Aquaculture beyond fishmeal: Time for the next big idea

Aquaculture took off when we started running out of wild fish and began feeding fishmeal to our farmed seafood. With limited global fishmeal supplies in a secular decline, what will we do next?

by **Eric J. BROOKS**

Future generations might consider aquaculture our way of denying reality. After running out of wild fish to catch, we tried getting around nature's limitations by growing our own seafood.

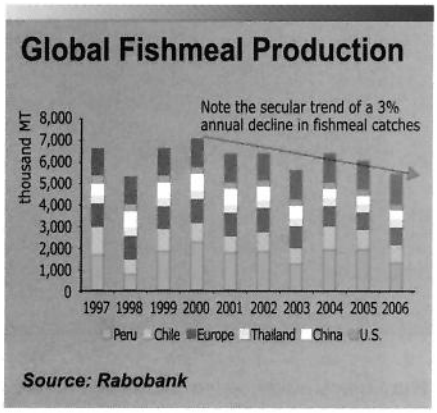
With aquaculture supplying almost half of all fish consumed, this excellent idea has but one fatal flaw: we still very much depend on fish caught in the wild, except now we feed it to our farmed fish, rather than to ourselves.

Because fish convert seafood into protein far more efficiently than humans do, we were in effect, using farmed seafood to extend our limited inventory of remaining wild catch. Farmed fish use ocean resources more efficiently than we do. Naturally, this extended the oceans' capacity to feed people, in effect, buying us a few more years of cheap seafood.

Unfortunately, wild fishmeal species have natural supply limits too. Koh Hui Meng, **eFeedLink**'s in-house feed operations analyst states that, "While fishmeal is a highly nutritious food for all aqua feeds, it is also becoming expensive and chronically scarce." Inevitably, just like wild salmon and tuna before it, limited fishmeal stocks were destined to collide with ever expanding seafood demand.

In permanent, long-term decline

Predictably, fishmeal species are going the way of wild salmon and entering a permanent, long-term decline. We could not see peak fishmeal production when it occurred but Gorjan Nikolik, Rabobank's Global Seafood Industry Analyst, Food & Agribusiness confirms that "the outflow of raw material towards the human consumption market results in the gradual decrease in global fish meal production. In the period 2001-2006 the CAGR [cumulative annual growth rate] is -3 percent and this is expected to continue for the medium term."



Yet, even as fishmeal supplies top out and decline, aquaculture demand is being joined by that of other sectors. Now that omega 3 fatty acid's role in the development of animals is fully appreciated, the proportion of fishmeal used by livestock is also increasing.

Supply deficit fuels unabated price increases

Rabobank's Nikolik states that, "Given the gradually decreasing supply and booming demand, our prediction is a continuation of annual price rises of 6 to 7 percent for the foreseeable future from the level achieved in mid 2007 of US$800-900 per metric tonne."

The real challenge however, is that at this point in time, there is nothing that can be fully substituted in place of fishmeal. This problem is the only factor that can threaten aquaculture's long running expansion. Helga Josupeit, Fishery Industry Officer, Fish Utilization and Marketing Service with the Food and Agriculture Organisation's (FAO) fisheries department states that, "the limited availability of fishmeal and fish oil, an essential ingredient to feed carnivorous species, may act as a constraint on rapidly increasing aquaculture production."

To get around this state of affairs, both short-term and long-term solutions are being employed. Over the short-term, fishmeal supplies are being reformulated.

Essentially, this entails using fishmeal strategically –at certain stages of the fish growth cycle, omega 3 fat is required to ensure that young fish mature into a healthy, high quality adult.

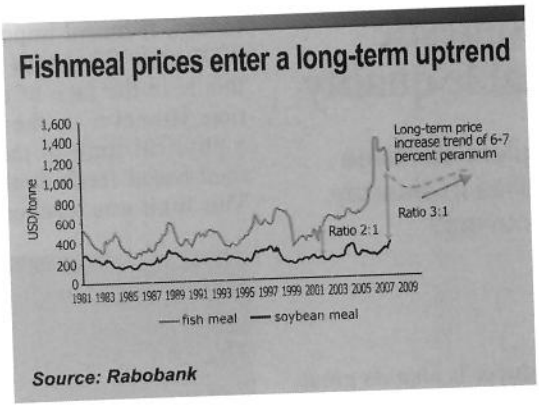
Other phases of the growth cycle require far less omega 3 fat. This means that the amount of omega 3 fish feed used can be greatly reduced –but at a hidden price. While such fish appear the same as others, they have greatly reduced levels of omega 3 oils, which are now recognised as an important component of human cardiovascular, immunological and prenatal health.

Krill, DDGS, grains: none are ready for the market

However, this should not be a problem for several decades. According to Patrick Vizzone, Rabobank's Asia Regional Head for Food & Agribusiness, "when you look at the hierarchy of needs, demand for seafood high in omega 3 comes mainly from developed nations, not so much Asia. Demand for species high in omega 3 kicks in at about

US$10,000."

In this respect, feed strategies that conserve omega 3 use, despite their long-run effects on human health, are viable in most Asian markets. Ultimately, the solution lies in finding a substitute for traditional fishmeal.



FAO's November 2007 Global Outlook for Fish and Fishery Products states that, "To overcome the problem, the industry in all main aquaculture feed producing countries is looking for new feed formulations based on non-fish protein that still develops omega-3 in the cultured fish."

Over the long run, Rabobank's Vizzone states that, "We see four alternatives to fishmeal; vegetable proteins, vegetable concentrates, animal byproducts and wild catch byproducts. Of these five, the two who have the most potential are krill and DDGS."

Of these, the most immediately available (but nutritionally awkward) is DDGS, which has a protein content of 28-30 percent according to Vizzone, "we forecast DDGS supply to approach 25 million tonnes and by 2011 it will be 38 million tonnes in the US." Progress has been made in adapting DDGS to fish, but its digestibility still needs to be improved.

In addition to corn and DDGS, there is much ongoing research to improve the marine digestibility of oil seeds. Vizzone comments that, "leading aquaculture producers are working hard on the technology and sourcing side to introduce oil seed feedstocks that are just as digestible as fishmeal." Though innovations have not yet hit the market, it has been determined that, in principle, 80 percent to 100 percent of fishmeal ration can be replaced by these alternative protein sources.

Trash fish, krill go bad quickly

Nevertheless, the real El Dorado of fishmeal substitutes, despite its difficulties, is krill. Rabobank estimates that, that globally, there are 500 million tones of krill. Hugely abundant, with a similar protein profile to fishmeal and rich in omega 3 oils, krill, in principle, is the ideal successor to fishmeal.

Krill's only problem is that it degrades very quickly so onship processing and cold storage facilities are required –a very large investment as much krill is found in Antarctic waters, far away from coastlines. Rising ship fuel prices may also work to keep krill uneconomical until fishmeal has risen much more strongly in price than it already has. That day of reckoning is coming but may still lie 7 to 10 years in the future.

While krill is in the future, for southeast Asia's rich coastal waters, trash fish is the expedient fishmeal substitute of choice. Countries such as Thailand and Vietnam are capitalising on their rich marine environments to exploit low grade fish unfit for human consumption to create fishmeal and omega 3 rich fish feed from non-conventional sources.

Unfortunately, trash fish, like krill, is a victim of its own spectacular protein and enzyme profile –such traits, while extremely nutritious, make the fish degrade within a matter of hours after being caught. Indeed, if it wasn't located close to Asian coastlines, trash fish would be as problematic as krill.

According to Koh, today's quality control techniques and new processing technologies make it possible to include 10 to 15 percent trash fish content into shrimp feed. However, trash fish's high enzyme levels, "makes this process a delicate balancing act."

It also requires an investment in on-ship cold storage and/or processing that many of southeast Asia's traditional fishermen cannot afford. Moreover, southeast Asia's domestic trash fish supplies, while they may reduce dependence on Peruvian fishmeal imports, are insufficient for export.

Consequently, they will not meet the growing fishmeal demand from aquaculture producers in China, the EU or North America. Moreover, Nikolik points out that relying on trash fish is itself a symptom of scarcity since, "as stocks are reduced, fishing then targets smaller species, known as low value or trash fish, lower down the ecosystem."

Hence, while innovation continues apace, the world is faced with at least ten years of fishmeal supply deficits –with historically high and rising prices for all manner of seafood. With Asia's aquaculture sector as hungry for feed as ever, >>

Maxed domestic supply, questionable quality

Over fishing, pollution and fraudulent additives have left domestic fishmeal supplies in disarray. What happens when demand recovers?

by Eric J. BROOKS

The world's greatest seafood producer is also its greatest fishmeal importer –with dependence growing all the time. Due to the increasing severity of sea pollution around China, it is producing less fishmeal each year. At the same time, China has the world's largest aquaculture sector, accounting for 70 percent of global production. With domestic seafood consumption, exports and aquaculture output all pointing upwards, this will result in greater import dependency. Imports account for 60 to 70 percent of China's fishmeal supply and this proportion is poised to keep rising.

China's aquaculture producers however, are doing their best to adapt to this situation. When fishmeal prices peaked in 2006, the proportion of fishmeal used in feed fell significantly. At this time, reformulation techniques are still in the early stages of development, but they are improving gradually. Feed enterprises adjust the level of fishmeal in feed accordingly to changes in the price ratio between fishmeal and soy.

Demand and supply of fishmeal in China from 2000-2007 ('000 tonnes)

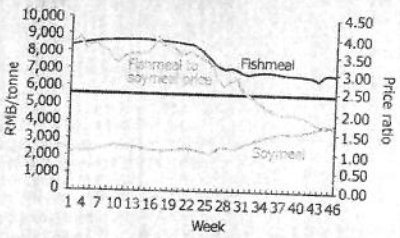
Year	2000	2001	2002	2003	2004	2005	2006	2007
Beginning inventory	110	215	65	117	90	87	108	160
China-produced fishmeal	476	480	400	400	350	300	280	190
Import volume	1,169	902	958	801	1100	1,580	980	970
Total supply	1,755	1,597	1,423	1,318	1,540	1,967	1,368	1,320
Ending inventory	215	65	117	90	87	108	160	140
Total consumption	1,540	1,532	1,306	1,237	1,453	1,859	1,208	1,180

Minimising use, compromising quality?

In truth, China's livestock is being fed little or no fishmeal and farmed fish are usually being fed the bare minimum –with many ground level reports of fish receiving less than the minimum required for their growth and health. Naturally, this creates issues with omega 3 oil content. In addition, if fishmeal is used too parsimoniously, it can affect the visible overall quality of the seafood too. So far however, this large reduction in fishmeal usage has not resulted in food safety issues or export blockages.

At the same time, after peaking in 2005 at 1.58 million tonnes, fishmeal imports crashed to 980 thousand tonnes in 2006 and 970 tonnes in 2007 –a fall of 38.61 percent. –All this is in the face of continually rising aquaculture production. However, in the absence of a viable substitute, there is a physical limit to the extent to which other protein or oil seed-based feeds could be substituted in place of fishmeal. This limit was reached by the end of last year.

Price ratio of China fishmeal and soymeal in 2007



Moreover, market forces are presently working against reformulation. When fishmeal prices took off in 2005 to early 2007, the maximum amount of soy was used in aqua feed.

Soon afterwards, soy jumped by two-thirds in price and touched record highs. It became uneconomical to substitute soy in place of fishmeal. The critical price ratio point of fishmeal to soy is 2.5:1. When the ratio falls below this minimum it becomes more economical to use fishmeal in feed.

After peaking in early 2007, fishmeal prices crashed and by the third quarter of 2007. Henceforth, it was again more economical to use more soy rather than fishmeal in feed. However, as all feed prices have risen to historically high levels, many Chinese buyers are still not actively procuring fishmeal. If possible, they prefer to rely on China's large domestic fishmeal inventories rather than import more. This was also the reason why China's demand for Peruvian fishmeal has stayed low even though Peruvian fishmeal producers are now raving about its cost effectiveness.

Domestic supply has quality problems

Unfortunately, reliance on local fishmeal creates issues of its own. First, due to China's inferior fishmeal resources (relative to countries like Peru), over fishing and coastal pollution, Chinese fishmeal is of lower quality. This is partly reflected in its lower price relative to imports. Secondly, much of the local fishmeal stayed unsold for a long time when prices were high. Hence, its quality has deteriorated to the point that it could adversely impact feed quality.

Last, it was recently discovered that fake fishmeal has been mixed into domestic fishmeal. This is a serious issue for the safety and credibility of China's domestic fishmeal supply. If China is not careful, its fishmeal supply will go the way of domestic meat-and-bone meal. Here, the mixing of fake or toxic ingredients gave it such a bad reputation that most livestock suppliers prefer to rely on imports, no matter what the price.

Nevertheless, with soy prices staying high, both China and the world's demand for fishmeal will recover later this year. Hence, after an eighteen month respite, we can expect Chinese fishmeal demand –and with it, global fishmeal prices to resume their uptrend.

Thailand: Self-sufficient, for now

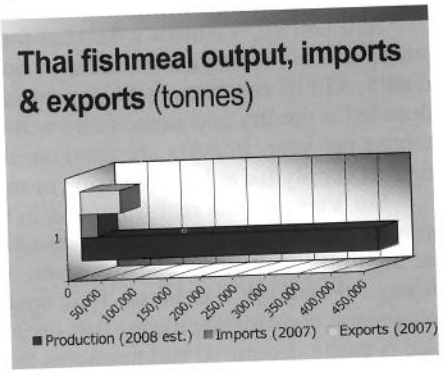
Can it bring trash fish to market before demand overtakes supply?

by **F.E. OLIMPO, with contributions by Eric J BROOKS**

Unlike the rest of Asia, Thailand is one of the few large aquaculture producers that is not heavily dependent on Peruvian fishmeal. Indeed, for now at least, it is a net fishmeal exporter.

Already where Vietnam wants to be, trash fish is the main raw material that is increasingly being used in lieu of traditional fishmeal. Fishmeal producers expect a 5-10 percent rise in fishmeal demand this year, simultaneous with a 5-10 percent projected growth in livestock production.

This year's fishmeal production is estimated at 450,000 tonnes, 5 percent more than last year's, according to the Thai Fishmeal Producers Association.



No cutbacks in fishmeal usage

Moreover, unlike China, Thailand does not suffer fishmeal supply shortfalls that force it to reduce its use in aquaculture or livestock. According to Ms. Nichkamol Umaree, manager of the Thai Fishmeal Producers Association, fishmeal usage has been consistent at farms and depends on livestock and aquaculture production, not fishmeal supplies or prices.

Thanks to its abundant fishmeal supply, Thai fish and livestock still enjoy traditional, high levels of fishmeal consumption. Nichkamol also reports that there has been no major attempt to substitute grains for fishmeal.

Nevertheless, with growing domestic and export demand, Thailand's fishmeal self-sufficiency may not last for much longer. According to a study conducted by Bangkok's Kasetsart University, local producers may have to import raw materials in the future.

Moreover, rising energy prices are working to reduce the domestic trash fish catch. Due to high oil prices, trawl operators in the country have scaled down their fishing activities, resulting in a 40 percent drop in fish catch in 2007. Fortunately, the Thai seafood sector has not yet suffered any shortages of raw materials as they also use river catch to fill their requirements.

Even so, Nichkamol says that a few aquaculture farms previously tried using DDGS imported from China in place of fishmeal. However, DDGS's cost is tied to the price of corn and has been rising, causing fish farms to cut down on its use.

Meanwhile, fishmeal supplies and demands are roughly balanced and will remain so for a while longer –thanks to a severe recession in the country's vast shrimp sector. With lower demand, Thai fishmeal prices are also expected to soften from their current high price of THB25-29/kg to THB21-25/kg as supply stabilises. Exports of fishmeal are also expected to drop in response to less attractive export prices.

With competition from new low cost suppliers, US import duties and the baht's rising value, shrimp production is falling due to plunging overseas orders. However, fishmeal consumption will rebound when the aquaculture sector recovers. In late 2008, the government expects the WTO to rule in its favour, allowing for a resumption of low-tariff shrimp exports to the US.

...and when demand recovers?

Consequently, one must ask, 'once demand recovers, can Thailand raise its productivity enough to avoid importing increasingly scarce Peruvian fishmeal?' On one hand, it has a modern, well-capitalised food processing industry. Giants like CP have the means and know-how to invest in the on-ship cold-storage facilities and advanced pellet mills that trash fish require.

On the other hand, much of Thailand's fishing sector remains unconsolidated. Numerous small fishermen cannot afford refrigeration facilities and high energy prices are already constraining their trash fish catches. It could very well turn out that by the time that fishing sector consolidation occurs, fishmeal demand will have permanently overtaken supply. But for now, Thailand can enjoy the best of both worlds: a reputation as a quality seafood exporter and plentiful domestic supplies of fishmeal and trash fish.

Vietnam: Will rising prices spur investment?

Government policy needs to guide the coordinated building of ship refrigeration, port and processing infrastructure.

by **Gemma C. DELMO**

With a peninsula and bay rich coastline of 3,260 kilometres, Vietnamese aquaculture is growing rapidly. The country aims to achieve 2 million tonnes of aquaculture production by 2010 and as it does, the dilemma of feeding this growing sector takes on increasing importance.

According to The Australian Centre for International Agricultural Research (ACIAR), Vietnam imports roughly 90 percent of its fishmeal requirements, mostly from Peru. With respect to domestic production, most of Vietnam's nineteen fishmeal plants are located in the south, where trash fish stocks is abundant. However, these plants are unable to produce the superior fishmeal grade similar to those in Peru because the major ingredient – mixed species of demersal fish – >>

are already degraded by the time they arrive at the plant due to poor storage facilities. ACIAR says that Vietnamese fishing boats lack cold storage facilities and cannot carry enough ice to preserve their catch. Inadequate handling and grading at the port then further accelerates the degradation of the fish.

Investment requires upgraded ports

Though the government is mulling new investments to build more fishmeal plants, experts are cynical about economic viability –and their concerns are based on cold facts. Ideally, ACIAR states that for a fishmeal factory to generate significant revenues, it needs 50 to 100 tonnes per day of fish to be processed, given a minimum of 30 tonnes per day of fishmeal. Unfortunately, very few companies can achieve this capacity because most Vietnamese ports are too small to handle such volumes. Hence, additional fishmeal production is, to a large extent, dependent on the government encouraging investment in large port infrastructures.

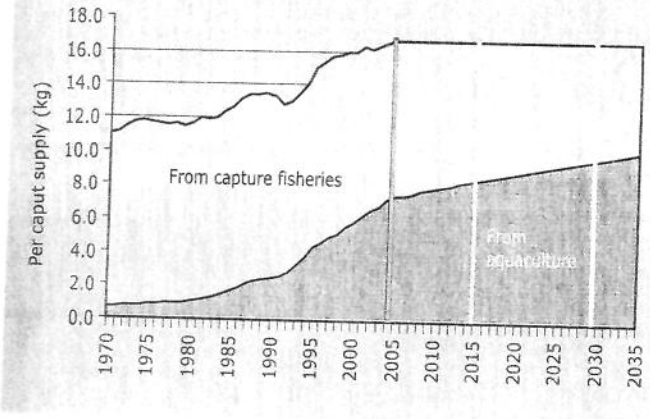
Furthermore, ACIAR stresses that there is a need for fishmeal plants to use more intricate technology with the pressing, separation of oil and dry matter, evaporation and returning the protein pressed out of the cooking raw material. This way, fish oil and fishmeal with high protein content can be created without overcooking the meal, which degrades its amino acid and fatty acid profile.

At the same time, the soaring costs of imported, high quality fishmeal is prompting producers to look into trash fish as an alternative. ACPIF notes that trash fish and other discards from the seafood industry are, "the main force influencing production of fishmeal in Vietnam."

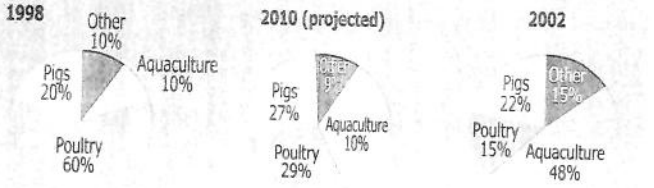
Though considered traditionally considered waste by Vietnam's less advanced fish plants, trash fish prices are climbing due to competition from fish sauce manufacturers and direct use for consumption, particularly in poor communities. However, to develop trash fish into a major fishmeal ingredient requires huge investments in on-ship cold storage, volume port and on-land fish processing infrastructure.

This, unfortunately, cannot be justified with the current market situation. Moreover, in Vietnam's case, over fishing and pollution have also considerably decreased the number of fish species available for fishmeal production. A simultaneous upgrading of ports, fishing industry ships and manufacturing infrastructure is required if Vietnamese fishmeal is to become viable –along with pollution abatement.

Limited by scarce fishmeal: Aquaculture growth tapers off



Fishmeal consumption, by livestock type, 1998 - 2010



Source: United nations FAO

Still and all, Vietnam's demand for fishmeal will remain strong due to intensification and ever growing aquaculture industry. APFIC estimates that fishmeal requirements in the next decade for poultry and aquaculture will hover around 800,000 tonnes per year. Imports are guaranteed a major share of the market supply for at least a decade or more.

For Vietnam, the real frontier is in trash fish, which offer similar protein digestibility characteristics to fishmeal as well as high omega 3 fat levels. However, according to Koh Hui Meng, **eFeedLink**'s in-house feed operations analyst, "their enzymatic constituents means that once caught, trash fish tissue is easily denatured and promotes bacterial growth. Freezing is therefore necessary, as it will otherwise rapidly decompose and become capable of causing food poisoning and other illnesses."

Need for policy coordination

This implies that to substitute its large trash fish base in place of fishmeal, Vietnam must invest heavily in on-ship freezing and processing facilities. An overhaul of storage facilities is also required to avoid spoilage of trash fish and to produce better quality feed. Finally, ports must be constructed to allow large, economical volumes to be efficiently transported to their processing plants. No one market player can be responsible for all of these factors. Hence, the need for a set of complimentary well coordinated government policies.

Consequently, while Vietnam will always depend on fishmeal imports, if it leverages its trash fish endowment wisely, it will be able to partially alleviate its dependence on increasingly scarce fishmeal. With fishmeal prices slated to rise by an average of 7 percent in real terms each year, they will drag trash fish prices up with them.

Sooner or later, trash fish prices will be high enough to justify the construction of on-ship cold storage and advanced on-shore fish processing. Will the government be there to expand port facilities and coordinate policies? Given the country's considerable aquaculture resources, foreign investors such as China's New Hope Group or Thailand's CP are probably eyeing Vietnam's trash fish.