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Research Article

Economic analysis of fish production using different feed types practiced in Dhanusha district, Nepal

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ABSTRACT

A study on the economic analysis of fish production using different feed types practiced in Dhanusha district was conducted in 2018. Out of 600 fish farmers, sixty fish farmers(10%) from the Fish Superzone region i.e. Janakpur sub-metropolitan city, Bideh municipality, Sahidnagar municipality, Kamala municipality, Hanspur municipality, Janaknandani rural municipality and Aaurahi rural municipality, selected using simple random sampling, were surveyed using semi-structured questionnaire. The study revealed that locally formulated mash feed was commonly used feed type in which rice bran and mustard oil cake (RB+MOC) was the principle feed ingredient. 55% of the farmers used rice bran and mustard oil cake (RB+MOC), 20% used rice bran, mustard oil cake and soybean (RB+MOC+SOB), 10% used rice bran, mustard oil cake and fish meal (RB+MOC+FM) and 15% farmers mineral and vitamin(RB+MOC+MIN/VIT) in their feed formulation. The productivity of the fish production in feed type RB+MOC+SOB (3.41±1.02) was significantly higher than other feed type. The total variable cost per ha (5.23±2.11) was found significantly ($p<0.05$) higher in feed type RB+MOC+SOB. Similarly, gross margin(4.44±2.74) received by farmers of feed type RB+MOC+SOB was also significantly high ($p<0.05$). The Benefit: Cost (B:C) ratio of the study area was found to be 1.69, high being of feed type RB+MOC+SOB (1.84) compared to others. The feed type RB+MOC+SOB is seen as a economically profitable one in the study area because of the high productivity, profit and B:C ratio. High feed cost was the major problem followed by the unavailability of feed. Fish farming can be a profitable business in Dhanusha with large opportunity to increase the fish production with increasing protein sources in the feed used. Farmers should be provided sufficient information, trainings and be encouraged to incorporate the protein rich sources like soybean and fish meal in the feed prepared to increase the productivity and ultimately return.

Keywords: Aquaculture, Fish farming, Feed types, Cost and Return

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INTRODUCTION

Aquaculture is emerging as an important sector of Nepalese Agriculture. Despite being low productivity, aquaculture is making encouraging progress in recent (Mishra, 2015). Aquaculture in Nepal, has achieved the economic growth of 18.64% during 13th fifth year plan accounting to 1.33% contribution on GDP and 4.25% on AGDP (DoFD, 2017). Nepalese aquaculture, typically managed semi-intensively in polyculture of Chinese and Indigenous major carps, is based on natural productivity of the pond. Carp polyculture is a dominant, most common and viable aquaculture production system adopted in Nepal (FAO, 2016). Annual fish production of Nepal is 83,897 ton(t) with an average productivity of 4.9 ton per hectare(t ha^{-1}) (DoFD, 2017). Dhanusha district is one of the major aquaculture production site of Nepal with many natural and artificially constructed ponds. Recently, Dhanusha has been declared as "Fish Superzone" by Prime Minister Agriculture Modernization Project (PMAMP).The annual fish production of Dhanusha is 4126.6 t and productivity is 4.75 t ha^{-1} (FDTC, 2073).

The fish productivity in Dhanusha is below the national average (DoFD, 2017). Majority of the farmers follow traditional feeding practice and major portion of the feed they provided to fish includes rice bran and mustard oil cake. Only few were found to include protein diet (soybean cake/ fish meal) and mineral and vitamin mixture in the feed. There are very few pellet feed industry in the country and none in Dhanusha to provide quality pellet feed to the farmers. Very few literature has been found on types and quality of feeds used by farmers including economics of fish production using different types of feeds. This study is focused in finding the profitable feed type and quality of feed using proximate analysis. This study also identifies different fish feeding practice, types of feed used, nutrient composition of different feed ingredients and compare the productivity and economics in different feed types.

MATERIALS AND METHODS

Study area

The study was carried out at Fish Superzone area of Dhanusha district namely, Janakpur sub-metropolitian city, Videha municipality, Hanspur municipality, Sahidnagar municipality, Kamala municipality, Janaknandani rural municipality and Aurahi rural municipality. These sites being PMAMP Fish Super zone area are purposively selected for the study.

Data collection and sampling procedure

The study was conducted during November 2017 to may 2018. The field survey was carried out from March to May, 2018 for the primary data collection using semi structured questionnaire. Out of 600 commercial fish farmers in the study area, those practicing carp polyculture on at least 0.2 ha water area, were identified and listed. Farmers depending solely upon natural phytoplankton's already present in the pond and using only fertilizers in the pond were excluded. 60 fish farmers were selected using simple random sampling from the sampling frame prepared. Carp polyculture included : Common carp(*Cyprinus carpio)*, Bighead carp (*Aristichthys nobilis*), Silver carp(*Hypophthalmicthys molitrix),*Grass

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carp(*Ctenopharyngodon idella)*, Rohu(*Labeo rohita)*, Naini(*Cirrhinus mrigala)* and Bhakur(*Catla catla*). The different types of feed prepared by the farmers were identified during the survey. Secondary data were collected from the various sources: District annual report, district profile, annual progress report and Statistical book of DOFD, Balaju; annual report of Fisheries Development and Training Centre(FDTC), Dhanusha; various other reports from Ministry of Agriculture Development (MoAD), Central Bureau of Statistics (CBS), bulletins, books, journal publications from different governmental and non-governmental organizations.

Feed samples were collected from the respondents procuring feeds from the same source and the proximate analysis (AOAC, 1995) of the collected feed samples was carried out were conducted in Aquaculture lab of Agriculture and Forestry University, Rampur, Nepal. The percentage crude protein and dry matter content in different feed type according to the percentage composition of feed ingredients was calculated.

Proximate analysis

Crude protein and dry matter content of the used feed ingredients were tested at Aquaculture lab, Agriculture and Forestry University(AFU), Rampur, Chitwan after collection of the samples during the survey.

1) For calculating the dry matter content, the difference in weight between dry and wet sample of the feed ingredients were calculated after drying them in the oven for 24 hours at 100^{o}C.

Moisture Content(%)= 100× [{ (B-A)-(C-A) } / (B-A)]

Dry matter content(%)= 100- moisture content(%)

Where:
A = weight of clean, dry scale pan(g)
B = weight of scale pan + wet sample (g)
C = weight of scale pan + dry sample (g) after oven dry 24 hours

2) For crude protein content, at first nitrogen content in the feed samples were calculated using Kjeldahl method and fitted in formulae to calculate the crude protein content (Kjeldahl, 1883).

Nitrogen in sample(%)= 100×[{(A×B)/ C}×0.014]
Crude protein (%) = nitrogen in sample × 6.25

Where:
A = Hydrochloric acid used in titration (ml)
B = normality of standard acid(H2SO4)
C = weight of sample (g)

Data analysis

Qualitative and Quantitative analysis was done with MS-Excel and SPSSv17. Both the

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descriptive and inferential statistics were computed. For statistical analysis of data, a one-way ANOVA (Analysis of Variance) and Tukey-b test was done by using the SPSS (Statistical Package for Social Science) version-17 (Shrestha and Shrestha, 2017).

Cost and Return Analysis

The variables (quantity and cost) are calculated per hectare to bring uniformity and easy comparison on various information between the feed types present. The total variable cost here in the study is calculated by summing up all the cost incurred on fish seed, fish feed, human labor, pond liming, equipments, irrigation, transportation, pond maintenance, medicines, land on lease and Interest on working capital. The price for the feed is calculated based on the percentage composition of the feed ingredients in the final feed prepared. The price of the fish is kept average of the price the carps receive in the market.

$$\textit{Total variable cost(NRs./ha)} = C_{seed} + C_{feed} + \underline{C}_{human\_labor} + C_{lime} + C_{equipments} + C_{irrigation} + C_{transortation} + C_{medicine} + C_{maintanence} + C_{land}$$

[Here, cost for every variable inputs were calculated in NRs/ha.]

And, a gross return was calculated by using following:
Gross returns(Total Return) = Total fish production in kilogram × price of fish per kilogram

Here, price is calculated using the average price received by for all carps in the market.
Gross Profit (NRs./ha) = Gross return (NRs./ha) – Total variable cost(NRs./ha)
Net Profit = Gross Profit-Total fixed cost
Undiscounted benefit-cost ratio (B:C) = Gross returns / Total variable cost

RESULTS AND DISCUSSION

Descriptive statistics

Fish farmers in Dhanusha district were not found to use readymade pellet feed for carp polyculture. Rather they used to buy the ingredients available, mix in certain proportion and feed the fishes in the pond using either bag feeding method or moist dough method. Different feed used by the famers in the study were rice bran, mustard oil cake, soybean meal, fish meal. Farmers were found to bring these ingredients, mix them and use it in moist form. Among the respondents, 55% were found to mix rice bran and mustard oil cake(RB+MOC), 20% mixed rice bran, mustard oil cake and soybean meal(RB+MOC+SOB), 10% mixed rice bran, mustard oil cake and fish meal(RB+MOC+FM) and 15% were found to mix mineral and vitamin on rice bran and mustard oil cake mixture(RB+MOC+MIN/VIT).

Pond information

The pond and feed information is shown in Table1.To create uniformity in calculation, all information are represented in per hectare (ha^{-1}) in the tables below There was no significant difference in pond related variables among different feed types ($p>0.05$). The annual average feed used area was found to be 7.18 t ha^{-1} (Table 1). The annual feed consumption in feed type RB+MOC+SOB was found to be significantly higher than in feed type RB+MOC

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(p<0.05). The fish stocked should be well fed with sufficient quantity and proper dietary content in order to achieve good production and ultimately good return. Farmers in feed type RB+MOC used only rice bran and mustard oil cake to feed the fish. Similarly, the average feed used per hectare was only 4.99 t ha^{-1} which is significantly lower than used by farmers in feed type RB+MOC+SOB(p<0.05). It was due to lack of proper knowledge and understanding in fish nutrition and daily feed requirement, which might be the cause for comparatively low production. Most of the farmers in the study area were not found to feed fish scientifically, in accordance to the body weight of fish in the pond. According to the site of procurement the price for the ingredients, rice bran ranged from NRs.30 to 32/kg , mustard oil cake NRs. 30 to 32/kg, Soybean cake NRs.35 to 40/kg, Fishmeal NRs. 40 to 50/kg. The expenditure in feed in RB+MOC+SOB(3.65) was also found to be significantly higher than RB+MOC(1.59)(p<0.05). Fishmeal and soybean though important appears to be used in limited amount in most fish and crustacean diets due to its high cost and availability (FAO, 1983).Both feed consumption and feed cost is found to be high for R+MOC+SOB. Fish farmers were not found to follow systematic and scientific stocking pattern in the study area.

Table 1: Pond and feed information site of the respondents in different feed types at Fish Superzone, Dhanusha, 2018

Particular \ Feed types	RB+MOC	RB+MOC +SOB	RB+MOC +FM	RB+MOC +MIN/VIT	Overall
Farmers adopting feed types (%)	55	20	10	15	100
Number of production ponds	5.1±5.6	12.0±7.6	8.7±5.4	15.3±25.8	8.4±11.7
Pond area (ha)	2.97±3.79	8.09±6.27	5.26±3.58	13.15±23.12	5.75±10.12
Pond water depth (m)	1.60±0.39	1.55±0.15	1.63±0.31	1.45±0.13	1.57±0.32
Pond liming (00kg ha^{-1})	1.56±1.11	2.80±1.45	1.85±1.34	2.23±1.57	1.94±1.34
Feed consumed (t ha^{-1})	4.99±3.64^{b}	10.95±5.58^{a}	8.77±6.03^{ab}	8.67±4.38^{ab}	7.18±5.05
Feed cost (NRs. ha^{-1})	1.59±1.16^{b}	3.69±1.97^{a}	2.91±1.94^{ab}	2.77±1.40^{ab}	2.33±1.67
Total stocking(000)	9.33±2.53	9.77±2.57	10.48±2.51	10.42±3.34	9.72±2.65
Fingerling(000)	3.80 ± 2.63	4.69 ±3.19	3.58 ± .75	3.53 ± .50	3.94 ± 2.45
Fry(000)	6.80±2.79	7.22±3.35	7.50±3.91	8.63±4.06	7.25±3.20

*Note: RB: rice bran; MOC: mustard oil cake; SOB: soybean meal; FM: fish meal; MIN: mineral mix; VIT: vitamin mix. Mean values with same superscript letters in the same row are not significantly different (p>0.05). Here, price is presented in NRs.1*10^5 ha^{-1}.*(Source: Field survey, 2018)

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Crude protein and dry matter content in different feed types

Selection of quality feed ingredients and their blending in well-proportioned formulations, their processing (Hardy and Barrows, 2005) and ultimately safe and secure storage (New, 1987) before delivering to fish, are all critical steps to ensure quality. The proximate analysis of the collected feed sample was conducted in Aquaculture Lab in Agriculture and Forestry University (AFU) and the crude protein and dry matter content in each feed type is shown in Table 2.

Table 2: Dry matter and crude protein content in different feed types with percentage composition of different feed ingredients

Feed types	Percentage composition	Dry matter %	Crude protein %
RB+MOC	50:50	89.40	19.73
RB+MOC+SOB	45:45:10	89.95	25.27
RB+MOC+FM	50:45:5	89.77	24.95
RB+MOC+MIN/VIT	50:50 (1kg Min/Vit mixture /Quintal feed)	89.40	19.73

Note: RB: rice bran; MOC: mustard oil cake; SOB: soybean meal; FM: fish meal; MIN: mineral mix; VIT: vitamin mix.
(Source: Lab test result, Agriculture and Forestry University, Department of Aquaculture, 2018)

Proximate composition of the ingredients was determined according to AOAC (1995). Protein is the major dietary nutrient affecting the performance of fish and has a positive effect in the growth and development of fish (Lovell, 1989). The essential and nonessential amino acids in protein is necessary for muscle formation and enzymatic function and also protein provides energy for the maintenance of the body function(Yang et al, 2002). Regardless of the species weight groups and the doses, protein present in the diet is found to enhances the growth of fish (Labh et al., 2014). Similarly, protein is found to increase the survival and resistance of the fish fingerlings to adverse conditions. It could be concluded that feed with increasing level of crude protein(CP %) in diet is essential for increasing survival rate and growth of carps (Prasad et al., 2017)

Productivity and economic analysis

For common carp, trials with higher protein content diets would help to achieve a better energy/protein balance and therefore a better growth (Hernandez, Gasca-Leyva, Gressler, & Krise, 2014). Improving the quality of farm-made feeds is one of the ways to improve aquaculture production (De Silva and Davy, 1992; De Silva & Hasan, 2007).

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Table 3: Productivity and economic analysis site among different feed types at Fish Superzone, Dhanusha, 2018

Particular \ Feed types	RB+MOC	RB+MOC +SOB	RB+MOC +FM	RB+MOC +MIN/VIT	Overall
Productivity (t ha^{-1})	1.25±0.73^{c}	3.41±1.02^{a}	2.42±0.73^{b}	2.16±0.52^{b}	2.31±0.9
Total Variable cost (NRs. ha^{-1})	2.53±1.44^{b}	5.29±2.11^{a}	4.31±2.20^{ab}	3.59±1.71^{ab}	3.40±1.99
Total return in(NRs. ha^{-1})	3.80±2.18^{c}	9.73±2.52^{a}	7.26±2.18^{b}	6.50±1.56^{b}	5.74±3.18
Gross profit (NRs. ha^{-1})	1.27±1.31^{b}	4.44±2.74^{a}	2.95±1.53^{b}	2.91±0.73^{b}	2.34±1.17
B:C ratio	1.50	1.84	1.69	1.81	1.69

*Note: RB: rice bran; MOC: mustard oil cake; SOB: soybean meal; FM: fish meal; MIN: mineral mix; VIT: vitamin mix. Mean values with same superscript letters in the same row are not significantly different (p>0.05).Here, price is presented in NRs.1*10^5 ha^{-1}* (Source: Field survey, 2018)

In the study area, the average productivity was found to be 2.31 t ha^{-1} (Table 3). The average productivity of feed type RB+MOC+SOB was found to be significantly higher to feed types RB+MOC+FM, RB+MOC+MIN/VIT and RB+MOC($p<0.05$). The productivity of RB+MOC+FM and RB+MOC+MIN/VIT were found to be statistically similar($p>0.05$). Likewise, the productivity of RB+MOC+FM and RB+MOC+MIN/VIT were found to be significantly higher than RB+MOC ($p<0.05$). This might be attributed to feed ingredients used, quantity of feed fed and its overall nutrient (crude protein) content.

The average of total variable cost per hectare in RB+MOC+SOB was found to be significantly higher than in RB+MOC ($p<0.05$) which might be mainly due to the variation in the cost of inputs used. In overall, 68.33% of total variable cost was incurred by feed alone in the study area. The average return per hectare in RB+MOC+SOB was found to be significantly higher than RB+MOC+FM, RB+MOC+MIN/VIT and RB+MOC($p<0.05$). Similarly, the gross profit in RB+MOC+SOB was found to be significantly higher than in RB+MOC+FM, RB+MOC+MIN/VIT and RB+MOC ($p<0.05$). The significantly higher average total productivity, return and gross profit in the feed type RB+MOC+SOB, can be attributed to the quantity of feed used and the inclusion of Soybean in the feed. Soybean is a good source of essential amino acids (EAA) and one of the very few plant source rich in lysine (FAO, 1983). Soybean is highly recognized as one of the most appropriate protein sources in aqua- feed because of the easy availability, nutritional composition, higher protein content, well balanced amino acid profile(El-Sayed,1999; Castro et al., 2011). Similarly, the digestibility of the protein fraction of soybean products has been reported to be more than 90% for common carp(Takeuchi et al., 2002).

Similarly, Soybean, most often used in compound aqua feeds, is the most prominent protein

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ingredient substitute for fish meal in aquaculture feeds (Tacon et al., 2011). Soybean meal has been well documented as a potential fish meal alternate because of its high protein value (49.46%) (Tacon et al., 1983; Reigh & Ellis, 1992). Nowadays, Soybean is extensively used to replace fish meal component in fish and prawn feed (Antolovic et al., 2012; Hasanuzzaman et al.2009; Yong et al.,2013).In addition to that, the percentage incorporation of soybean in the feed prepared was high (10%), farmers were also found to feed high feed per hectare in case of feed type RB+MOC+SOB which is the major reason for the significantly higher productivity. It is found that the use of soybean meal (up to 50%) might be advantageous for rearing of carp fingerlings (Jahan, Hussain, Islam, & Khan, 2013). The percentage incorporation of fish meal in the feed (5%) and the feed used per hectare was less in the feed type RB+MOC+FM which was the reason for its productivity being less than in feed type RB+MOC+SOB. Mustard oilcakes were found to give lower growth and poorer feed conversion ratio compared to soybean based diets. Mineral and vitamin assist in supplementing essential nutrient which fish body can't make and thus might assist in growth and development as fish can absorb many minerals directly from the water through their gills and skin, allowing them to compensate to some extent for mineral deficiencies in their diet (Craig & Helfrich, 2002).

Profitability ratio is a division of monetary metrics that allows investors to assess the capability of any business to generate earning compared with its operating cost and other applicable costs, gain throughout a specific period. A higher ratio is a representation for a profitable business (Okwu & Acheneje, 2011). Here in our study, Benefit: Cost(B:C) ratio was calculated for a year using the operational cost incurred in the process. The B:Cost ratio was found to be high in feed type RB+MOC+SOB(1.84), which indicated that farmers are receiving benefit of NRs. 1.83 for each NRs.1 of cost incurred or invested. The B:C ratio greater than one indicates profitable business as the farming benefits significantly outweighs the costs (Investopedia, 2019). The gross profit is also found to be significantly higher in feed type RB+MOC+SOB (4.98) ($p<0.05$). So, from the perspective of productivity, profit and B:C ratio the feed type RB+MOC+SOB is found to be better compared with others. The B:C ratio for the overall region was found to be 1.69, which indicates fish farming is a profitable business in the study area. Economic viability of carp polyculture was also confirmed by Mazid et al. (1997). Preparation of cost effective feeds from locally accessible ingredients resulted in high revenue. In conclusion, carp polyculture is a highly lucrative business. The productivity and profitability in carp polyculture can be further increased by incorporating protein rich diet such as soybean and fish meal in higher percentage in the fish feed.

Problems related to fish feed

Problems associated with the fish feed were ranked with the use of index. Scaling techniques, which provides the direction and extremity attitude of the respondent towards any proposition (Miah, 1993) was used to construct index. The intensity of problems were identified by using five point scaling technique using scores of 1.00, 0.80, 0.60, 0.40, 0.20, and 0.10. The formula given below was used to find the index.

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$$\mathbf{I_{prob}= \Sigma \{(S_i f_i)/N\}}$$

Where,
I_{prob} = Index value for intensity
Σ = Summation
S_i = Scale value of i^{th} intensity
f_i = Frequency of i^{th} response
N = Total number of respondents

Table 4. Problems associated with fish feed at Fish Superzone, Dhanusha, 2018

Problems	1st	2nd	3rd	4th	5th	Weightage	Index	Rank
High cost of feed	40	18	2	0	0	55.6	0.93	I
Poor knowledge on feed formulation	17	19	5	8	11	40.6	0.68	II
Unavailability of feed in time	3	10	19	18	10	31.6	0.53	III
Low quality of feed	0	0	18	19	23	23	0.38	IV
Lack of pellet feed industry	0	3	15	14	16	20.2	0.34	V

Source: Field survey, 2018.

The present study showed that the major problem associated with fish feed at Fish Superzone, Dhanusha, was high cost of feed followed by poor knowledge on feed formulation, unavailability of feed in time, low quality of feed and lack of pellet feed industry. Measures should be taken to provide feed at lower price. Scope for the pellet feed industry can be there due to large water area coverage and large number of fish famers in the district which ensures easy availability of quality feed at affordable price.

CONCLUSION

Rice bran and mustard oil cake(RB+MOC) was the major feed used in the study area. Use of protein diet (soybean/ fish meal) and different mineral and vitamin supplements in the fish feed was very low which has lowered the overall production. The inclusion of soybean meal (10%) in feed resulted in higher productivity compared to the sole use of rice bran and mustard oil cake RB+MOC. The productivity(3.41t/ha)in feed type RB+MOC+SOB (45:45:10) was found to be significantly higher. The average B:C(1.84) ratio shows that fish farming is a profitable business. Feed type RB+MOC+SOB is found to have higher productivity, profit, B:C ratio. There is a large opportunity to increase the production of fish in the study. Thus, inclusion of protein source in feed is highly recommended to increase the productivity and ultimately gross profit gain. High cost of feed was the major problem associated with fish feed in the study area followed by poor knowledge on feed formulation, unavailability of feed in time, low quality of feed and lack of pellet feed industry. Farmers should be provided sufficient information and training on feed nutrients composition. Farmers should be encouraged to consider incorporating the protein rich sources like soybean and fish meal in the feed prepared to increase the productivity and ultimately return. Further research on the different inclusion rate of protein sources in the feed and its effect on the productivity can be studied.

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CONFLICT OF INTEREST

The authors declare that there is no conflicts of interest regarding publication of this manuscript.

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ANNEX

Annex 1. Variable cost incurred in different inputs with their percentage share in total variable cost incurred for four different feed categories.

Parameters	RB+MOC	RB+MOC+SOB	RB+MOC+FM	RB+MOC+MIN/VIT
1. Labor (household +hired)	10676.77 (4.22)	46836.83 (8.84)	8809.524 (2.04)	2994.484 (0.83)
2. Lime (disinfectant in pond)	3127.273 (1.24)	5200 (0.98)	3600 (0.84)	4466.667 (1.24)
3. Fish seed (price for fingerlings and fry according to FDTC)	7685.682 (3.04)	18075.54 (3.41)	17212.5 (3.99)	11608.33 (3.23)
4. Cost incurred in feed	159951.3 (63.24)	363684.3 (68.62)	291454.8 (67.61)	277348.5 (77.18)
5.Fertilizer (Organic FYM + Chemical)	8170.028 (3.23)	6335.636 (1.20)	4710.492 (1.09)	5350.055 (1.49)
6. Electricity and fuel (for water supply and farm house)	7364.401 (2.91)	20022.97 (3.78)	9820.545 (2.28)	11227 (3.12)
7. Medicine/Chemicals for disease control	1716.167 (0.68)	1394.865 (0.26)	756.9124 (0.18)	721.0402 (0.20)
8. Land lease cost	53216.17 (21.04)	67824.9 (12.80)	94705.1 (21.97)	44767.53 (12.46)
9. Pond Maintenance and Miscellaneous (equipments and transportation)	1010.101 (0.40)	602.6095 (0.11)	----------	858.9441 (0.24)

Note: numbers in the parenthesis represents percentage share of the each item in total variable cost incurred.