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# Fish as feed inputs for aquaculture

## Practices, sustainability and implications

***Cover photographs:***
*Left:* Preparation of trash fish/low-value fish to be fed in a soft-shelled crab farm, Myanmar (courtesy of U Hla Win).
*Right top to bottom:* Anchoveta (*Engraulis ringens*) for fishmeal production, Chimbote City, Peru (courtesy of N. Sánchez Durand). Feeding of mouse grouper with trash fish/low-value fish in a cage farm, Lampung bay, Lampung, Indonesia (courtesy of Mohammad R. Hasan). Heading and gutting operation of anchoveta, Chimbote City, Peru (courtesy of N. Sánchez Durand).

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Edited by
**Mohammad R. Hasan**
Aquaculture Management and Conservation Service
FAO Fisheries and Aquaculture Department
Rome, Italy

and

**Matthias Halwart**
Aquaculture Management and Conservation Service
FAO Fisheries and Aquaculture Department
Rome, Italy

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# Preparation of this document

This document was prepared by a group of experts under the leadership of Dr Mohammad R. Hasan as part of the FAO Aquaculture Management and Conservation Service (FIMA) project "Towards Sustainable Aquaculture: Selected Issues and Guidelines" (GCP/INT/936/JPN), implemented with funding from the Government of Japan. Component 4 of the project addressed the issue of "Use of wild fish and/or other aquatic species to feed cultured fish and its implications to food security and poverty alleviation". It reviewed the status of and trends in the use of wild fish as aquafeed, the types of uses (fresh or processed) for aquaculture, the relative amount used for aquaculture and the potential alternative uses, e.g. for human consumption. To reflect the diversity of the use of wild fish to feed aquaculture species in the various regions, four regional reviews (Africa and the Near East, Asia and Pacific, Europe, and Latin America and North America) and three case studies from Latin America were conducted. On the basis of the regional reviews and case studies, an attempt was made to develop a global perspective on the status and trends in the use of fish as feed and the issues and challenges confronting reduction fisheries. The global perspective was further supported by case studies in China and Viet Nam. In addition, a targeted workshop entitled Use of Wild Fish and/or Other Aquatic Species as Feed in Aquaculture and its implications to Food Security and Poverty Alleviation was convened in Kochi, India, from 16 to 18 November 2007. The workshop was organized by FIMA of FAO and was hosted by the Marine Products Export Development Authority (MPEDA), India. The report of the workshop was published as a FAO Fisheries Report (www.fao.org/docrep/fao/011/i0263e/i0263e.pdf).

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[1] FAO. 2008. Report of the FAO Expert Workshop on the Use of Wild Fish and/or Other Aquatic Species as Feed in Aquaculture and its Implications to Food Security and Poverty Alleviation, Kochi, India, 16–18 November 2007. FAO Fisheries Report No. 867. Rome, FAO. 29 pp.

# Abstract

This technical paper provides a comprehensive review of the use of wild fish as feed inputs for aquaculture covering existing practices and their sustainability as well as implications of various feed-fish fisheries scenarios. It comprises four regional reviews (Africa and the Near East, Asia and the Pacific, Europe, and Latin America and North America) and three case studies from Latin America (Chile, Peru and the study on the use of the Argentine anchoita in Argentina, Uruguay and Brazil). The four regional reviews specifically address the sustainable use of finite wild fish resources and the role that feed-fish fisheries may play for food security and poverty alleviation in these four regions and elsewhere. With additional information from case studies in China and Viet Nam, a global synthesis provides a perspective on the status and trends in the use of fish as feed and the issues and challenges confronting feed-fish fisheries. Based on the information presented in the global synthesis, regional reviews and three case studies, and through the fresh analysis of information presented elsewhere, an exploratory paper examines the use of wild fish as aquaculture feed from the perspective of poverty alleviation and food security.

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# Contents

# Contributors

**P. Raggi Abdallah,** Department of Economics, Universidade Federal do Rio Grande, Rio Grande RS, Brazil.

**S. Fernández Amorín,** Fisheries Research Institute of the Veterinary Faculty of the La Republica University, La Paloma campus, Uruguay.

**N. Avdalov,** INFOPESCA, Centre for Marketing Information and Advisory Services for Fishery Products in Latin America and the Caribbean, Uruguay.

**M.I. Bertolotti,** National Institute for Fisheries Research and Development, Mar del Plata, Argentina.

**A.S. Bórquez,** Aquaculture Nutrition Unit, School of Aquaculture, Catholic University of Temuco, Agro-aquaculture Nutritional Genomic Centre, CGNA, Temuco, Chile.
E-mail: aborquez@uct.cl

**J.P. Castello,** Fisheries Technology and Pelagic Resources Laboratories, Institute of Oceanography, Universidade Federal do Rio Grande, Rio Grande RS, Brazil.

**Sena S. De Silva,** Network of Aquaculture Centres in Asia-Pacific, PO Box 1040, Kasetsart Post Office, Bangkok 10903, Thailand.
E-mail: sena.desilva@enaca.org

**N. Sánchez Durand,** Peruvian Institute of Fishery Technology, Km. 5.2 Carretera a Ventanilla, Callao, Peru.
E-mail: nsanchez@itp.org.pe

**M.L. Espírito Santo,** Institute of Chemistry, Universidade Federal do Rio Grande, Rio Grande RS, Brazil.

**M. Gallo Seminario,** Peruvian Institute of Fishery Technology, Km. 5.2 Carretera a Ventanilla, Callao, Peru.
E-mail: mgallo@itp.org.pe

**J. Hansen,** National Institute for Fisheries Research and Development, Mar del Plata, Argentina.

**Mohammad R. Hasan,** Aquaculture Management and Conservation Service, FAO Fisheries and Aquaculture Department, Rome, Italy.
E-mail: Mohammad.Hasan@fao.org

**T. Hecht,** Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown, South Africa.
E-mail: T.Hecht@ru.ac.za

**A.J. Hernández,** Aquaculture Nutrition Unit, School of Aquaculture, Catholic University of Temuco, Agro-aquaculture Nutritional Genomic Centre, CGNA, Temuco, Chile.
E-mail: ajhernandez@uct.cl

**Tim Huntington,** FAO Consultant, Poseidon Aquatic Resource Management Ltd., Windrush, Warborne Lane, Portmore, Nr. Lymington, Hampshire SO41 5RJ, United Kingdom.
E-mail: tim@consult-poseidon.com

**C.L.W. Jones,** Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown, South Africa.
E-mail: c.jones@ru.ac.za

**E. Manca,** National Institute for Fisheries Research and Development, Mar del Plata, Argentina.

**L.S. Pastous Madureira,** Fisheries Technology and Pelagic Resources Laboratories, Institute of Oceanography, Universidade Federal do Rio Grande, Rio Grande RS, Brazil.
E-mail: doclsm@furg.br

**C. Prentice-Hernández,** Institute of Chemistry, Universidade Federal do Rio Grande, Rio Grande RS, Brazil.
**M.I. Queiroz,** Institute of Chemistry, Universidade Federal do Rio Grande, Rio Grande RS, Brazil.
**W.A. Ruiz,** Institute of Chemistry, Universidade Federal do Rio Grande, Rio Grande RS, Brazil.
**Albert G.J. Tacon,** FAO Consultant, Aquatic Farms Ltd., 49-139 Kamehameha Hwy, Kaneohe, HI 96744, United States of America.
E-mail: agjtacon@aol.com
**Giovanni M. Turchini,** School of Life and Environmental Sciences, Deakin University, PO Box 423, Warrnambool, Victoria, 3280, Australia.
E-mail: giovanni.turchini@deakin.edu.au
**Ulf N. Wijkström,** FAO Consultant, Skottsfall, S 578 92 Aneby, Sweden.
E-mail: pamus@swipnet.se
**M.I. Yeannes,** National Council for Technological and Scientific Research, Engineering Faculty, Mar del Plata University, Argentina.

# Preface

## BACKGROUND

In 2006, global aquaculture production (including aquatic plants) was estimated at 85.9 million tonnes and valued at US$85.9 billion (FAO, 2008a)[2]. The average annual percentage growth rate (APR) of the aquaculture sector between 1990 and 2004 was 9.4 percent (FAO, 2008b)[3]. In 2005, about 28.2 million tonnes or 44.8 percent of total global aquaculture production (excluding filter-feeding species such as silver carp and bighead carp) was dependent upon the direct use of feed, either a single dietary ingredient, farm-made aquafeed or industrially manufactured compound aquafeeds (FAO, 2007)[4].

Fishmeal and fish oil are two major dietary ingredients used in compound aquafeeds. Total estimated compound aquafeed production in 2006 was about 25.4 million tonnes (Gill, 2007)[5] and about 42 percent of this amount was consumed by non-filter feeding carps (Tacon and Hasan, 2007)[6]. In 2006, the total global industrial feed output exceeded 635 million tonnes to which the aquafeed industry contributed only 4 percent (Gill, 2007). World reduction fisheries have remained at between 20 and 30 million tonnes for the last 30 years (FAO, 2008b). Global fishmeal and fish oil production has remained relatively static over the last quarter century, fishmeal production fluctuating from a low of 4.57 million tonnes in 1977 to a high of 7.48 million tonnes in 1994 (mean of 6.07 million tonnes), and fish oil production fluctuating from a low of 0.85 million tonnes in 2002 to a high of 1.67 million tonnes in 1986 (mean of 1.25 million tonnes) (Tacon, Hasan and Subasinghe, 2006).

Aquaculture is the largest overall user of fishmeal. Pigs and poultry account for around a quarter of total usage, with other livestock types account for the remainder. Ruminants now account for only 1 percent and this is likely to drop. Total estimated amount of fishmeal and fish oil used in the production of aquafeeds has grown over three-fold from 0.96 million tonnes to 3.06 million tonnes and from 0.23 million tonnes to 0.78 million tones, respectively, from 1992 to 2006, (Tacon, Hasan and Subasinghe, 2006[7]; Tacon, 2007). This increase has come from the land-animal sector, particularly

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[2] FAO. 2008a. FAO. *Fishstat Plus: Universal software for fishery statistical time series.* Aquaculture production: quantities 1950–2006; Aquaculture production: values 1984–2006; Capture production: 1950–2006; Commodities production and trade: 1950–2006; Total production: 1970–2006, Vers. 2.30. FAO Fisheries Department, Fishery Information, Data and Statistics Unit. (available at www.fao.org/fi/statist/FISOFT/FISHPLUS.asp).

[3] FAO. 2008b. *Report of the FAO Expert Workshop on the Use of Wild Fish and/or Other Aquatic Species as Feed in Aquaculture and its Implications to Food Security and Poverty Alleviation*, Kochi, India, 16–18 November 2007. FAO Fisheries Report No. 867. Rome, FAO, 29 pp.

[4] FAO. 2007. *Fishstat Plus: Universal software for fishery statistical time series.* Aquaculture production: quantities 1950–2005; Aquaculture production: values 1984–2006; Capture production: 1950–2005; Commodities production and trade: 1950–2005; Total production: 1970–2005, Vers. 2.30. FAO Fisheries Department, Fishery Information, Data and Statistics Unit. (available at www.fao.org/fi/statist/FISOFT/FISHPLUS.asp).

[5] Gill, C. 2007. World feed panorama: bigger cities, more feed. *Feed International*, 28(1): 5–9.

[6] Tacon, A.G.J. & Hasan, M.R. 2007. Global synthesis of feds and nutrients for sustainable aquaculture development. *In* M.R. Hasan, T. Hecht, S.S. De Silva and A.G.J. Tacon (eds.). *Study and analysis of feeds and fertilizers for sustainable aquaculture development*, pp. 3–17. FAO Fisheries Technical Paper. No. 497. Rome, FAO. 510 pp.

[7] Tacon, A.G.J., Hasan, M.R. & Subasinghe, R.P. 2006. Use of fishery resources as feed inputs for aquaculture development: trends and policy implications. *FAO Fisheries Circular*. No. 1018. Rome, 99 pp.

from the poultry sector, which is continuously reducing its use of fishmeal because the price has risen (FAO, 2008b). The aquafeed sector uses fishmeal, thus reducing availability to the poultry sector and fish oil, thus reducing availability to the all other sectors.

The estimate of fishmeal use for aquaculture varies from 46 to 56 percent and of fish oil use is over 80 percent of total production. It is estimated that aquaculture sector used about 3.06 million tonnes or 56.0 percent of the world's fishmeal production and 0.78 million tonnes or 87.0 percent of total fish oil production in 2006 (Tacon, 2007)[8], with major consumers of fishmeal being marine shrimp (22.4 percent), marine fish (18.3 percent), salmon (18.0 percent), carp (13.1 percent), trout (6.6 percent), freshwater crustaceans (5.3 percent) and eels (5.1 percent), and over 64 percent of fish oil production going into the diets of salmonids (salmon 49.7 percent and trout 14.8 percent) diets (Huntington and Hasan, 2009)[9]. The trend in fishmeal use indicates a decrease in use for salmon and trout although use may increase after 2010, while consumption of fishmeal by marine finfish and penaeid shrimp is increasing and is likely to continue to increase over the next few years.

Demand and use of fishmeal in some of the emerging aquaculture countries in Asia are increasing rapidly. Viet Nam uses approximately 62 500 tonnes of fishmeal per year, solely for aquaculture (Hasan *et al*., 2007[10]). China is the single largest user of fishmeal and used 1.6 million tonnes in 2004, of which 1.2 million tonnes were imported and 0.4 million tonnes were produced domestically (Weimin and Mengqing, 2007[11]). Of this 1.6 million tonnes of fishmeal, approximately 75 percent was used for aquafeed production. It was estimated that the Asia-Pacific aquaculture sector uses about 2.4 million tonnes of fishmeal (equivalent to approximately 10.3 tonnes of raw material) as a feed source. The low and high predictions for the year 2010, are in the order of 2.0 and 2.2 million tonnes of fishmeal, respectively (equivalent to 8.4 and 12.8 million and/or 7.3 and 11.2 million tonnes of raw material, based on efficiency of raw material to fishmeal conversion rates of 4.0 and 3.5, respectively) (FAO, 2008b).

In addition to fishmeal and fish oil used in compound and farm-made aquafeeds, low-value fish or "trash" fish are used in different parts of the world as a complete or supplementary feed for farmed fish, crustaceans and a few molluscan species. It is generally estimated that an approximate 5 to 6 million tonnes of low-value/trash fish are used as direct feed in aquaculture worldwide (Tacon, Hasan and Subasinghe, 2006), particularly for marine carnivorous fish species in China and in several Southeast Asian countries (e.g. Viet Nam, Indonesia, Thailand), marine crustaceans (lobsters and crabs) and certain freshwater fish species. A recent estimate placed the Asian use of trash fish as fish feed at about 1.6 to 2.8 million tonnes per year and the low and high predictions for the year 2010 are in the order of 2.2 to 3.9 million tonnes of trash fish/low-value fish, respectively as direct feed inputs (FAO, 2008b). The total use of trash

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[8] Tacon, A.G.J. 2007. *Meeting the feed supply challenges.* Paper presented FAO Globefish Global Trade Conference on Aquaculture, Qingdao, China, 29–31 May 2007.

[9] Huntington, T.C. & Hasan, M.R. 2009. Fish as feed inputs for aquaculture – practices, sustainability and implications: a global synthesis. *In* M.R. Hasan and M. Halwart (eds.). *Fish as feed inputs for aquaculture: practices, sustainability and implications,* pp. 209–268. FAO Fisheries and Aquaculture Technical Paper. No. 518. Rome, FAO. 407 pp.

[10] Hasan, M.R., Hecht, T., De Silva, S.S. & Tacon, A.G.J. (eds.). 2007. *Study and analysis of feeds and fertilizers for sustainable aquaculture development.* FAO Fisheries Technical Paper. No. 497. Rome, FAO. 510 pp.

[11] Miao, W.M. & Liang, M.Q. 2007. Analysis of feeds and fertilizers for sustainable aquaculture development in China. *In* M.R. Hasan, T. Hecht, S.S. De Silva and A.G.J. Tacon (eds.). S*tudy and analysis of feeds and fertilizers for sustainable aquaculture development*, pp. 141–190. FAO Fisheries Technical Paper. No. 497. Rome, FAO. 510 pp.

[12] Edwards P., Tuan, L.A. & Allan, G.L. 2004. *A survey of marine trash fish and fish meal as aquaculture feed ingredients in Viet Nam*. ACIAR Working Paper 57. 56 pp.

fish by the aquaculture industry in Viet Nam was estimated to be between 176 420 and 323 440 tonnes in 2001 (Edwards *et al.*, 2004)[12]. It is further projected that Viet Nam will use nearly 1 million tonnes of trash fish and China will require approximately 4 million tonnes by the year 2013 to sustain their marine cage-culture activities (De Silva and Hasan, 2007)[13]. Available information indicates that a significant quantity of trash fish/low-value fish (conservatively estimated at 2.3 million tonnes per year) is being used by the pet food industry (FAO, 2008b).

Other fishery products used in the production of aquafeeds are krill meal, squid meal, squid liver powder and squid oil, shrimp meal and crab meal, and the market size for these products as inputs to aquafeeds is currently estimated to be about 0.29 million tonnes (range: 0.19 to 0.52 million tonnes) (Tacon, Hasan and Subasinghe, 2006). Finfish and crustacean aquaculture is, therefore, highly dependent upon capture fisheries for sourcing feed inputs in the form of fishmeal and fish oil, low-value/trash fish or other marine resources.

## The issue

Although capture fisheries provide a significant input for the growth of aquaculture production, questions surrounding the ethics and long-term sustainability of this practice are often raised. The global fishmeal industry observes that there might not be enough demand (i.e. for direct human consumption) for 90 percent of the wild-caught fish that is reduced to fishmeal. However, on a regional or on an individual country basis, it is possible that a good portion of the reduction fishery products is simply not available for human consumption, though if available, a certain portion of it would certainly have been consumed. In Asia and Africa, small pelagic fish are an important component of the diet of lakeside and coastal communities. In several countries, the increasing demand for pelagic fish by the animal feed industry is reducing the availability of fresh fish for poor communities, and this has a negative impact on food security. Nevertheless, it has also been shown that reduction fisheries and downstream animal production activities contribute to employment generation and eventually contribute to improved living standards and, hence, food security (Hecht and Jones, 2009)[14]. This may be the case when the fishmeal is used in the country of origin, i.e. employment generated through the production of fishmeal as well as created through the aquaculture or the animal feed industries where fishmeal is used in aquafeeds.

The situation in Europe and the Americas, however, is very different from that in Africa and Asia. The catch of the large feed fisheries targeted for fishmeal and fish oil in Europe is considered to have few alternative uses (Huntington, 2009)[15]. However, some fish such as blue whiting, capelin, anchovy, herring and sprat can be used for direct human consumption. The portion that goes for human consumption is not determined by technical limitations but depends largely on economic and cultural factors, which are more difficult for the fishery industry to address directly. Despite their relatively low cost, products originating from small pelagic fisheries do not contribute significantly

[13] De Silva, S.S. & Hasan, M.R. 2007. Feeds and fertilizers: the key to long term sustainability of Asian aquaculture. *In* M.R. Hasan, T. Hecht, S.S. De Silva and A.G.J. Tacon (eds). *Study and analysis of feeds and fertilizers for sustainable aquaculture development*, pp. 19–47. FAO Fisheries Technical Paper. No. 497, Rome, FAO. 510 pp.

[14] Hecht, T. & Jones, C.L.W. 2009. Use of wild fish and other aquatic organisms as feed in aquaculture – a review of practices and implications in Africa and the Near East. *In* M.R. Hasan and M. Halwart (eds.). Fish as feed inputs for aquaculture: practices, sustainability and implications, pp. 129–157. FAO Fisheries and Aquaculture Technical Paper. No. 518. Rome, FAO. 407 pp.

[15] Huntington, T. 2009. Use of wild fish and other aquatic organisms as feed in aquaculture – a review of practices and implications in Europe. *In* M.R. Hasan and M.H. Halwart (eds). *Fish as feed inputs for aquaculture: practices, sustainability and implications,* pp. 209–268. FAO Fisheries and Aquaculture Technical Paper. No. 518. Rome, FAO. 407 pp.

towards ensuring the food security in any part of Europe, due to the ready availability of other nutritional options. Although Japanese and Eastern European markets have shown interest in utilizing feed-fish species such as capelin for human consumption, the volumes consumed are low and are not likely to grow significantly. In case of Latin America, some fish species (e.g. mackerel, anchovy), even though acceptable for direct human consumption, are available in too large quantities relative to the size of nearby markets.

Further, there are issues related to the long-term ecological sustainability of reduction/feed fisheries. Feedfish are mainly short lived, small pelagic fish that show a high level of inter-annual variability that may depend upon extrinsic, often climate-related factors. For example, the Peruvian anchovy fishery (which represented over a quarter or 28.5 percent of the total estimated marine fisheries landings destined for reduction in 2003) is extremely vulnerable to the El Niño southern oscillation events (Tacon, Hasan and Subasinghe, 2006). Although the high levels of fecundity of small pelagic fish species and the relatively short life cycles permit stocks to recover relatively quickly and thus provide a certain degree of protection from high levels of exploitation, the consequences of stock variability on natural predators, as well as the contribution of fishing mortality to these variations in stock sizes, are not fully understood.

Although quality and price are the main determinants for fishmeal purchasers in the aquafeeds industry, the sustainability of feed-fish sources is beginning to become more important. At present, most buyers depend upon the FIN S*ustainability Dossier*[16] for information on what stocks are "sustainable", but there is a recognized need for a comprehensive analytical framework that integrates target stock assessment with the wider ecosystem linkages (Huntington, 2009). To a degree this exists with the development of ecosystem models and approaches such as the MSC (Marine Stewardship Council) criteria for "responsible fishing". Once such a framework has been created and is accepted as a suitable benchmark by the aquafeed industry and its detractors, then it will be easier for purchasers to purchase only from sustainable feed-fish stocks. This process will inevitably have consequences, such as greater pressure on those stocks deemed sustainable as well as possible effects on market economics. This implies that greater use of vegetable-based substitutes will be essential, which in turn may require a reduction in consumer attitudes towards their inclusion in farmed-fish diets.

The above scenarios, therefore, call for a comprehensive study and analysis to determine the sustainability of feed fisheries in relation to food security, poverty alleviation, long-term ecological sustainability and the environment, and indeed the growth and sustainability of important subsectors of the aquaculture industry.

## Activities

With funding from the Government of Japan, the Aquaculture Management and Conservation Service (FIMA) of FAO implemented the project "Towards Sustainable Aquaculture: Selected Issues and Guidelines" (GCP/INT/936/JPN). Five key thematic areas was identified for targeted action under the project. Component 4 of the project addressed the issue of the "Use of Wild Fish and/or Other Aquatic Species to Feed Cultured Fish and its Implications to Food Security and Poverty Alleviation". Component 4 assessed and reviewed the status of and trends in the use of wild fish as aquafeeds, the types of uses (fresh or processed) for aquaculture, the relative amount

[16] Fishmeal Information Network (FIN) *Sustainability Dossier*, an annually updated assessment initiated by the Grain and Feed Trade Association (GAFTA) and funded by the United Kingdom Sea fish Industry Authority (SFIA). FIN aims to provide the latest information available about fishmeal and its role in livestock production. A key element of this is the assurance that fishmeal is produced from fish stocks that are properly monitored according to independent scientific advice and managed to ensure that supplies are not over-fished, or from the recycled trimmings from the food-fish processing sector. (www.nautilus-consultants.co.uk/seafeeds/Files/IFFO-sustainability%20dossier.pdf)

used for aquaculture and the potential alternative uses, e.g. for human consumption. The project is expected to develop policy and technical guidelines on sustainability issues of feed-fish fisheries, including improved management and the criteria for the sustainable use of fish as aquafeeds. These guidelines are expected to assist policy-makers in deciding ways and means of utilizing low-value fish, *inter alia* through development and application of methodologies to estimate optimal allocations of fish for animal and human purposes.

Under this component, four regional reviews (Africa and the Near East, Asia and the Pacific, Europe, and Latin America and North America) and three case studies from Latin America were conducted. The regional reviews specifically addressed the ways of feed-fish fisheries may impinge on food security and poverty alleviation in the four regions and elsewhere, including the sustainable use of these finite resources and the environmental implications of the direct use of fish as feed. On the basis of the four regional reviews and the three case studies, an attempt was made to develop a global perspective on the status of and trends in the use of fish as feeds and issues and challenges confronting feed-fish fisheries.

As a part of the consultative process and to review and analyse critical issues related to the use of wild fish to feed aquaculture species, a targeted workshop entitled "Use of Wild Fish and/or Other Aquatic Species as Feed in Aquaculture and its Implications to Food Security and Poverty Alleviation" was convened in Kochi, India, from 16 to 18 November 2007. The workshop addressed the following thematic areas and other issues of significance emerging from the regional reviews and case studies: a) fisheries management; b) policy development; c) food security; d) poverty alleviation; e) social and ethical issues; and f) aquaculture technology and development. Following several working group deliberations, the workshop agreed on ten principles on the use of wild fish as feed in aquaculture, concluded that such use should be governed by the above ten guiding principles and recommended a number of actions for the FAO to undertake to address the issues raised. The ten guiding principles adopted in the workshop (for details see FAO Fisheries Report No. 867 available at www.fao.org/docrep/fao/011/i0263e/i0263e.pdf) will be elaborated to develop FAO Technical Guidelines for Responsible Fisheries on the "Use of wild fish as feed in aquaculture".

This technical paper has been published in response to the recommendation of the workshop and contains a global synthesis, four regional reviews, selected case studies and a review on the use of wild fish as aquaculture feed from the perspective of poverty alleviation and food security.

# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AA | Arachidonic acid |
| ACFM | Advisory Committee on Fishery Management (ICES) |
| AFMA | Animal Feed Manufacturers Association of South Africa |
| AIC | Agricultural Industries Confederation |
| APB | Anchoita protein base |
| APR | Annual percentage growth rate |
| ASIPES | Asociación de Industriales Pesqueros |
| AUD | Australian dollar |
| B.C. | Before Christ |
| BCC | Banco Central de Chile |
| BCLME | Benguela Current Large Marine Ecosystem programme |
| BMP | Better management practices |
| BSE | Bovine spongiform encephalopathy |
| BV | Biological value |
| CBR | Cost/benefit ratio |
| CCAMLR | Commission for the Conservation of Antarctic Marine Living Resources |
| CCRF | Code of Conduct for Responsible Fisheries |
| CE | Conversion efficiencies |
| CEFAS | Centre for Environment, Fisheries and Aquaculture Science |
| CEP–Paita | Centro de Entrenamiento Pesquero (Perú) |
| CFP | Common Fisheries Policy (EC) |
| CJD | Creutzfeld-Jacob Disease |
| CNPq | Conselho Nacional de Ciência e Tecnologia do Brazil |
| CNY | Chinese yuan |
| CONA | Comité Oceanográfico Nacional (Chile) |
| CORFO | Corporación de Fomento de la Producción (Chile) |
| CPUE | Catch per unit effort |
| DFID | Department for International Development, (United Kingdom) |
| DG | Directorate-General |
| DHA | Docosahexaenoic acid |
| DHC | Direct human consumption |
| DIEESE | Dipartamento Intersindical de Estatísticas e Estudios Socioeconômicos (Brazil) |
| DP | Digestible protein |
| EAF | Ecosystem Approach to Fisheries |
| EC | European Commission |
| EEZ | Exclusive economic zone |
| EIA | Environmental impact assessment |
| ELIFONTS | Effects of Large-scale Feed fisheries On Non-Target Species |
| ENSO | El Niño Southern Oscillation |
| EPA | Eicosapentaenoic acid |
| EQS | Environmental Quality Standards |
| EQV | Environmental quality variables |
| ETFU | Estimated trash fish/low-value fish used |

| | |
|---|---|
| EU | European Union |
| F | Fishing mortality |
| FAO | Food and Agriculture Organization of the United Nations |
| FCR | Food conversion ratio |
| FEMAS | Feed Materials Assurance Scheme |
| FIN | Fishmeal Information Network |
| FOB | Freight on board |
| FOI | Danish Research Institute of Food Economics |
| FONDEPES | Fondo de Desarrollo Pesquero (Perú) |
| FOPROBI | Fund for the Protection of the Biomass (Perú) |
| FPC | Fish protein concentrates |
| FTE | Full time equivalent |
| g | gram |
| GAFTA | Grain and Feed Trade Association |
| GDP | Gross Domestic Product |
| GFCM | General Fisheries Council for the Mediterranean |
| GRT | Gross registred tonnes |
| GTZ | Gesellschaft für Technische Zusammenarbeit |
| HACCP | Hazard Analysis and Critical Control Points |
| H&G | Head and gutted |
| HIV | Human immunodeficiency virus |
| IAFMM | International Association of Fish Meal Manufacturers |
| ICCAT | International Commission for the Conservation of Atlantic Tuna |
| ICES | International Council for the Exploration of the Sea |
| ICLARM | International Center for Living Aquatic Resources Management, now renamed WorldFish Center |
| IFFO | International Fishmeal and Fish Oil Organisation |
| IFPRI | International Food Policy Research Institute |
| IHC | Indirect human consumption |
| IIAP | Peruvian Amazon Research Institute |
| ILO | International Labour Organization |
| IMARPE | Instituto del Mar del Perú |
| INAPE | National Fisheries Institute (Uruguay) |
| INE | Instituto Nacional de Estadísticas |
| INEI | Instituto Nacional de Estadística e Informática (Perú) |
| INR | Indian rupee |
| INRH | Institut National de Recherche Halieutique |
| ITP | Instituto Tecnológico Pesquero (Perú) |
| ITQ | Individual Tradable Quota |
| K | Condition Factor |
| LT | Low temperature |
| M | Natural mortality |
| MAFF | Ministry of Agriculture, Fisheries and Food (United Kingdom) |
| mm | millimetre |
| MMBM | meat meal and bone meal |
| MSC | Marine Stewardship Council |
| MSFOR | Multi-species Forward Projection (ICIES) |
| MSVPA | Multispecies Virtual Population Analysis |
| N | Nitrogen |
| NAO | North Atlantic Oscillation |
| NEPAD | New Partnership for Africa's Development |

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|---|---|
| ng | nanogram |
| NGO | Non-governmental organization |
| NMFS | National Marine Fisheries Service (United States of America) |
| NOAA | National Oceanic and Atmospheric Administration |
| OMP | Operational Management Procedure |
| PAMA | Adaptation Program for Environmental Impact |
| PBDE | Polybrominated diphenyl ethers |
| PCB | Polychlorinated biphenyls |
| PEPPA | Perspectives of Plant Protein Use in Aquaculture |
| POP | Persistent organic pollutants |
| ppt | parts per thousand |
| PRODUCE | Ministry of Production (Perú) |
| PROMPEX | Oficina Nacional para la Promoción de Exportaciones (Perú) |
| RAFOA | Researching Alternatives to Fish Oils in Aquaculture |
| RFO | Regional Fisheries Organizations |
| RPP | Radio Programas del Perú |
| RSPB | Royal Society for the Protection of Birds |
| RUP | rumen undegradable protein |
| SANIPES | Servicio Nacional de Sanidad Pesquera (Perú) |
| SAPW | Subantarctic Platform Waters |
| SCAHAW | Scientific Committee on Animal Health and Animal Welfare (EC) |
| SCAN | Scientific Committee on Animal Nutrition |
| SDRS | Sustainable Development Reference System |
| SEAFEEDS | Sustainable Environmental Aquaculture Feeds |
| SENATI | Servicio Nacional de Adiestramiento en Trabajo Industrial (Perú) |
| SERNAC | Servicio Nacional del Consumidor (Chile) |
| SERNAPESCA | Servicio Nacional de Pesca (Chile) |
| SFIA | United Kingdom Sea Fish Industry Authority |
| SISESAT | Sistema de Seguimiento Satelital |
| SNP | National Society of Fisheries (Perú) |
| SOFIA | The State of World Fisheries and Aquaculture |
| SONAPESCA | Sociedad Nacional de Pesca (Chile) |
| SQS | Scottish Quality Salmon |
| SSB | Spawning Stock Biomass |
| STECF | Scientific, Technical and Economic Committee for Fisheries (of the EC) |
| STSF | Subtropical Shelf Front |
| STSW | Subtropical Shelf Waters |
| SUBPESCA | Subsecretaria de Pesca (Chile) |
| SWAO | South Western Atlantic Ocean |
| TAC | Total allowable catch |
| Taiwan POC | Taiwan Province of China |
| THB | Thai baht |
| TSE | Transmissible spongiform encephalopathy |
| TWI | Tolerable weekly intake |
| UFAS | Universal Feed Assurance Scheme |
| UK | United Kingdom |
| UN | United Nations |
| UNDP | United Nations Development Programme |
| US$ | United States dollar |
| USA | United States of America |

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|---|---|
| VMP | Vice-ministry of Fisheries (Perú) |
| VMS | Vessel monitoring systems |
| VND | Vietnamese dong |
| ₩ | weight |
| WHO | World Health Organization |
| WWF | World Wildlife Fund |
| Y/B | yield/biomass |
| ZCPAU | Argentine-Uruguayan Common Fishing Zone |