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Local feeds in aquaculture and their feeding efficiency: Review from Nepal

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Abstract

Aquaculture, being a new practice in Nepal, has taken a prior position recently. Most cultured fish species include rohu, naini, bhakur, common carp, grass carp, silver carp and bighead carp. Apart from this, rainbow trout along with tilapia, *Puntius*, and *Pangasius* are also reared in small number. The type and amount of feed apportioned, largely depends on fish species. Generally, rice bran, mustard oil cake, crop grain, kitchen leftover and maize powder are the main components used in homemade feed. Rice bran with mustard oil cake mixed in equal proportion is generally used as feed in Nepal. Around 60% of the fishes are fed with rice bran and mustard oil cake mixture. The remaining 40% are left to feed on natural productivity of the pond in context of Nepal. Various grasses like Napier, Berseem, Banana leaves etc. are fed to herbivorous fishes especially grass carp.

Keywords: local feed, aquaculture, rice bran, mustard oilcake, feeding frequency

Introduction

Aquaculture also known as aqua farming, is basically breeding, rearing and harvesting of fish, crustaceans, molluscs, aquatic plant, algae and other animal with human intervention in the process to achieve maximum production and also implies the ownership of stock owned [1]. Aquaculture is mainly of two types namely, freshwater aquaculture and marine aquaculture. It is one of the rapidly growing forms of food industry in order to meet the growing demand of sea foods and fresh water fishes. History of aquaculture can be dated back to 2000-1000 B.C. in China. Aquaculture in Nepal is a new practice introduced in 1940s [1].

Fish meal and fish oil are the two ingredients that are extensively used in commercialized feed in aquaculture. They are obtained from forage fish and low value fishes. Since the aquaculture is rapidly growing, feed demand for it is also increasing rapidly. Increment in the global production of commercial aquaculture feed was 106% from 2000 to 2008 and is projected to increase 124% between 2008 and 2020 [2, 3]. Use of the forage fish and low value "trash fish" in the rapidly growing feed industry poses a serious threat of overfishing, aquatic food web disruption, insecurity of food and potential loss of availability of human consumption seafood [4, 5].

The main cost in aquaculture is the cost of feed. Feed alone constitute more than 60% of the total cost [6]. The total cost of feed in aquaculture amounts to Rs 1,21,53,01,000 in 2072 B.S. [7]. Even though natural productivity of the pond constitute a certain amount of feed, it is not sufficient in its own. Supplementary feed used can be locally prepared or commercially bought. Commercial feeds even though known as complete feed [8] can be a hindrance due to their higher cost. Instead locally prepared feed with cheaper rates can be of better option economically. More specifically, locally available sources of feed of plant origin can be of great substitute to those fish meal and fish oil. However, use of plant source can alter with the nutritional characteristics by decreasing level of omega-3 fatty acid [9]. These nutritional defects can be reduced by addition of nutrients in feed.

Current status of aquaculture in Nepal

Even though aquaculture being relatively new in Nepal, 24,559 ponds are found in 1,01,398.8 hectares of land and the production was found to be 31,401 metric tons throughout the year [7].

These ponds are distributed among 65 districts of Nepal. 232 types of fish are found in Nepal among which seven are most commercially reared [10]. Rohu, naini, bhakur, common carp, grass carp, silver carp and bighead carp are the ones that are commercially reared. Rainbow trout along with tilapia, *Puntius*, and *Pangasius* are also reared in small number [10]. Aquaculture has been recognized as a prominent subsector to reduce poverty [11]. Nepal has aimed to be a self-sustaining nation in fish production in the next three years according to the budget speech of 2073/74 but this is going to be a huge challenge as about 60% of total fishes consumed are imported from India [12].

Table 1: Fish production by species in Nepal in 2072

Name of species	Production (Metric ton)
Rohu	4976
Naini	4681
Bhakur	2304
Common carp	4208
Grass carp	3833
Silver carp	5138
Bighead carp	3910
Trout	144
Rohu chaddi	886
Naini chaddi	682
Others	639

Source: Nepal Fishery Survey, 2072 [7]

Feed in aquaculture

Feed constitute the major cost in aquaculture. Natural feed and the supplementary feed are the two broad classification of the feed. Supplementary feed can be further classified into homemade feed and complete feed. Natural feed includes the planktons, wolffia, pistia, lemna, tiny aquatic insects, rotted

parts of animal and plants, basal organic element and different types of grasses [13]. Rice bran, mustard or sesame cake, fish meal, crop grain, blood and innards of poultry and animal, kitchen leftover and maize powder are the main components used in supplementary feed [13]. Homemade feed is prepared simply by mixing one or two components like rice bran, mustard oil cake and maize powder. These feeds are locally available feed. Complete feed is a mixture of all the components required for the proper development and growth of the fishes. The feed used depend upon the species of fish and the stage of development [14]. Around 60% of the fishes are fed with pellets either floating or sinking as well as homemade feed which includes 50% rice bran and 50% oil cake. The remaining 40% are left to feed on natural productivity of the pond in context of Nepal [15].

Feed quantity and frequency of feeding

Appropriate feed management ensures the optimal use of feeds that directly reflects the highest economic return to farmer [16]. Maximum growth is achieved by feeding of fishes to satiation. Over-feeding and under-feeding will result in insufficiencies of feed [17]. Taking into consideration the effect of body size and water temperature on the relative feed intake of the fish which is expressed as a percentage of body weight, various feeding schedule have been developed [18]. These schedules quantify the amount of feed to be given at certain intervals. With the increasing size and deviation of water temperature from optimum, the feeding frequency and the amount of feed quantity generally decreases [17]. Feeding frequency is determined by the size of fish and the culture system. Frequent feeding provides better feed efficiency and faster growth in young fishes but this trend decreases with the increase in the size of fish [18].

Table 2: Feeding chart for common carp during summer

Individual Weight of Fish (g)	Density of fish per Hectare					
	2000-4000		4000-6000		6000-8000	
	Feed weight (gram)	Protein content of feed (%)	Feed weight (gram)	Protein content of feed (%)	Feed weight (gram)	Protein content of feed (%)
20-50	1	12	2	12	2	12
50-100	2	12	3	12	4	12
100-200	6	12	6	18	9	18
200-300	10	12	11	18	11	18
300-400	11	18	13	25	14	25
400-500	14	18	15	25	16	25
500-600	15	25	17	25	18	25
600-700	15	25	18	25	19	30
700-800	16	25	18	25	20	30
800-900	17	25	19	25	18	30
900-1000	17	25	19	25	20	30
1000-1100	18	25	20	30	21	30
1100-1200	18	25	20	30	21	30

Source: Hepar (1988) [19]

The table indicates that with the increase in body weight of the fish, the amount of feed required decreases. Fishes should be fed in accordance to their body weight to meet their requirement.

Feeding methods

Various methods can be used while feeding the fishes. Hand feeding, demand feeder, and automated feeding machine are generally in practice [20]. Monitoring of feeding behavior and adjustment of ration accordingly can be easily done in hand feeding whilst automated feeders has the ability to feed the large volumes of feeds reducing labor requirement and

making it cost effective. Whereas demand feeders consider behavioral patterns of farmed species, return of appetite, and the nutritional status of feed [17]. Local feeds when used in aquaculture are generally fed with hand feeding. Balls of mixture of rice bran and mustard oil cake are prepared and thrown on the ponds.

Local feeds in aquaculture

Locally available materials that are the by-product of agriculture, plants, human feed leftover and the by-products of slaughter house are used as feed in aquaculture. They are used as they are cheaper than commercial feeds and easily

available [14]. The growth is increased with the use of local feeds than left on the natural productivity [15]. As aquaculture is used a means of poverty reduction among poor communities, the numbers of the farmers who can afford commercial feeds is low which is also aggravated by the low level of knowledge among the farmers about the additional benefits of commercial feeds. Locally available feed can substitute the commercial feeds to a certain extent in those scenarios. Locally available feed materials used in right amount and proportion can still give a satisfactory yield. Rice bran with mustard oil cake mixed in equal proportion is generally used as feed in Nepal. Various grasses like Napier, Berseem, Banana leaves etc. are feed to herbivorous fishes especially grass carp.

Local feed: Feeding efficiency and feed conversion ratio

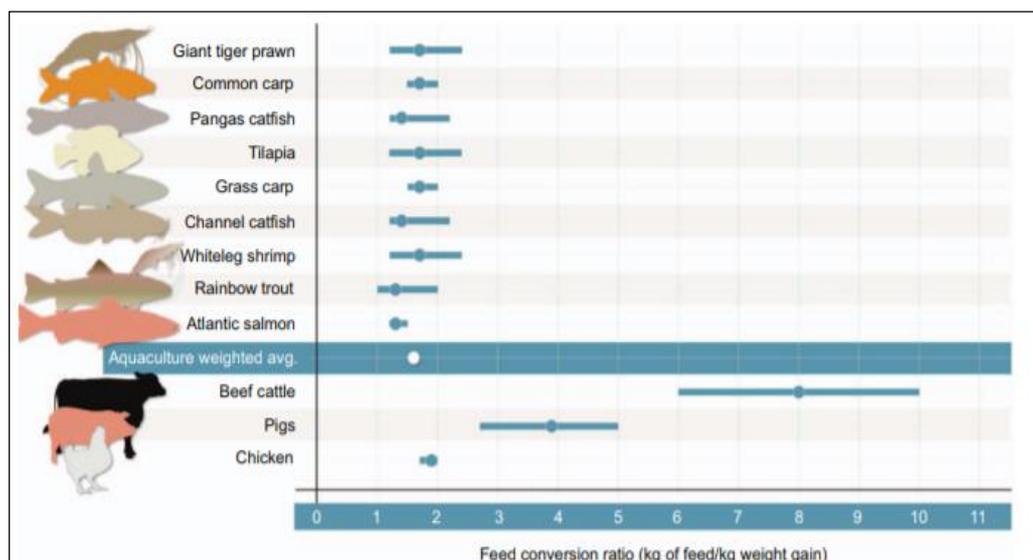
Feeding efficiency is the efficiency with which the feed is converted into meat and other products by an animal [21]. Feeding efficiency gives an idea about the use of feed and the growth achieved through it. It has been used as benchmark for profitability in aquaculture [22]. The major indicator of feeding efficiency is the feed conversion ratio and is the mathematical relationship between the amount of feed given and the weight gain of a population [21]. However, it is not the only

representation [21]. Viscerosomatic index also relates to the feeding efficiency in aquaculture which is the net amount of filet gained and can also be explained as the ratio of weight of animal viscera to the animal weight [23]. Feed conversion ratio is the ratio of the feed given to the fishes to the total weight gain [23].

Mathematically,

$$\text{Feed Conversion Ratio} = \frac{\text{Amount of feed given}}{\text{Weight gain}}$$

Lower the feed conversion ratio, higher is the efficiency of feeding. Aquatic animals have lower feed conversion ratio in comparison to land animals because they require less energy to move and stay upright [21]. However feed conversion ratio does not take into consideration the nutritional content of the feed, the inedible part of the animal and the nutritional quality of the animal product which are the essential component in analysis of feeding efficiency [21]. Therefore, feed conversion ratio can be an improper to compare the feeding efficiency among different species [21] but still is a tool of choice within a single species. A more precise method is devised for the measurement of feeding efficiency known as protein/calorie efficiency ratio or protein/calorie ratio [21].



Source: (Fry et al., 2018) [21]

Fig 1: Feed conversion ratio of various fishes along with land animals. Dot represent mean and bar represent range.

Rice bran and mustard oil cake are the two major ingredients used as homemade feed [24]. Rice bran is the by-product of rice which is a major food of Nepalese people. Mustard oil cake is the remains of mustard after oil is extracted out. These by-products are used as a feed in aquaculture with a varying level of nutrients available in them.

Table 3: Digestible crude protein and total digestible nutrients of rice bran and mustard oil cake

Feed	Digestible crude protein	Total digestible nutrient
Rice Bran	13%-16%	55%-65%
Mustard oil cake	27%	74%

Source: (Banerjee, 2012) [25], (Rice bran de-oiled - Dairy Knowledge Portal, 2019) [26]

Feed conversion ratio for a local feed (Mixture of mustard oil cake and rice bran in equal ratio mixed thoroughly and kept

for sun drying over one week) was observed to be 3.474±0.96 when fed to Goldfish and Red Cap Oranda in an aquarium in the aquaculture lab of Institute of Agriculture and Animal Science located at Paklihawa, Rupandehi [27]. In the same research, when sweet potato leaves powder was added to the feed, the feed conversion ratio was reduced to 3.325±0.48. All the other factors like dissolved oxygen, temperature and pH were regularly monitored to keep at desired level. Similarly, rice bran and mustard oil cake when mixed together in the ratio of 1:1 and fed to the carps kept on the cages in earthen ponds in horticultural farm of IAAS, growth of fishes was recorded from mean weight of 0.133 kg to mean weight of 0.160 kg over a period of 136 days [28]. The growth and the feed conversion ratio attained show the effectiveness of the use of local feeds in aquaculture. Satisfactory level of feed conversion ratio and growth performance was achieved with the use of locally available feed ingredients.

Conclusion

Since the demand for aquaculture feed is increasing, the availability of fish meal and fish oil is not increasing in line with demand for feed. In contrast to that, the amount of fish meal and fish oil used is almost same^[2, 3]. Feeds that can give a satisfactory growth and are readily available at a reasonable price and doesn't rely on fishes and their products are the essence to sustain the aquaculture industry. So, the next best alternative can be the use of locally available feed materials mainly of plant origin with higher feeding efficiency. These feeds renders far more importance in developing land locked nation like Nepal as even the poor farmers can afford them.

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