on inland aquaculture with finfish farming. Climatic condition favors cultivation of both warm and cold water species. Culture fishery is relatively new in Nepal and was started in small scale in the mid-1940s with the introduction of Indian major carps seed (FAO, 2016). In Nepal, 200 fish species are available in which around 190 are indigenous species and remaining are exotic species. (Sharma C. M., 2008). Some of the major cultivated indigenous carp species in Nepal are Rohu (*Labeo rohita*), Catla (*Catla catla*), Naini (*Cirrhinus mrigal*) etc whereas exotic species are Common carp (*Cyprinus carpio*), Grass carp (*Ctenopharyngodan idella*), Silver carp (*Hypophthalmichthys molitrix*), Bighead carp (*Arishtichthys nobilis*), Nile tilapia (*Oreochromis niloticus*), Rainbow trout (*Oncorhynchus mykiss*) etc. Basically, the people of terai are found to be engaged in fish farming as majority of fish species (carps) are warm water species. Mid hills and hills is best for Rainbow trout farming.

1.2 Statement of Problem

Low productivity of fish has been realized in study area despite having great potentialities of aquaculture. Lack of technical knowledge, lack of innovation adoption, poor status of mechanization are major hindrances for fish sub-sector to have high pace of growth. Beside this there are many challenges experienced by the farmers in fish farming. Among them limited capital is the major hindrance for almost all the farmer to make a

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technically approved pond for aquaculture. Scarcity of water to fill up the pond, leakage of water from the pond, unavailability of good quality fry and fingerlings as well as theirs high mortality, unavailability of good quality feed and fertilizers at needy time, problems of electricity, transportation and market, are the majors challenges faced by the farmers. Flooding during monsoon, theft of fish, poisoning of pond water, birds and snakes preying fry and fingerlings are some others problems. Diseases like Columnaris, Saprolegniasis, Ichtyophthirius, Dactylogyrosis, Argulosis and Trichodiniasis are others serious problems encountered by fish farmers.

Even small scale fish farmers are involved in carp poly culture, the scientific knowledge about better feed use and feeding practices is clearly lacking. Farmers are slowly stepping into intensive culture but they are not well aware of technical knowledge. Use of artificial feeds in intensive poly culture is basic need but the farmers don't have proper knowledge about feeding rate, quantity and frequency and majority of farmers are still depended on natural food.

1.3 Rationale

Mahottari is one of the leading district in terms of fish production. Recently PMAMP has declared this district as Fish zone with a long term vision of increasing production to make a whole country self-sufficient in fish production. However, the productivity is still below the national average. To achieve that vision, the current production needs to be expanded by many folds. It is very important to know status of fish production, problems faced by farmers during fish farming, policies of local, state and central government related fish farming, the current scenario of resources utilization, the current market efficiency, and opportunities to evaluate the potential of fish farming in the future. Thus, this study helps to find out the major drawbacks encountered in fish farming and their possible solution. The findings of the study will be significant for the technical personnel, extension workers and policy makers to solve the problems related to fish farming and lift the production and productivity.

1.4 Objectives

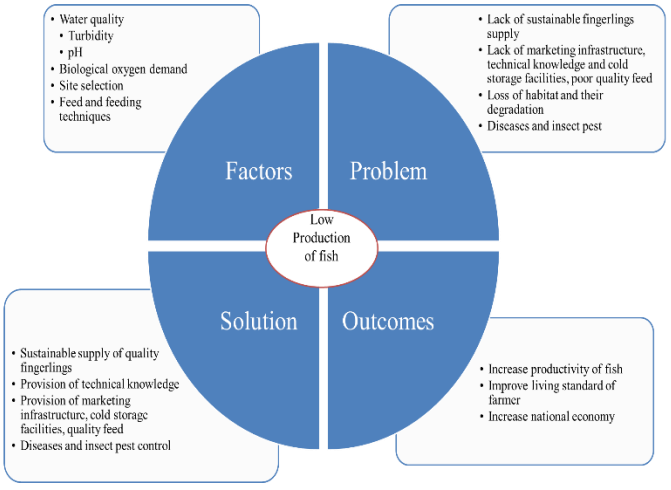
1.4.1 General Objectives

- To study the status of fish production in fish zone, Mahottari district.

1.4.2 Specific

- To study the various feed types and feeding practices adopted in carps poly culture
- To know the status of technology adoption by fish farmers in Mahottari district.
- To identify the problems related fish farming
- To conduct the economic analysis of fish farming in fish zone, Mahottari

2. Conceptual Framework



3. Materials and Methods

Materials and methods for this study have been described in following heading and sub-headings.

3.1 Study area

Mahottari district spreads from 26° 36' to 28° 10' north latitude and 85° 41' to 85° 57' east longitude. It occupies an area of 1002 sq. km .It has an average length of 58 km (north- south) and average width of 18 km (east – west). It's elevation ranges from 61 to 808 masl.

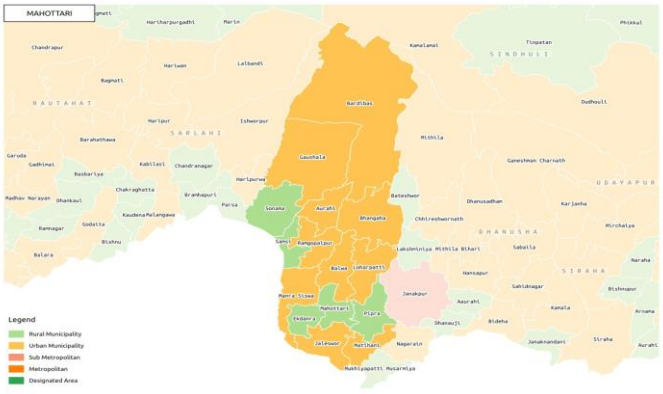


Figure 1: Map of Mahottari district

This study was conducted in Gaushala Municipality, Aurahi Municipality, Bhangaha Municipality, Loharpatti Municipality and Sonama Rural Municipality of Mahottari district of province 2, Nepal under fish production zone of PMAMP.

3.2 Sampling procedure and techniques

Based on the fish zone profile of Mahottari, a sampling frame was prepared for drawing representative sample. For household survey, only farmer having pond size larger than 0.2 ha (6 kathha) and engaged in fish farming at least for 2 years were selected. Gaushala Municipality, Aurahi Municipality, Bhangaha Municipality, Loharpatti Municipality, and Sonama Rural Municipality were selected as they were the most potential fish production area and fall under the fish zone profile of Mahottari. Afterwards 60 households were selected based on simple random sampling.

3.3 Techniques of data collection

3.3.1 Household survey

A total of 60 fish producing households was survey by telephone using semi structured pretested interview schedule for the primary data collection. Virtual interview was conducted using telephone as the whole country was under complete lockdown due to COVID-19 pandemic. Respondent of age above 18 years old was only interviewed to obtain more accurate and complete data. Information regarding no. of ponds, area of pond, species of fishes placed in pond, types of fish seeds used, stocking rate of fish seed and their mortality placed in pond, types of feed supplement used, harvesting weight of fish, total cost of production and total production of fish were collected.

3.3.2 Key informant interview

The progressive farmer, leaders of different farmer groups or cooperatives, local extension workers, local leaders, was identified as key informant. The key informant was interviewed using an interview checklist. The information obtained from the KII guided in verifying the information gathered from HH survey.

3.4 Sources of information

Both primary and secondary data was used as sources of information.

3.4.1 Primary data

Primary data was collected from farmers through HH survey through virtual interview using telephone, KII and field observation.

3.4.2 Secondary data

During the study the data was collected from different research articles, journals, reports, books, along with the publication of different government and non government organization as the secondary source of information. This helped in understanding and analizing the collected information.

3.5 Methods and techniques of data analysis

The data collected from HH survey was carefully edited and then it was entered in Ms-Excel SPSS software. Before proceeding to data analysis, data updating and validating was done.

4. Experimental Results and Discussion

The findings of the study were presented and discussed in following heading and sub-headings.

4.1 Family status of respondents

Maximum and minimum family size of the study area was found 22 and 3, respectively. Average male population within the family was found 3.866 where as average female population was 3.55 that is nearly equal to average male population. Average population below 18 years old and above 60 years old within family were found 2.483 and 1.15, respectively. Overall mean of economically active population within family was found 3.8 which reveals that the family is dominated by active age group within the study area.

Table 1: Family status distribution among the respondents in study area, 2020.

Family status	Minimum	Maximum	Mean	S.D	Total
Total family member	3	22	7.433	3.548	446
Male	1	14	3.866	2.332	233
Female	0	10	3.55	1.789	213
Below 18	0	7	2.483	1.641	149
Above 60	0	3	1.15	0.917	69
Economic active member	2	17	3.8	2.589	228

Source: Field Survey, 2020

4.2 Source of income

Out of 60 fish farming family, it was found that fish farming was the only major source of income of around 38.33% of the respondents and 35% of the respodents were involved both in fish farming and other agricultural practices. It was also found that source of income of the 11.66% of the respondent was fish rearing along with other business. Similarly 15% of the respondents of the study area were engaged in services along with fish farming for the source of income.

Table 2: Source of income of respondent's family in study area, 2020.

Source of income	Frequency	Percentage
Fish farming only	23	38.333%
Fish + other agri farming	21	35%
Fish farming + business	7	11.667%
Fish farming+ service	9	15%
Total	60	100.000%

Source: Field Survey, 2020

4.2 Fish farming experience of respondent's family

Farming experience of respondents were catogeried as 2-5 years, 6-10 years, 11-15 years, 16-20 years, and greater than 20 years. It was found that majority(63.33%) of respondents have fish farming experience of 2-5 years, 18.33% of 6-10 years, 8.33% of 11-15 years, 6.67% of 16-20 years and only 3.33% of them had farming experience of greater than 20 years. Overall mean of fish farming experience was 6.75 years. Minimum and maximum years of experience in fsh farming was found 2 and 40 years respectively.

Table 3: Fish farming experience of respondent's family in study area, 2020

Farming Experience	No of respondents	Min	Max	Mean ± SD
2-5 years	38(63.33)			
6-10 years	11(18.33)			
11-15 years	5(8.33)	2	40	6.75±7.24
16-20 years	4(6.67)			
> 20 years	2(3.33)			
Total	60(100)			

Figure in the parenthesis indicate percentage to the total. Source: Field Survey, 2020

4.3 Exposure and training activity

4.3.1 Exposure/field visit

Exposure or field visit helps to gather information about the differents farming techniqes used in different area. To broadens the knowledge about the fish farming techniques, govenments offices and farms of the respective district had organized the exposure/ field. Only 6.33% had participated in the exposure visit whereas 93.67% hadn't participated in such activity(. Among the respondents who had participated exposure visit, half of the them had participated for one or two times and half of them were participated for five times or more.

Table 4: Percentage of respondents participated in exposure visit in study area, 2020

Exposure visit	Yes	No	Total
No of respondents	4(6.33)	56(93.67)	60

Figure in the parenthesis indicate percentage to the total. Source : Field Survey, 2020

Table 5: Percentage of respondents and theirs' no of exposure visit in study area, 2020

No of exposure visit	No of respondents
1-2 times	2(50)
3-4 times	0
5 or more	2(50)
Total no of respondents	4

Figure in the parenthesis indicate percentage to the total. Source : Field Survey, 2020

4.3.2 Participation in training

Among the surveyed households, it was found that 55% of the respondents hadn't participated in any kinds of training about fish farming whereas 45% of the respondents had participated in commercial fish farming training. From the study among the training participated farmers, it was also found that majority of the farmers (44.44%) had receive training for only one times . Likewise, farmers attending training for two, three, four and five times accounts 33.33%, 3.704%, 7.404% and 11.11%, respectively .This shows that majority of the fish growers in the study area were deprived of the necessisate technical knowledge about fish farming. So providing various training relating commercial fish farming and encouraging fish farmers to attend those training would be productive work to obtain the objective of PMAMP, PIU, Fish zone, Mahottari.

Table 6: Percentage of respondents participated in training in study area, 2020

Training participation	Yes	No
No of respondents	27(45)	33(55)

Figure in the parenthesis indicate percentage to the total. Source: Field visit, 2020

Table 7: Respondents percentage and theirs' number of training in study area, 2020

No of training	No of respondents
1 times	12(44.44)
2 times	9(33.33)
3 times	1(3.70)
4 times	2(7.40)
5 times or more	3(11.11)
Total no of respondents	27(100)

Figure in the parenthesis indicate percentage to the total. Source: Field Survey, 2020

4.4 Pond information

4.4.1 Total no of ponds

Ponds number per households was catogeried as only 1, 2-5, 6-10 and greater than 10. It was found majority(45%) of the respondents had 2-5 pond, 40% had single pond ,8.33% had 6-10 pond and 6.67% had greater than 10 ponds respectively.It was also found that per surveyed households, the ponds number ranges from 1-25 whereas no of ponds from all the surveyed family was 219 in total. The ponds no. status of the study area had presented in:

Table 8: Pond number status of respondents in PMAMP in study area, 2020

No of Ponds	No of respondents	Min	Max	Mean ± S.D	Total ponds
only 1	24(40)				
2-5 ponds	27(45)	1	25	3.65±5.46	216
6-10 ponds	5(8.33)				
> 10 ponds	4(6.67)				
Total	60(100)				

Figure in the parenthesis indicate percentage to the toal. Source: Field survey, 2020

4.4.2 Pond ownership pattern

In the study, pond ownership was catogories as owns land only, leased land only and both owns and leased land using for fish rearing. It was found that 80% of the respondents have using theirs owns land only for fish farming whereas only 6% of the respondents were using leased land only for fish farming and only 6% of the respondents have using both owns land and leased land for fish farming.

Table 9: Pond ownership pattern among the respondents in study area, 2020

Parameter	No of respondents
Using owns' land only for fish farming	48(80)
Using owns' and leased land for fish farming	6(10)
Using leased land only for fish farming	6(10)
Total	60

Figure in the parenthesis indicate percentage to the total. Source: Field survey, 2020

4.4.3 Pond area status

Among the surveyed family the minimum and maximum area of pond including bund used for fish rearing is 6 and 700 kattha, respectively (Table 4.14). All together about 4396 kattha i.e 146.53 hectare had been used for fish rearing by 60 households, out of which self owned area is 2382 kathha(79.4 hectare) and leased area is 2014kathha(67.13 hectare). Total pond water area ranged from 3.5 to 500 kathha whereas total pond water area of 60 household is 3277kattha (109.23 hectare).

4.5 Culture species and system

4.5.1 Culture species of fish

It was found that carp species as rohu, naini, bhakur, silver carp, bighead carps, common carp and grass carp were used for culture by farmers of study area. Majority of the farmers were adopting polyculture with all these species in the single pond. While, few of the farmers were culturing minimum 3 or 4 species of these carps in the single pond simultaniously. It was also found few were culturing mangur/catfish along with carps.

4.5.2 Culture system

Different fish culture system have been practicing such as monoculture, polyculture and integrated fish farming in terai region of Nepal. It was found that none of the fish grower were practicing monoculture. It was also found that some farmers were growing catfish/mangur and livestock along with carps polyculture. So for this study purpose, culture system was catogoried as carps polyculture only, carps polyculture plus catfish and integrated fish farming (carps polyculture plus livestock). In was found that, 88.33% of the respondents were practicing carp polyculture only whereas 6.67% of the respondents were practicing carps polyculture plus catfish and 5% of the respondents were practicing integrated fish farming (carps polyculture plus livestock).

Table 10: Pond area status among the respondents in study area, 2020

Area in Kattha	Minimum	Maximum	Mean	Standard deviation	Total area kathha	Total area Hectare
Pond area including bund	6	700	73.267	125.72	4396	146.53
Ownership area including bund	6	320	44.11	54.057	2382	79.4
Leased area including bund	18	700	167.83	197.57	2014	67.13
Pond water area only	3.5	500	54.617	92.97	3277	109.23

Source: Field survey, 202

Table 11: Culture system among the respondendts in study area, 2020.

Culture System	Carp Poly culture only	Car poly culture plus mangur	Integrated (carp poly culture Plus livestock)
No of respondents	53(88.33)	4(6.67)	3(5)

Source: Field survey, 2020

4.6 Fish seed types, place and means of procurement, stocking rate and mortality

4.6.1 Seed types

Respondents of the present survey used four types of fish seeds *viz.,* hatchlings(5-8mm size), fry (20-25mm size), fingerlings (80-100mm size), advanced fingerlings(100-150mm size). These differences in size of fish seeds affects the mortality and growth of fish with least size having high mortality and biggest size less mortality. Among the 60 respodents it was found that only 3.33% of respondents used hatchling, 6.67% used fry, 48.33% used fingerlings and 41.67% used advanced fingerlings, respectively.

Table 12: Fish seed types cultured among the respondents in study area, 2020.

Fish seed type	Hatchlings	Fry	Fingerlings	Advanced fingerlings
No of respondents	2(3.33)	4(6.67)	29(48.33)	25(41.67)

Figure in the parenthesis indicate percentage to the total. Source : Field survey, 2020

4.6.2 Seed procurement place

From the study it was found that 3.33 % of respondents have their own hatchery, 68.33% of the respondents procured seed from private hatchery only, 33.33% of the respondents procured seed from private and government hatchery both and none of the respondents dependent on government hatchery only for seed procurement which might be due to lack of abundant fish seeds available from government farms. Place of fish seed procurement among the surveyed households was presented below:

Table 13: Place of seed procurement among the respondents in study area, 2020

Seed procurement place	Own hatchery	Government hatchery only	Private hatchery only	Both
No of respondents	2(3.33)	0	38(63.33)	20(33.33)

Figure in parenthesis indicate percentage to the total.
Source: Field survey, 2020

4.6.3 Means of seed procurement

Means for the procurement of fish seed were catogeries as bicycle, motorbike, four wheelers, and motorbike and four wheelers both. Among the surveyed households 70% of respondents used motorbike only and 30% of the respondents used motorbike and four wheelers both for the procurements of the fish seed.

Table 14: Means of seed procurement among the respondents in study area, 2020

Means of seed procurement	No of respondents
Bicycle	0
Motorbike	42(70)
Four wheelers	0
Motorbike and four wheelers both	29(30%)

Source: Field survey, 2020

4.7 Pond input

4.7.1 Feed Supplements

Feed supplements plays an important role in the growth and development of fingerlings and overall to the total table fish production. Two types of fish supplements were commonly used as fish supplements *viz.,* traditional and commercial feed supplements. It was revealed that out of 60 respondents 80 % of the respondents were supplying traditional feed only, 6.67% were supplying commercial feed only, 10% of the respodents were supplying both traditional and commercial feed whereas 3.33% of the fish farmers were completely depend on the pond natural food.

Table 15: Feed types used by the respondents in study area, 2020.

Feed Types	Traditional	Commercial	Both	Only depend on pond natural food
No of respondents	48(80)	4(6.67)	6(10)	2(3.33)

Figure in the parenthesis indicate percentage to the total.
Source: Field survey, 2020

4.7.1.1 Traditional feed

Among the respondents who supplied traditional feed, it was found that 79.63% of the respondents supplied mustard oil cake (MOC) in pure form, 1.85% of the respondents supplied rice bran in pure form as traditional feed supplements whereas 16.67% of the respondents have used MOC with ricebran and 1.85% of the respondents have used MOC with wheat flour in combined form as traditional feed supplements . The study revealed that traditional feed supplementary user were dominated at the study area. The main reason for low preference of commercial feed supplements among respondents was found because of its more expensiveness than traditional feed supplements.

Table 16: Traditional feed supplements used by respondents in study area, 2020

Traditional feed supplements	No of respondents
MOC only	43(79.63)
Rice bran only	1(1.85)
Wheat flour only	0
MOC + rice bran combined	9(16.67)
MOC + wheat flour combined	1(1.85)

Figure in the parenthesis indicate percentage to the total.
Source :Field survey, 2020

4.7.1.2 Commercial feed supplements

Commercial feed supplements used by the respondents in the fish zone was catogeried in two types as floating and sinking types. Among the commercial feed supplements user out of the 60 household, it was found that 70% of the commercial feed supplements used floating types whereas 30% used sinking types.

Table 17: Types of commercial feed supplements used by respondents in study area, 2020.

Types	Floating	Sinking
No of respondents	7(70)	3(30)

Figure in the parenthesis indicate percentage to the total.
Source : Field survey, 2020

4.7.1.3 Feeding interval

Feeding interval was catogeried in six different group as daily, weekly, half monthly and monthly. Among the traditional feed feeder respondents, it was found that 70.37% of the respondents fed at daily basis, 9.26% of the respondents fed at weekly interval, 11.11% of the respondents fed at 15 days interval and 9.26% of the respondents fed at monthly interval. It was also found that 90% of the commecial feed feeder respondents fed at daily basis whereas 10% provided feed at monthly basis (Table 4.28). None of the respondents of the commercial feed feeder had found who fed at weekly and 15 days interval.

Table 18: Feeding interval of traditional feed feeder respondents in study area, 2020.

Feeding interval for traditional feed	No of respondents
Daily	38(70.37)
Weekly	5(9.26)
Half monthly	6(11.11)
Monthly	5(9.26)

Figure in the parenthesis indicate percentage to the total.
Source: Field survey, 2020

Table 19: Feeding interval of commercial feed feeder respondents in study area, 2020.

Feeding interval for commercial feed	No of respondents
Daily	9(90)
Weekly	0
half monthly	0
Monthly	1(10)

Figure in the parenthesis indicate percentage to the total.
Source: Field survey, 2020

4.7.1.4 Feeding time

Feeding time of fish was catogeried as morning, afternoon and evening. Out of 60 respondents, it was found that 84.48% of the respondents fed at morning, 13.79% of the respondents fed at evening and 1.72% of the respondents fed at aftenoon.

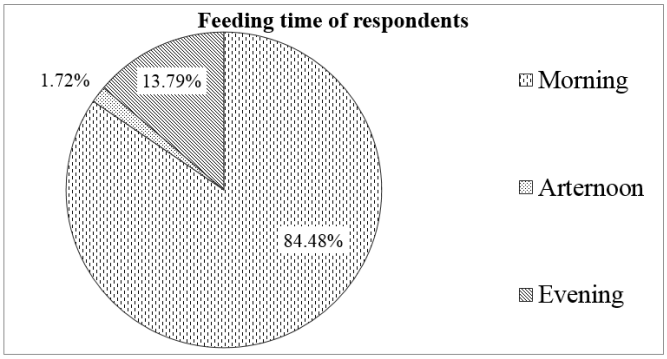


Figure 1: Percentage of respondents feeding at different times of day in study area, 2020

4.7.1.5 Feeding quantity

In the study it was found that the minimum quantity of MOC, rice bran, and commercial pellet fed at a time was 0.041kg, 0.041kg and 0.029 kg per kathha, respectively. Whereas, maximum quantity fed at a time was 5.55kg, 1.5kg and 1kg per kattha, respectively. Similarly, it was found that minimum feedinq quantity of MOC, rice bran and commecial pellet for adults at a time was 0.083kg, 0.083kg and 0.058kg per kattha, respectively. However, maximum feeding quantity for adult at a time was 10 kg , 3.33kg, 1.62kg of MOC, rice bran and commercial pellet respectively per kathha. Likewise, it was also found that average feeding rate of MOC, rice bran and commercial pellet at a time for fingerlings was 0.92kg, 0.61 and 0.43kg per kathha, respectively whereas average feeding rate of MOC, rice bran and commercial pellet at a time for adult was 1.59kg, 0.92kg, and 0.76 kg per kathha respectively.

Table 20: Feeding rate by respondents in study area, 2020

Feeding quantity (Kg) per kathha	Minimum	Maximum	Mean	Standard Deviation
MOC for fingerling	0.041	5.55	0.92	1.09
MOC for adult	0.083	10	1.59	1.76
Rice bran for fingerling	0.041	1.5	0.61	0.49
Rice bran for adult	0.083	3.33	0.92	1.08
Commercial pellet for fingerling	0.029	1	0.43	0.33
Commercial pellet for adult	0.058	1.62	0.76	0.64

Source: Field survey, 2020

4.7.1.6 Purchase rate of feed

It was found that the average purchase rate of MOC, rice bran and commercial pellet per kg by the 60 respondents was 39.81Rs, 25.63Rs and 57.3Rs with standard deviation 1.37, 2.22 and 2.49 Rs, respectively.

Table 21: Purchase rate of feed by the respondents in study area, 2020.

Purchase rate of feed per kg	Minimum	Maximum	Mean	Standard Deviation
MOC	35	42	39.81	1.37
Rice bran	25	32	25.63	2.11
Commercial pellet	55	60	57.3	2.49

Source: Field survey, 2020

4.7.2 Fertilizer types

Fertilizers are used for the production of phytoplanktons in the pond . Two types of fertilizer were used *viz.,* organic and inorganic. Among the surveyed households it was found that 8.33% of the respondents applied organic fertilizer only, 1.67% of the respondents applied inorganic fertililizer only and 90% of the respondents applied both types of fertilizer.

Table 22: Types of fertilizers applied by the respondents in study area, 2020

Fertilizer types	Organic only	Inorganic only	Both
No of respondents	5(8.33)	1(1.67)	54(90)

Figure in the parenthesis indicate percentage to the total.
Source: Field survey, 2020

4.7.2.1 Organic manure application interval

Among the respondents who applied organic manure, it was found that 8.50% of the respondents applied organic manure at weekly interval, 11.87% of the respondents applied at the monthly intervals, 15.27% of the respondents applied organic manure at the 2 monthly intervals, 33.90% of the respondents applied at quarter yearly (3 months) interval, and 15.27% of respondents applied at half yearly and yearly interval, respectively.

Table 23: Application interval of organic manure by the respondents in study area, 2020

Organic manure application interval	No of respondents
Weekly	5(8.50)
half monthly	0
Monthly	7(11.87)
2 monthly	9(15.27)
quarter yearly	20(33.90)
half yearly	9(15.27)
Yearly	9(15.27)

Figure in the parenthesis indicate percentage to the total.
Source: Field survey, 2020

4.7.2.2 Inorganic fertilizer application interval

Application of the inorganic fertilizer at a regular interval increases the productivity and carrying capacity of the pond. Study was conducted to know the chemical fertilizer application interval in the fish zone. Among the respondents who applied chemical fertilizer, the study showed maximum no of respondents (43.64%) applied chemical fertilizer at monthly interval (Table 4.33). Similarly, the study show 34.55% of the respondents applied chemical fertilizer at 15 days intervals, 7.27% of the respondents applied at two monthly interval, 10.91% of the respodents applied at 3 months interval (quarter yearly) and 3.63 % of the respondents applied at half yearly interval respectively.

Table 23: Inorganic fertilizer application interval by the respondents in study area, 2020

Inorganic fertilizer application interval	No of respondents
Weekly	0
15 days	19(34.55)
Monthly	24(43.64)
2 monthly	4(7.27)
Quarter yearly	6(10.91)
Half yearly	2(3.63)
Yearly	0

Figure in the parenthesis indicate percentage to the total.
Source: Field survey, 2020

4.7.2.3 Rate of Fertilizer application

Farm yard manure (FYM) was the commonly used organic manure used in the study area whereas urea and DAP were the commonly used inorganic fertilizer. It was found that the average FYM quantity applied by the respondents who applied FYM at weekly, monthly, 2monthly, quarter yearly, half yearly and yearly basis to be 16kg, 39kg, 46.32kg, 64.72, 65.88,102.35 kg per kathha, respectively. It was also found that the average quantity of DAP applied by the respondents who applied DAP at fortnightly, monthly, 2 monthly, quarter yearly, half year to be 2.28kg, 2.38, 4.70, 3.36 and 4.45 kg per kathha, respectively (Table 4.34). Similarly the amount of Urea applied by respondents accordingly at fortnightly, monthly, 2 monthly, quarter yearly, and half yearly was found to be 1.87kg, 1.99kg, 1.10kg, 1.95kg and 4.45kg per kathha respectively. According to the Directorate of Fish Development, Government of Nepal, application of 10-15kg FYM/kathha fortnighly ; weekly application of 750gm urea/ kathha and 500gm DAP/kathha was highly effective for the higher productivity of carp polycultue. The result from the study shows that DAP has been used at more quantity than urea at the study site.

Table 24: Rate of application of different fertilizer by the respondents in study area, 2020.

Fertilizer application schedule	**Quantity application in kg per kathha**		
	Average rate ± Standard deviation		
	FYM	DAP	Urea
Weekly	16±21.07	-	-
Fortnightly	-	2.28±1.65	1.87±1.36
Monthly	39±29.52	2.38±1.33	1.99±1.12
2 monthly	46.32±27.89	4.70±5.78	1.10±0.48
Quarter yearly	64.72±37.92	3.36±1.88	1.95±0.43
Half yearly	65.88±31.53	4.45±2.53	4.45±2.53
Yearly	102.35±91.96	-	-

Note Dash (-) sigh denote no use of fertilizer.
Source: Field survey, 2020

4.8 Pond maintainance/management

4.8.1 Provision of inlet and outlet

Provision of water inlet and outlet of the pond provide different benefit to the farmers. From the inlet one can add water to the pond at the needy time while the outlet helps during the removal of water when water became excess at the pond and also at the time of pond drying. From the study it was found that out of 60 respondents 44 (73.33%) respondents have provision of inlet outlet in their pond while 16 (26.67%) respondents have not provision of inlet and outlet in the pond.

Table 25: Status of provision of water inlet and outlet in the pond in study area, 2020

Provision of inlet and outlet	**Yes**	**No**
No of respondents	44(73.33)	16(26.67)

Figure in the parenthesis indicate percentage to the total.
Source: Field survey, 2020

4.8.2 Use of external equipments

Various equipments have various purpose in the pond. Aerator were used to dissolve oxygen, pH meter to check pH and DOmeter to check the amount of dissolved oxygen in the pond. Study was conducted to know the status of this equipments used. Among the 60 respondents, only 2 (3.33%) respondents have all the three equipments, 1(1.67%) have aerator only and 57 (95%) respondents doesn't have any kind of equipments. This revealed that fish farmers of the fish zone, Mahottari were lacking far behind in the adoption of technology.

Table 26: Status of external equipments used by respondents in study area, 2020

Equipment	**Aerator only**	**pH meter only**	**DO meter only**	**All**	**None**
No of respondents	1(1.67)	0	0	2(3.33)	57 (95)

Figure in the parenthesis indicate percentage to the total. Source: Field survey, 2020

4.8.3 Cleaning of pond and cleaning interval

Fish rearing pond is attacked by different insect pest, pond weeds and diseases which hampered the environment of pond and resulting poor growth and development of fish. Cleaning of pond at a regular interval helps to make the pond environment clean and suitable for fish growth and developments. In the study of fish zone, it was found that all the surveyed household cleaned theirs pond at certain interval. Talking about cleaning interval, it was found that 1.66% of the respondents cleaned pond at monthly interval, 16.67% at quarter yearly (3 monthly) interval, 56.67% of respondents at half yearly and 25% of the respondents cleaned theirs ponds only one time yearly after the drying of pond.

Table 27: Cleaning interval of pond by the respondents in study area, 2020

Cleaning interval	**No of respondents**
Monthly	1(1.66)
Quarter yearly	10(16.67)
Half yearly	34(56.67)
Yearly	15(25)

Figure in the parenthesis indicate percentage to the total.
Source: Field survey,2020

4.8.4 Turbidity checking/maintainance

Turbidity is the measure of degree to which water losses its transparency due to present of suspended particle. Checking of turbidity plays an important role to maintain the fertility status of pond . Before fertigating the pond it is very important to know the turbidity status of pond. Among the respondents who were interviewed, it was found that only 2 (3.33%) respondents checked turbidity technically by using sechhi disk while 58 (96.67%) respondents were found ignorant about turbidity checking technically and found responding that they had never check turbidity technically because they had experienced to know it just seeing the colour of the pond water. Based on the water colour they used to apply fertilizer in the pond.

Table 28: Turbidity checking response among the respondents in study area, 2020

Turbidity check	**Yes**	**No**
No of respondents	2(3.33)	58(96.67)
Use of	**Sechhi disk**	**Hands**
No of respondents	2(100)	0

Figure in the parenthesis indicate percentage to the total.
Source: Field survey, 2020

4.9 Prevalence of diseases

Prevalence of diseases is one of the major problem in the fish pond that increases the mortality of fish and decreases the overall production of the fish. Study of the fish zone was conduction also to know the diseases prevalence status, name of the diseases noticed and medicine used to counteract the diseases . The results of survery showed that 15% of respondents hadn't faced any disease problem while 81% of respondents have noticed some problem of diseases. Among the disease faced respondents ,47.06% hadn't consulted technician while 52.94% of respondents had consulted the technician to know the nature of disease and its management. It was found that 76.47% of the diseases noticed respondents were face problems of E.U.S, 23.52% were faced tail and fin rot problems, 13.72% were faced problem of ichthyophthiriasis, 3.92%

have columnaris, 5.88% were faced trichodina problem and all the respondents among the diseases noticed respondents were facing the problem of diseases. This revealed that the major fish disease prevailed in fish zone is argulosis followed by E.U.S followed by tail and fin rot, ichtyophthiriasis, trichodina and columnaris.

Medicine used to counteract the diseases in the fish zone was categoried as locally available only , expert (technician) suggestion only and both. It was found that 47.06% of respondents among the respondents who had faced problem of diseases used locally available medicine only whereas 52.94% of the respondents used both locally available and expert suggestion medicine. Locally available medicine was also catogeried during the study as common salt solution, lime, kerosone, salt solution and lime and all. It was found that 3.92% of the respondents who used locally available medicine used common salt solution only, 5.88% had used lime only, 35.29% had used both lime and common salt solution, 54.90% had used all three types of locally available medicine (salt solution, lime and kerosene).

Table 30: Disease prevalance status, name of diseases noticed and medicine used by respondents in study area, 2020.

Disease prevalence	**Response**
Yes	51(85)
No	9(15)
Consult technician	
Yes	27(52.94)
No	24(47.06)
Name of disease	
E.U.S	39(76.47)
Tail and fin rot	12(23.52)
Ichthyophthiriasis	7(13.72)
Columnaris	2(3.92)
Argulosis	51(100)
Trichodina	3(5.88)
Medicine use	
Locally available only	24(47.06)
Expert suggestion only	0
Both	27(52.94)
Locally available medicine	
Salt solution only	2(3.92)
Lime only	3(5.88)
Salt solution and lime both	18(35.29)
Kerosene only	0
All	28(54.90)

Figure in the parenthesis indicate percentage to the total.
Source: Field survey, 2020

4.9.1 Technician suggested used medicine

Differents medicine had been used by respodents in the study area as suggested by the technician. Some of the commonly used medicine were malachite green, $CuSO_4$, pottasium permanganate, malathion, all clear, biomethane, aquacare and superkiller.

4.10 Expenses

From the study among the fish rearing farmers in the fish zone Mahottari, it was found that there were lots of expenses in fish rearing. Expenses includes from land rent, purchasing of fingerlings to packaging and transportation of product.The result show that there was high expensed in feed which contributed to 35.75% whereas there was least expensed in packaging which contributed only 0.65%.

Table 31: Various expenses and their contribution in fish farming among the respondents in study area, 2020

Categories of expenses	**Contribution**
Land rent	17.81%
Equipment	6.72%
Fingerlings	5.61%
Feed	35.75%
Fertilizer and manure	14.13%
Medicine	0.75%
Liming	0.80%
Transportation	2.50%
Electricity and fuel	2.53%
Pond management	0.87%
Labors	11.88%
Packaging	0.65%

Source: Field survey, 2020

4.11 Harvesting information

4.11.1 Seed produce for sell

It was found that only 2(3.33%) of the respondents produced fish seed for sell also and 58(96.67%) of the respondents sold adult table fish. Out of 2 respondents who sold fish seed, table showed that one of the respondents sold only fingerlings and one of the respondents sold hatchlings, fry and fingerlings all. The results also showed that the number of hatchlings sold per annum in the study area was 3000000, fry sold was 5000 and fingerlings sold was 4850000.

Table 32: Percentage of respondents producing fish seeds, seed types produced among respondents and number of seed being sale in study area, 2020

Seed produce for sale	**No of respondents**
Yes	2(3.33)
No	58(96.67)
Types of fish seed sell	**No of respondents**
Hatchlings	0
Fry	0
Fingerlings	1(50)
All	1(50)
No of seeds sold	**Piece per annum**
Hatchlings	3000000
Fry	5000
Fingerlings	4850000

Figure in the parenthesis indicate percentage to the total.
Source: Field survey, 2020

4.11.2 Harvest of table fish

It was found that 8.33% of the respondents harvested fish by themselves and 91.67% of the respondents harvested by hiring fisherman. Table below showed the percentage of respondents who harvested fish by themselves and percentage of those who hired fisherman for fish harvesting.

Table 33: Respondents' percentage harvesting by self or hiring fisherman in study area, 2020.

Harvest by	No of respondents
Self	5(8.33)
Fisherman	55(91.67)

Figure in the parenthesis indicate percentage to the total.
Source: Field survey, 2020

4.11.3 Harvesting frequency of table fish

Harvesting of table fish was done when the fish attained its maximum size as desired by the respondents. Harvesting frequency of table fish depend on the types of fish seed used and upon its growth rate. It was found that the fish species namely rohu and naini have slow growth rate as compared to others carps and the harvesting frequency of rohu and naini were also same as followed by the respondents. Similarly the harvesting frequency of others carp excluding rohu and naini were also same. The results showed the harvesting frequency of different carp species by the respondents of the fish zone Mahottari .The results also showed that 48.33%, 11.67%, 35%, and 5% of the respondents harvest rohu and naini once, twice, thrice and four times in a year, respectively. About 11.67%, 15%, 68.33%, 5% of the respondents harvested remaining carps once, twice, thrice and four times per year, respectively. All the respondents who cultured the catfish also found harvesting the catfish only one time per yearly.

Table 34: Harvesting frequency of different fish species as followed by the respondents in study area, 2020

Fish species	Frequency of harvesting per annum	No of Respondents
Rohu and Naini	Once	29(48.33)
	twice	7(11.67)
	Thrice	21(35)
	Four times	3(5)
	Once	7(11.67)
Others carps	Twice	9(15)
	Thrice	41(68.33)
	Four times	3(5)
	Once	4(100)
Catfish/mangur	Twice	0
	Thrice	0
	Four times	0

Figure in the parenthesis indicate percentage to the total.
Source: Field survey, 2020

4.11.4 Table fish harvesting weight

Harvesting of table fish was done when the fish species attained its maximum weight as desired by the fish rearing farmers. It was found that different respondents had different preference of harvesting weight for different carp species which was range from 500gram to 2 kg. So the harvesting weight were catogeried into four class as 500-700g, 700g-1kg, 1-1.5kg and 1.5kg+.. It was found that 20.33%, 6.77% and 72.88% of the respondents harvested rohu when rohu attained 500-700g, 700g-1kg and 1-1.5kg weight, respectively (Table 4.46). Harvesting weight of naini was also quite similar like rohu. It was found that 20.68% of the respondents harvested naini when it attained weight of 500-700g, 6.89% respondends harvested it when it attained the weight og 700g-1kg whereas 72.41% harvested it when it become 1kg+. It was found that all the respondents harvested silver carp and grass carp when they attained weight of 1kg plus(1kg-1.5kg). Similarly results showed that 89.83% of the respondents harvested bighead carp after it becomes 1kg plus whereas only 10.16 % harvested it after it become 1.5kg plus. Likewise, it was found that 96.56% of the respondents harvested common carp after it gained weight of 1kg plus while 3.44% harvested it only after it become 1.5kg plus. the harvesting weight of bhakur/catla was more as compared to the other carp species by showing that 11.11% of respondents harvested it when it becomes 1kg plus and 88.89 % of the respondents harvested it when it gained the weight of 1.5 kg plus. Also the harvesting weight of catfish as followed by the respondents culturing catfish was found 1kg plus. This study revealed that the harvesting weight of rohu and naini was less as compared to other carp and the harvesting weight of bhakur was more among all the carp species.

Table 35: Harvesting weight of different fish species among the respondents in study area, 2020.

Fish Species	Harvesting weight characterization	Percentage of respondents
	500-700g	20.33
Rohu	700g -1kg	6.77
	1-1.5kg	72.88
	500-700g	20.68
Naini	700g -1kg	6.89
	1-1.5kg	72.41
Silver carp	1-1.5kg	100
Bighead carp	1-1.5kg	89.83
	1.5kg+	10.16
Common carp	1-1.5kg	96.56
	1.5kg+	3.44
Grass carp	1-1.5kg	100
Bhakur/catla	1-1.5kg	11.11
	1.5kg+	88.89
Mangoor	1-1.5kg	100

Source : Field survey, 2020

4.11.5 Species wise table fish production(in quintals)

It was found that the species naini was produced more and species bhakur/catla was produced less among the carps species in the study area with 943.1632qts and 356.7774 qts respectively. The results showed production of rohu, silver, bighead, common, grass carps were 855.788qts, 482.676qts, 451.5354qts, 586.0542 and 424.0932qts, respectively (Figure 4.4). The production of catfish was very less compared to carps species with only 58qts as it was cultured by very few respondents in the study area.

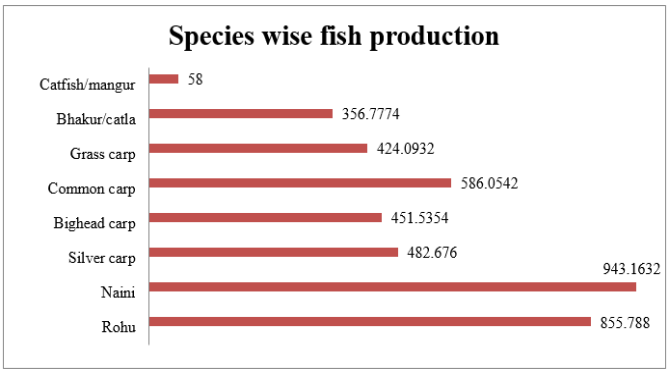


Figure 2: Species wise total table fish production (in quintals) of the total surveyed households in study area, 2020

4.11.6 Production consumption and sales of table fish

From the study, it was found that the farmer of fish zone Mahottari were producing good amount of fish. The average production of table fish accounted 70.47 quintals, consumptions accounted 1.29 quintals and sales accounted 62.48 quintals. Average annual consumption of fish per household (1.29 qts or 129kg) was too higher than the average national consumption 3.5kg/year (DOFD, 2016).Total production of fish from the study area was found 4158.09 quintals whereas total consumption and

sales of fish was found 76.25 quintals and 3686.652 quintals, respectively.

Table 36: Production, consumption, and sales of table fish in study area, 2020

Parameters	Average yield in quintals	Total yield in quintals
Production	70.47	4158.09
Consumption	1.29	76.25
Sales	62.48	3686.652

Source: Field survey, 2020

4.12 Marketing information

4.12.1 Marketing place

Marketing place for produced fish of respondents of study area were categoried into two types as within district and within district plus outside. It was found that among 60 respondents 75% of the respondents sales their produced fish within district only while 25% of the respondents sales theirs produced within district plus outside. Marketing place outside the district were morang, sindhuli and sarlahi.

Table 37: Percentage of responents and their marketing place in study area, 2020

Marketing place	No of respondents	Percentage
Within district only	45	75
Within district + outside	15	25

Source: Field survey,2020

4.12.2 Average price of fish

It was found that the bhakur fetched higher price in market with average of Rs 428.18 per kg while silver fetched lower price in market with only Rs 252.03 per kg. The average selling price fetched by the respondents in case of rohu, naini, bighead,common, grass and catfish was Rs 349.15, Rs 297.41, Rs 312.71, Rs 323.30, Rs 290 and Rs 180 per kg, respectively.

Table 38: Average market price of fishes Fetched by the respondents in study area, 2020

Fish species	Average price per kg	Standard deviation
Rohu	349.15	15.45
Naini	297.41	8.49
Silver	252.03	8.86
Bighead	312.71	17.3
Common	323.20	15.35
Grass	290.00	55.29
Bhakur	428.18	85.26
Mangur	180.00	0

Source: Field survey, 2020

4.13 Economics analysis

4.13.1 Expenses

From the study among the respondents family in the study area, the average households expenses in fish farming was found RS 1422249.933 while per kathha was Rs 19411.87 (Table 4.50).

4.13.2 Income/Gross margins/ Benefit

Fish farming was one of the main occupation of Mahottari district. It was found that the respondents were generating a fair amount of income through the fish rearing in the study area. It was observed that the average income accounted Rs 2036426.017 per household while average income per household per kathha was accounted Rs 27794.58 (Table 4.50).

4.13.3 Net margins/profits

Fish rearing farmers of the study area were generating a good amount of profit from fish farming. It was found that the average profit per household from fish farming accounted Rs 656912.6 while average profit per household per kathha was Rs 8966.009 (Table 4.50).

4.13.4 Benefit cost ratio(B/C)

Calculation of benefit cost ratio is an important indicator to check the feasibility of every agricultural subsector. It provides knowledge whether the business should run forward or not. B/C ration if have greater than 1 suggested that the business is having good amount of profitability and the subsector can run forward sucessfully. It was found that the B/C ratio in the fish farming of the respondents family to be 1.43 which seems quite good in agricultural occupation. This suggested that the farmer are economically viable to run this subsector sucessfully in the future.

Table 39: Expenses, income, profit and benefit cost ratio of the respondents in fish farming in study area, Mahottari, 2020

Particulars	Per household	Per kathha
Expenses	1422249.933	19411.87
Gross margins/income	2036426.017	27794.58
Net margins/profit	656912.6	8966.009
B/C ratio	1.43	1.43

Source: Field survey, 2020

4.14 Problems

Five major problems were highlighted and put forward in interviewed of respondents to ranked them according to their severity affecting production and productivity of fish. Problem indexing was done to rank them, 1 to 5 on the basis of their importance as presented in Table 4.51. Unavailability of quality input (seed and feed) was found major hindrances for inreasing production with index of 0.81. Transportation and electrity was found second most importation problems in commerial fish farming with index of 0.68. Lack of technical knowledge with index 0.62 was found third most importance problems followed by low capital and lack of subsidy(0.44), and market problems(0.43).

Table 40: Respondents perception on fish production problems in study area, 2020

Problems	Scores					Weight	Index	Rank
	1	0.8	0.6	0.4	0.2			
Lack of technical knowledge	14	14	12	5	15		0.62	III
Unavailability of quality input (seed and feed)	23	23	10	3	1	48.8	0.81	I
Market problems	4	2	12	24	18	26	0.43	V
Transportation and electricity problems	16	12	18	9	5	41	0.68	II
Low capital and lack of subsidy	3	9	8	18	22	26.6	0.44	IV

Source: Field survey, 2020

5. Conclusion

Fish farming is the growing subsector of agriculture in Fish zone , Mahottari. Because of its higher profitabilty than the other agricultural business, fish farming family have been increasing and the area of production was also in incerasing trends. Though it is a growing subsector, farmer of fish zone, Mahottari were facing the problem such as unavailabity of quality fish seed and feed at the right time, lack of

transportation and electricity facilities, lack of technical knowledge, low capital and lack of subsidy, market problems etc. Moreover the fish farmers were supplying traditional feeds where only few were supplying commercial feed. The reasons behind less used of commercial feed was found its expensiveness. Farmers were found applying DAP in more quantity than urea and none of the farmers were using potassium as fertilizer at pond. Less used of equipment such as aerator, pH meter and DO meter in pond and pond turbidity maintenance by few farmer showed less technology adoption in study area .Despite having so many problems and poor in technology adoption , the average production of table fish from the study area per household was found 70.47qts and the total production accounted 4158.09 qts . B/C ratio was found 1.43 which was quite profitaible in agricultural occupation and suggested that farmer are economically viable to run the business forward.

6. SUGGESTION

6.1 Government offices/Policy Makers

- Input (quality seed and feed) should be timely assured and reached to all the farmers.
- Demonstration plots in different location should be established with direct involvement of the farmers and technicians to create confidence in farmers to adopt modern technology for fish production
- Encourage farmers to participated more in training activities about fish farming
- Subsidy scheme should be brought and implemented with proper evaluation of farmers
- Policy makers should focus to facilitate towards the improvement of pond

6.2 Farmer

- Farmers should focus more on mechanization and commercial method of fish farming rather than traditional method.
- They should have participated more on various activities such as training and field visit organized by government office
- They should concern with government officer and technician before taking any decision related fish farming.

6.3 Researchers

- Further research to assess the nutrient requirements of carp species under commercial poly culture system
- Research on farmer perception and awareness level of farmer's in improved fish production technology
- Undertake research to carry out the production and economic efficiency of using different feeds; traditional vs commercial and sinking vs floating
- Undertake research to assess the impact of fish farming in the livelihood of fish farmer

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