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Feeding fish in a challenging economic environment

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Options for farmers to consider when feed supplies or markets are temporarily interrupted

Fish farmers should expect and anticipate disruptions to feed supply and markets, and proactively plan for alternative courses of action to support continuity of their operations. Photo by Darryl Jory.

One of the most problematic and least-discussed topics in commercial aquaculture production is what to do when feed supply and/or markets are disrupted. This is a more common problem than one would think, but it is one that is often not discussed in advance of the challenge. Unfortunately, this could come about by numerous scenarios, but from the point of view of this article, we will concentrate on the assumption that we have an existing operation and the feed, feed ingredients and/or markets have been interrupted. There are no fixed answers as species, resources and finance will vary, but hopefully the following discussion will provide you with some good ideas.

Start with feed

Over the years we have seen interruption of the flow of ingredients due to disruption of shipping lanes, delays of offloading or changes in import restrictions. Disruption of typical ingredients simply means the feed formulator and those involved in purchasing need to move to secondary ingredients of the best quality. This is often simply a shift to local ingredients as well as byproducts that are available. This does not mean the nutritional quality of the feed will change, but the color is likely to shift, which has no meaning in nutrition.

Of course, it is likely that digestibility of ingredients could be reduced and possibly fiber levels will increase. Also, this is a great opportunity to use enzymes to help with digestion if they are available, and carbohydrases and phytase would be my first choice as they will help reduce fiber and phytate effects on digestion and will typically also increase protein digestion by about 5 percent. Additionally, proteases can be added for further enhancement.

Adjustments in feed formulations

One of the potential difficulties is the availability of protein sources. As most of us recognize, there is no dietary requirement for an ingredient: We simply need to blend ingredients as best we can. We just use the best protein available and make sure we balance our amino acid (AA) profiles. In aquaculture, farmers as well as many nutritionists such as myself, are often fixated on protein levels of the diets. This is also true of government regulations, which may require certain protein levels. However, we all also know that it is actually the levels and ratio of essential amino acids (EAA; an amino acid that cannot be synthesized by the organism fast enough to supply its demand) that are important.

Although there is considerable information on EAA requirements, there is limited information on needs for non-essential AA (NEAA; those amino acids the body can synthesize). From a feed formulation standpoint, the best thing to do when protein is limiting is to reduce the level of protein and increase the level of EAA supplements. If protein sources are limited, you are not likely going to do this with intact protein; however, we can do it by reducing the level of NEAA or protein. For example, in a 32 percent protein diet, we are likely to have 1 EAA limiting or at the requirement whereas most of the other EAA are well in excess i.e., 120 to 140 percent of the requirement – these are not being used efficiently. Hence, if we simply reduce the dietary protein but supplement more EAA to the diet (if available), then the lower dietary protein feed could still perform as well as the higher protein diet.

For example, consider reducing the protein in a feed from 32 to 26 percent or so. If done properly, such a reduction does not influence fish growth and can improve protein retention. In the aforementioned case, the farmer must allow the feed mill to do its job and provide the best feed under the circumstances. This means they cannot complain about nutritionally irrelevant issues like feed color or smell being different, as these have no effect on nutrition. They should also allow the feed mill to adjust desirable ingredients to allow the best outcome, which means not insisting on the inclusion of a specific level of marine ingredients in their feed formula, as these ingredients may not be available.

Adapting feed management

In addition to adjustments in feed formulations, the farmer must adjust the management of its ponds depending on the particular situation. In my book, the first thing to do is top harvest any fish near market size to reduce inventory. One can look for local markets as outlets, or simply process and freeze these fish for later sale. Clearly, this may bring reduced revenue, but it is better than losing money due to fish losses. Of course, the problem faced by the farmer is that markets have crashed, hence it may not be possible to reduce inventory. In this case, we need to slow the growth of fish or hold them for an extended time period. The issue could be that there is no market for the fish presently, or possibly because the supply chain of feed or ingredients has been disrupted.

In the case of limited feed or no market, it is critical to precisely manage feed inputs in aquaculture production ponds and to be aware of possible outcomes. Quite often farmers are feeding their animals to satiation and not really controlling feed inputs. If you simply skip one day feeding, the fish will essentially make it up by eating more the following days. Hence, if you want to reduce feed inputs by skipping a day or more, you need to control how much feed is going into the production system when you do feed, and it should be around the same amount you would typically feed when feeding every day.

In my experience, farmers often overfeed their fish, so a good approach is to start by simply cutting feed inputs by 10 to 15 percent. If you were feeding 100 kg/day/ha, you can simply skip one day but do not increase the feed level. Or you can simply cut 15 percent across the board. At this rate you are still giving plenty of feed to the animals but will still need to make sure it is well distributed and all fish have access to feed during feed applications.

If we move to the other end of the spectrum and feed near maintenance (approximately one day per week) or 15 percent of the ration, this will equate to feeding just one day per week. However, under this scenario, do not try to spread the feed out to seven days of feeding, as this will simply provide food to the more aggressive fish and none to the smaller fish. Typically, one day of feed per week is above maintenance for fish (general observation), and even at three days per week (to satiation) you will get adequate good growth for most fish. Therefore, depending on markets and availability of feed, you can consider feeding from one day per week through normal feed inputs.

Menghe, et al. (https://doi.org/10.1080/15222055.2016.1146182) (2016) conducted an excellent trial with channel catfish that are at marketable size. As shown in Table 1, the authors took market size fish and simply did not feed for two months, fed once weekly for two month or daily. Even at one feeding per week, these fish gained weight over the two-month period. Once this was done, the authors then refed the fish for one month, and results showed that, after refeeding, fasted fish and those feed once per day had similar net yields (~3,600 kg gain), indicating both approaches worked albeit significantly lower than those fed for 3 months (~6,500 kg gain).

Davis, feeding, Table 1

Feeding regimen	Feed fed (kg/ha)	Net yield (kg/ha)	Est. final weight (g/fish)	Weight gain (%)	FCR	Observed mortality (%)
–	–	–	RESULTS AT 2 MONTHS	–	–	–
N2	0	-1,454v	552u	-14.3v	–	1.1
W2	1,606v	492u	689v	6.7u	2.7	1.7
D2	9,477u	NH	NH	NH	–	1.4
Pooled SE	2890	135	8	1.3	–	0.5
P-value	<0.01	<0.01	<0.01	<0.01	–	
–	–	–	RESULTS AT 3 MONTHS	–	–	–
N2/D1	9,184y	3,604y	898y	38.9y	2.51xy	1.2
W2/D1	10,345y	3,646y	910y	40.0y	2.71y	2.2
D3	16,024x	6,513x	1,107x	70.4x	2.38x	2.1
Pooled SE	505	263	18	2.7	0.08	0.5
P-value	<0.01	<0.01	<0.01	<0.01	0.05	0.39

Table 1. Means of production characteristics of market-size hybrid catfish on various feeding regimens, with an initial weight of 644 grams per fish. Means within each column and each section followed by different letters differ significantly ($P \leq 0.05$; Fisher's protected least significant difference procedure). Abbreviations: N2 = fish not fed for 2 months, W2 = fish fed once weekly for 2 months, N2/D1 = fish not fed for 2 months and then fed daily for 1 month, W2/D1 = fish fed once weekly for 2 months and then fed daily for 1 month, D3 = fish fed daily for 3 months (control) a portion of which were removed for processing at 2 months (D2), and NH = not harvested. Dashes denote metrics that were not determined or relevant.

The authors of this study concluded that feeding once weekly can generally maintain body weight of channel catfish and would be better than not feeding at all, as the fish do not lose weight. No feeding or feeding once weekly for two months does not affect survival but significantly reduces fillet yield, as you will produce long and skinny fish. However, results showed that after refeeding for one month, the fish will rebuild muscle and filet yields were back to typical levels (33 percent dress out). The primary disadvantage of this approach is that the feed conversions will increase, as the fish lost weight or gained weight less efficiently during the months where feed was withdrawn completely or offered at near maintenance ration.

Reducing feed or switching to a low protein feed does not always work, so the above advice is simply that you have to work with your systems and determine what works and what does not. Make sure you collect good data and try different approaches at the same time to help you make informed decisions, and always consider financials like cash flow and credit.

Real life cage and pond examples

Here are a few relevant examples based on my experience. The first example involves a tilapia farmer growing tilapia in cages, who decided to reward workers that reduced the feed conversion ratio (FCR). They succeeded in reducing it down to 1.2 kg feed per kg of fish but extended the time to market by over a month and then ran into the cold season, during which the fish do not grow. Consider that small feed reductions to optimize FCR may not impact fish growth, but beyond a threshold, if you restrict feed significantly to achieve a better FCR, you will impact fish growth and time to market.

The second example is of a tilapia farmer with cages in an oligotrophic lake (clear low nutrient environment) who chose to feed the fish a full ration every other day, but the fish still lost weight. This was probably due to water currents in the lake forcing the fish to spend energy to stay in place, thus needing more feedings, as well as the lack of primary production in the lake to supplement the diet of the fish, and/or the fish being stocked at a high density.

One more example is a tilapia farmer with cages in a eutrophic lake [a high nutrient environment with high quantities of algae production and Secchi disk (device used to determine water transparency) visibility of less than 80 cm], who lowered the fish density to around 25 animals per cubic meter. The fish still grew well without feed but were harvested – and were marketed – at the relatively small individual size of around 300 grams. Consider that smaller tilapia use natural productivity better than larger fish.

An example from pond culture of tilapia is also relevant. Tilapia stocked at low density (~3 fish per square meter) can be managed using fertilizer to maintain a good phytoplankton bloom. Feed is generally only needed after the tilapia average over 90 grams, at which time they can be fed at 1 percent body weight once a day, in addition to continuing fertilizer applications. This approach allows low input production that can reach 10 tons of fish per hectare without aeration. In the example used in this case, fish were harvested at a weight of around 300 grams for the whole fish markets. The apparent FCR of the feed can be reduced (0.7 to 1.0) but the culture time (time to market) may be greater than when fish are fed twice daily to about 85 percent of satiation, as the more feed you can provide, the better the fish growth will be.

Final remarks

Consider that feed is the primary driver of water quality, so management of the production systems will also need to adjust so that water quality is always maintained at optimal levels. This is particularly important when you start feeding again, as you will need to transition to full feed and allow both the fish and the production system to progressively adapt to the increasing nutrient loads. In the case of fish species that use natural foods, the approach will be to add fertilizer to improve natural productivity, as there will be far less nitrogen and phosphorus going into any system that is either not being fed or is at just a maintenance level.

Trying to manage in a crisis is always a challenge, and it is best to try to be proactive and anticipate and plan what can be done in advance so that you can prepare appropriately. Quite often markets cannot accept fish, or fish are off flavor, or some other barrier, so knowing how fish respond to reduced rations has many applications and is worth evaluating in advance.

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