

New Developments in Fish Feeds and Feeding Practices



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Fish meal in aquafeeds

- In early 1990s, aquafeeds used ~12% of annual fish meal production; most was used in poultry and swine feeds
- Today, aquafeeds use >45% of average annual fish meal production
 - Aquaculture production has grown at 9-10% annually for the past decade
 - Aquafeed producers have been willing to pay higher prices for fish meal than poultry or swine feed producers
- If fish meal use in aquafeeds increases proportionate to aquafeed production, within 5-10 years, aquaculture will consume all global production

This outcome would definitely be considered unsustainable

Fish meal in aquafeeds

- **Researchers have recognized this problem since the 1970s when an el Niño event reduced fish meal production and prices reached historical highs**
- **Efforts to replace fishmeal with alternatives were a catastrophe**
 - Lack of knowledge of amino acid requirements of farmed fish
 - Since then, nutritional requirements have been established
- **Considerable research has shown that fish meal levels in aquafeeds can be reduced significantly**
- **However, use of alternate proteins to replace fish meal in aquafeeds is an economic decision, and, until recently, there was no incentive to do so**

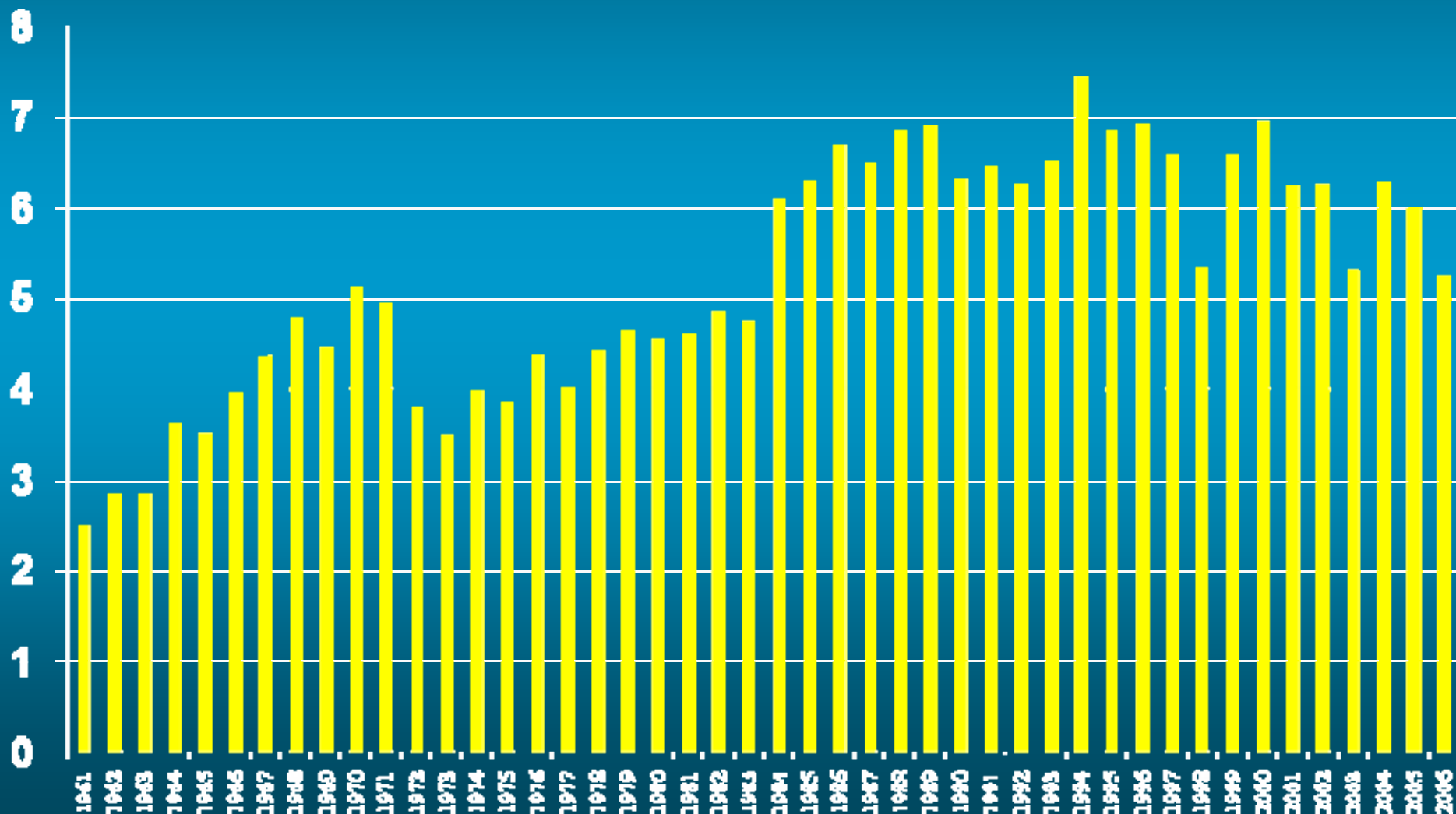
Why are we looking for alternate proteins for aquafeeds?

- **Supply limitations**
- **Increasing demand**
- **Increasing cost**
- **Sustainability concerns**

Fish meal production & supply

- **Prior to WWII, global production was ca. 1,000,000 mt/yr**
- **Following WWII, production increased to ca. 2,000,000 mt/yr by 1960**
- **Construction of fish meal production plants in Peru, Chile, Norway, and other countries resulted in a gradual expansion**
- **Production has been relatively constant at 6-7 mmt since the mid-1980s, except in el Niño years**

Global fishmeal production 1960-2006 (mmt)



Expected demand for fish meal in aquafeeds

- Aquaculture production is expected to grow by 9.0% per year over the next decade, especially...
 - Carnivorous marine species requiring high protein feeds
 - Omnivorous species requiring high protein feeds at fry and juvenile stages (huge potential problem for fish meal supplies)
- Conversion from extensive (no formulated feeds) to semi-intensive (formulated feeds being used) production in Asian cyprinid culture (carp species)
- Aquafeed production is expected to double in the next 12-15 yrs

Need for protein in aquafeeds also expected to double

World aquafeed production (mt)



Summary of fish meal demand

- Demand for fish meal in aquafeeds will remain high due to increased aquaculture production

- Use levels feeds for various species will decline on a percentage basis

- Demand will continue to increase in Far East, mainly China

- Far East: ~ 3,300,000 mt in 2005 (pigs, poultry, aquaculture)

- Europe: ~ 800,000 mt in 2005 (mainly aquaculture)

- Americas: ~ 600,000 mt in 2005 (mainly aquaculture)

- All others: ~ 950,000 mt in 2005

How price dictates fish meal use

- **Global price increases during el Niño events because production in Peru declines by as much as 1,000,000 mt**
- **When prices reach the high end of the normal range...**
 - **Aquafeed producers use less high quality and more FAQ fish meal**
 - **Higher inclusion levels of alternate protein sources in aquafeeds**
 - **Lower inclusion levels of fish meal in poultry and swine feeds**

However, prices in 2006 reached \$1,600/mt in North America and EU countries, delivered. Now down about 25% from that level

Why did fish meal prices increase so much last year?

- **Supply was down**
 - Landings in Peru were lower than average
 - Japanese sardine fishery and catches in North Sea were lower
 - Hurricane Katrina reduced USA menhaden fish meal production
- **Demand was up**
 - Aquafeed production increased
 - Ban on use of slaughter by-products by EU continued, increasing fish meal use in the EU and also in Asian countries supplying EU with shrimp and fish
 - China became a major purchaser of fish meal (> 1.3 mmt)
- **New price range \$850-\$1,200 per mt, about double of old price range**

What are the options to meet these challenges?

- Stop growing carnivorous species; stick with catfish, tilapia, carp, etc.
- Change feed formulations to use less fish meal and find alternative protein sources for fish feeds
- Concerning alternatives, all of which are by-products, researchers are...
 - Developing and testing new alternate proteins
 - Modifying existing alternate proteins or the industrial processes used in their production to make them suitable for use in aquafeeds
 - Establishing appropriate use levels

Why has fish meal been the protein source of choice in aquafeeds?

- Essential amino acids mirrors dietary requirements of fish; protein highly digestible
- Fish meal is palatable, easy to use and readily available worldwide
- Growth performance of fish is high when fish meal-based diets are fed
- Up to 2006, fish meal was relatively inexpensive on a protein-unit basis

What has been the role of other protein sources in aquafeeds?

- Reduce the price of feeds when fish meal is expensive
- “extend” fish meal supplies when they are tight
- Lower dietary P level in low-pollution feeds used in freshwater production of trout and salmon (plant protein sources)

What will be the role of alternative proteins in aquaculture diets?

- Supply most of the protein used in aquafeeds
- Keep cost of aquafeeds (and farmed fish) competitive
- Move aquafeeds to more stable and sustainable foundation

Paradigm shift for role of fish meal in aquafeeds

- Supply essential amino acids to balance deficiencies when grain and oilseed protein sources replace fish meal
- Supply minerals and other growth factors
- Increase palatability
- Use in starter feeds for fry

Potential alternatives to fish meal

- Existing ingredients
 - SBM & CGM (now being widely used)
 - SPC, wheat gluten (existing products are excellent but produced as human food and until recently, too expensive compared to fish meal)
- Modified ingredients
 - Oilseed or grain protein concentrates made to feed grade standards
 - Soy, barley or wheat protein concentrate
 - Rapeseed, lupin, pea protein concentrate
 - *Protein recovered from ethanol or biofuel production*
- Single-cell proteins, e.g., yeast grown on methane
- Seafood processing by-products
- By-products of poultry processing

How much protein will be needed for aquafeeds by 2012?

	Feed (000mt)	Fish meal (000mt)
2005	13678	2700
2012 (at 2005 use levels)	32000	6700
2012 (estimate)		3600
Difference		3,000,000 mt*

*** to be supplied by alternate protein sources**

Alternate Protein Sources to Fish Meal



Plant proteins

Soybean meal, soybean concentrate, canola meal, canola concentrate, pea meal, lupin seed meal, corn and wheat gluten meal, sunflower seed meal, cottonseed meal

Fishery by-products

Fish meal from processing by-products, crab meal, shrimp meal, squid hydrolysate, krill hydrolysate, zooplankton

Animal by-products

Poultry by-products, hydrolyzed feather meal, blood meal, whey products

Other

Single cell protein

Use of Plant Proteins – Major constraints

- Protein content lower than animal proteins
- Imbalanced amino acids in plant protein
- High amount of carbohydrates
 - Indigestible polysaccharides and sugars
- Inherent antinutritional factors, e. g.
 - Protease inhibitors
 - Goitrous glucosinolates
 - Agglutinating lectins
 - Antigenic proteins
 - Toxic gossypols
 - Phytic acid

Challenges to overcome with alternative proteins in aquafeeds

- **Amino acid and mineral balance**
 - Use supplements to overcome deficiencies in plant proteins
 - Marine proteins as supplements
 - Feed-grade amino acids
 - Bone meals from seafood processing waste
 - Phytase?
- **Palatability**
 - Specialty marine proteins from processing waste
- **Unrecognized nutrients or growth factors present in fish meal that are absent in plant proteins**
 - Specialty marine proteins from processing waste
 - Need to identify these and find alternative supplies

Challenges to overcome with alternative proteins in aquafeeds

- **Anti-nutrients in oilseeds, such as glucosinolates, phytate, phytoestrogens**
 - Need to develop processing techniques to eliminate or supplements to overcome these biologically-active compounds
- **Increased fecal output due to higher fiber associated with plant protein concentrates**
 - Protein concentrates are made by removing carbohydrates
 - Protein and fiber are concentrated by this process
 - Fiber is not digestible, so increasing levels of plant protein concentrates in feeds increases fecal output
 - Solution is to use phytase or other technique to lower indigestible fiber

Alternate Protein Sources

Evaluation of nutritional quality

- Amino acid availability & req.
- Use of bioactive compounds from marine sources
- Other strategies

Elimination of antinutritional factors

- Processing technology
 - Plant breeding
- Sensitive indicators....

Feed processing Technology

- co-processing
- Application of feed additives e.g. enzymes

Better use of plant and marine products