

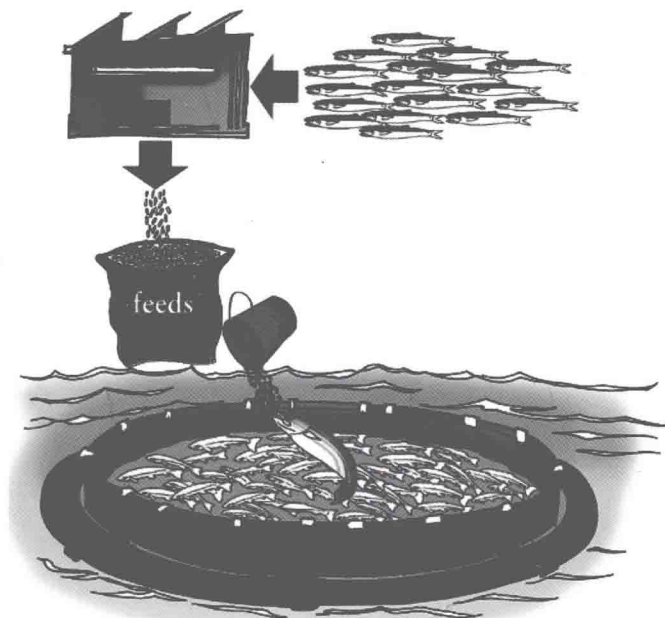
**FAO
TECHNICAL
GUIDELINES FOR
RESPONSIBLE
FISHERIES**

5

Suppl. 5

AQUACULTURE DEVELOPMENT

5. Use of wild fish as feed in aquaculture



AQUACULTURE DEVELOPMENT

5. USE OF WILD FISH AS FEED IN AQUACULTURE



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PREPARATION OF THIS DOCUMENT

These technical guidelines have been prepared by the Fisheries and Aquaculture Department of the Food and Agriculture Organization of the United Nations (FAO) under the coordination of Mohammad R. Hasan and are based on the outputs 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 that was held in Kochi, India, 16–18 November 2007. The participating experts included B. Vishnu Bhat, Aliro R. Bórquez, Cécile Brugère, Chris Carter, Sena S. De Silva, Simon Funge-Smith, Nyoman A. Giri, Brett Glencross, Matthias Halwart, Mohammad R. Hasan, Thomas Hecht, Adrián J. Hernández, Tim Huntington, Andrew Jackson, G. Mohan Kumar, D.D. Nambudiri, M.C. Nandeesh, Sih Yang Sim, Victor Suresh, Albert G.J. Tacon, Giovanni M. Turchini, Shyam P. Vemuri and P.N. Vinod.

These guidelines are a further contribution towards the implementation of the provisions of the FAO Code of Conduct for Responsible Fisheries (the Code) and thus have no formal legal status. Although the Code does not address issues related to the use of wild fish as feed in aquaculture, the need for guidance in these matters is recognized. *Inter alia*, the Code strongly emphasizes the need for responsible fisheries and aquaculture development, equitable international trade, and the protection of the environment and aquatic biodiversity. The information presented is meant to assist with consideration of issues related to the implementation of the provisions of the Code. Furthermore, any differences in the terminology employed should not be considered as a reinterpretation of the Code. These guidelines are intended to be flexible and capable of evolving as circumstances change or as new information becomes available.

The initial drafts of these technical guidelines were compiled by Sunil N. Siriwardena (FAO Consultant). Additional contributions and/or comments were provided by J. Richard Arthur, Devin Bartley, Gabriella Bianchi, Cécile Brugère, Pedro Bueno, Sena S. De Silva, Simon Funge-Smith, Matthias Halwart, Thomas Hecht, Iddya Karunasagar, John Moehl, Thomas Moth-Poulsen, Alejandro F. Nava, Ulf Wijkström, Rolf Willmann and Raymon van Anrooy. Marianne Guyonnet is acknowledged for her assistance in quality control and FAO house style and José Luis Castilla Civit for the layout design. Jiansan Jia, Chief of the Aquaculture Service, FAO is acknowledged for his support throughout the process. The contribution by the Government of Japan, which enabled FAO to prepare for and hold the expert workshop, is gratefully acknowledged.

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ABSTRACT

These technical guidelines on the use of wild fish as feed in aquaculture have been developed in support of Article 7 (responsible fisheries management) and Article 9 (aquaculture development) of the FAO Code of Conduct for Responsible Fisheries, and in particular in support of Articles 9.1.3, 9.1.4 and 9.4.3. The objectives of the guidelines are to contribute towards the development of aquaculture and the sustainable utilization of feed-fish stocks. The guidelines cover a number of issues relevant to the use of wild fish in feeds in aquaculture, including ecosystem and environmental impacts, ethical considerations on the responsible use of fish as feed, aquaculture technology and development, and statistics and information needs for managing the development of aquaculture. Specific matters relating to the management of fishery resources that may be used as feeds are briefly considered in these guidelines, as these have been dealt with in detail in separate FAO guidelines relating to fisheries management and which, *inter alia*, would also apply to feed-fish fisheries. The guiding principles for these technical guidelines were developed and adopted at 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, 16–18 November 2007, Kochi, India.

ABBREVIATIONS AND ACRONYMS

ACFM	Advisory Committee on Fishery Management
BMP	better management practice
CCRF	Code of Conduct for Responsible Fisheries
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COFI	Committee on Fisheries
CPUE	catch per unit effort
CSD	Commission on Sustainable Development
EAF	ecosystem approach to fisheries
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FCR	feed conversion ratio
GAA	Global Aquaculture Alliance
GAFTA	Grain and Feed Trade Association
GFCM	General Fisheries Commission for the Mediterranean
GMP	good manufacturing practice
HACCP	Hazard Analysis and Critical Control Point (system)
ICCAT	International Commission on Conservation of Atlantic Tuna
ICES	International Council for the Exploration of the Sea
IFFO	International Fishmeal and Fish Oil Organisation
FIN	Fishmeal Information Network
IUU	Illegal, unregistered and unreported (fishing)
MPA	marine protected area
MSC	Marine Stewardship Council
NGO	non-governmental organization
PCB	polychlorinated biphenol
PCDD	polychlorinated dibenzo-para dioxin
PCDF	polychlorinated dibenzofuran
POP	persistent organic pollutant
RFMO	regional fisheries management organization
RFO	regional fisheries organization
SCSA	GFCM's Sub-Committee on Stock Assessment
SDRS	sustainable development reference system
SFP	Sustainable Fisheries Partnership
TAC	total allowable catch
TSE	transmissible spongiform encephalopathy
TURF	territorial use rights in fisheries
UNCED	United Nations Conference on Environmental Development
UNCLOS	United Nations Convention on the Law of the Sea
UNFSA	United Nations Fish Stocks Agreement
WSSD	World Summit on Sustainable Development
WSSD-POI	World Summit on Sustainable Development Plan of Implementation
WWF	World Wide Fund for Nature

BACKGROUND

1. From ancient times, fishing from oceans, lakes and rivers has been a major source of food, and a provider of employment and other economic benefits for humanity. With increasing knowledge and the dynamic development of fisheries, it was realized that living aquatic resources, although renewable, were not infinite and needed to be properly managed if their contribution to the nutritional, economic and social well-being of the growing world's population was to be sustained.
2. For nearly three decades, because of the dramatic increase of pollution, illegal, unreported and unregulated fishing and other abusive fishing techniques worldwide, catches and landings have been shrinking and fish stocks declining, often at alarming rates.
3. Stock depletion has negative implications for food security and economic development and reduces social welfare, particularly in developing countries, where many people rely on fish as their main source of animal protein and income. Living aquatic resources need to be properly managed if their benefits to society are to be sustainable.
4. To maintain societal benefits, depleted stocks must be rebuilt and healthy stocks must be fished on a sustainable basis. Adoption of the United Nations Convention on the Law of the Sea, in 1982, provided the framework for improved management of marine resources.
5. Overexploitation of important fish stocks, modifications of ecosystems, significant economic losses, and international conflicts on management and fish trade still threaten the long-term sustainability of fisheries and the contribution of fisheries to food supply.
6. In light of this situation, FAO Member States have expressed the need to develop aquaculture as one of the ways with which to bridge the gap between capture fisheries output and the increasing world demand for fish and shellfish.
7. In the last three decades, aquaculture has grown rapidly and has developed into a globally robust and vital industry. However, aquaculture can have significant adverse environmental and social impacts.

8. Consequently, the Nineteenth Session of the FAO Committee on Fisheries (COFI), held in March 1991, recommended that new approaches to fisheries and aquaculture management embracing conservation and environmental, as well as social and economic considerations, were urgently needed. FAO was asked to develop the concept of responsible fisheries and elaborate a Code of Conduct to foster its application.

9. Subsequently, the Government of Mexico, in collaboration with FAO, organized an International Conference on Responsible Fishing in Cancún in May 1992. The Declaration of Cancún, endorsed at that Conference, was brought to the attention of the United Nations Conference on Environment and Development Summit in Rio de Janeiro, Brazil, in June 1992, which supported the preparation of a Code of Conduct for Responsible Fisheries (the Code). The FAO Technical Consultation on High Seas Fishing, held in September 1992, further recommended the elaboration of a code to address the issues regarding high seas fisheries.

10. The One Hundred and Second Session of the FAO Council, held in November 1992, discussed the elaboration of the Code, recommending that priority be given to high seas issues and requested that proposals for the Code be presented to the 1993 session of the COFI.

11. The Twentieth Session of the COFI, held in March 1993, examined in general the proposed framework and content for such a Code, including the elaboration of guidelines, and endorsed a time frame for the further elaboration of the Code. It also requested FAO to prepare, on a "fast track" basis, as part of the Code, proposals to prevent reflagging of fishing vessels which affect conservation and management measures on the high seas. This resulted in the FAO Conference, at its Twenty-seventh Session in November 1993, adopting the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, which, according to FAO Conference Resolution 15/93, forms an integral part of the Code. It was also recognized and confirmed that issues of responsible aquaculture development and aquaculture sustainability should be addressed in the formulation process so that these be appropriately covered in the envisaged Code.

12. The implicit recognition of the importance of governance in aquaculture is underlined in Article 9.1.1 of the Code, which requires States to "establish, maintain and develop an appropriate legal and administrative framework to facilitate the development of responsible aquaculture". In addition, at the beginning of the new millennium, there has been growing

recognition of the significant potential for the use of ocean and coastal waters for mariculture expansion. The outstanding issue in this area is that the existing applicable principles of public international law and treaty provisions provide little guidance on the conduct of aquaculture operations in these waters. Yet, experts agree that most of the future aquaculture expansion will occur in the seas and oceans, certainly further offshore, perhaps even as far as the high seas. The regulatory vacuum for aquaculture in the high seas would have to be addressed should aquaculture operations expand there.

13. The Code was formulated so as to be interpreted and applied in conformity with the relevant rules of international law, as reflected in the 10 December 1982 United Nations Convention on the Law of the Sea. The Code is also in line with the Agreement for the Implementation of the Provisions of this Law, namely the 1995 Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks. It is equally in line with, *inter alia*, the 1992 Declaration of Cancún and the 1992 Rio Declaration on Environment and Development, in particular Chapter 17 of Agenda 21.

14. The development of the Code was carried out by FAO in consultation and collaboration with relevant United Nations Agencies and other international organizations, including non-governmental organizations.

15. The Code consists of five introductory articles: Nature and scope; Objectives; Relationship with other international instruments; Implementation, monitoring and updating; and Special requirements of developing countries. These introductory articles are followed by an article on General principles, which precede the six thematic articles on Fisheries management, Fishing operations, Aquaculture development, Integration of fisheries into coastal area management, Post-harvest practices and trade, and Fisheries research. As already mentioned, the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas forms an integral part of the Code.

16. The Code is voluntary. However, certain parts of it are based on relevant rules of international law, as reflected in the United Nations Convention on the Law of the Sea of 10 December 1982. In capture fisheries, the Code also contains provisions that may be or have already been given binding effect by means of other obligatory legal instruments amongst the Parties, such as the Agreement to Promote Compliance with Conservation and Management Measures by Fishing Vessels on the High Seas, 1993. In aquaculture, the provisions of the Code implicitly encourage participatory governance of the sector, which extends from industry self-regulation, to

co-management of the sector by industry representatives and government regulators and to community partnerships. Compliance is self-imposed or enforced by peer pressure, with industry organizations having the ability to exclude those who do not comply coupled to periodic inspections by government regulators.

17. The Twenty-eighth Session of the Conference in Resolution 4/95 adopted the Code of Conduct for Responsible Fisheries on 31 October 1995. The same Resolution requested FAO *inter alia* to elaborate appropriate technical guidelines in support of the implementation of the Code in collaboration with Members and interested relevant organizations.

18. The expanding role and increasing contribution of aquaculture to economic growth, social welfare as well as global food security was recognized and reiterated at international levels such as the 1995 FAO/Japan Conference on the Contribution of Fisheries and Aquaculture to Food Security, the 1996 World Food Summit, the 1999 Ministerial Meeting on Fisheries, the 2000 FAO/NACA (Network of Aquaculture Centres in Asia and the Pacific) Conference on Aquaculture in the Third Millennium and its Bangkok Declaration and Strategy, and most recently, the 2009 World Summit on Food Security.

19. The application of the ecosystem approach to fisheries and aquaculture as strategies for the development of the sector contributes to the implementation of the provisions of the Code, thereby enforcing the technical, ecological, economic and social sustainability of the industry.

CONTENTS

Preparation of this document	iii
Abstract	iv
Abbreviations and acronyms	vii
Background	ix
 1. INTRODUCTION	 1
1.1 Statement of purpose	1
1.2 Structure and content of this document	1
1.3 Terms and definitions	2
 2. OVERVIEW OF THE USE OF WILD FISH AS FEED IN AQUACULTURE AND RELATED ISSUES	 13
2.1 Use of fish in feeds	13
2.2 The issues	16
2.3 Sustainability of fish stocks	17
2.4 Food security and livelihoods and low-value/bycatch fish	18
 3. EXISTING GUIDELINES ON FISHERIES MANAGEMENT AND INITIATIVES TO IMPROVE SUSTAINABLE MANAGEMENT OF FISH STOCK RESOURCES	 21
3.1 Technical guidelines on fisheries management	21
 4. PRINCIPLES AND TECHNICAL GUIDELINES ON THE USE OF WILD FISH AS FEED IN AQUACULTURE	 23
4.1 Principles governing the use of wild fish as feed in aquaculture	23
4.1.1 Fisheries management considerations	23
4.1.2 Ecosystem and environmental impacts	25
4.1.3 Ethical issues and responsible use	26
4.1.4 Aquaculture technology and development	32
4.1.5 Statistics and information needs for management	38
 REFERENCES	 41
 ANNEXES	
1. Technical guidelines on fisheries management	51
2. Technical guidelines on the ecosystem approach to fisheries	55
3. Precautionary approach	63

4.	Initiatives to improve sustainable management of fish stock resources	67
5.	Initiatives to develop sustainability standards for aquaculture feeds	75
6.	Initiatives by retailers, processors and feed manufacturers	79

1. INTRODUCTION

These technical guidelines on the use of wild fish as feed in aquaculture have been developed to support Articles 7 and 9, in particular Articles 9.1.3¹, 9.1.4² and 9.4.3³ of the FAO's Code of Conduct for Responsible Fisheries (CCRF). The objective of these guidelines is to provide assistance in ensuring the orderly and sustainable development of aquaculture and the equitable and sustainable use of wild fish stocks.

1.1 Statement of purpose

The purpose of the technical guidelines is to provide guidance on the responsible use of wild fish as feed in aquaculture. The guidelines consider a range of issues that are relevant for the use of wild fish as feed in aquaculture, including: a) fisheries management; b) policy development; c) food security; d) poverty alleviation; e) social and ethical issues; and f) aquaculture technology and development. There are extensive national and international management frameworks already in place for various aspects of fisheries management. These cover issues such as the ecosystem approach to fisheries (EAF), initiatives on improved sustainable management of feed-fish stocks, and development of indicators to measure the sustainability of feed-fish fisheries and to avoid duplication; thus, these are not considered here. Where appropriate, these guidelines will refer to the relevant articles of the CCRF that cover fisheries management.

Implementation of the technical guidelines may be undertaken by any entity that is competent or has the responsibility to do so. These may include, *inter alia*, governments, non-governmental organizations (NGOs), private-sector groups (e.g. producers, feed manufacturers, processors, traders, farmers and professional associations), civil society and consortia comprising some or all of these stakeholder groups.

1.2 Structure and content of this document

The guiding principles used in this document were developed at the FAO Expert Workshop on "Use of Wild Fish and/or Other Aquatic Species as Feed

¹ CCRF Article 9.1.3: States should produce and regularly update aquaculture development strategies and plans, as required, to ensure that aquaculture development is ecologically sustainable and to allow the rational use of resources shared by aquaculture and other activities.

² CCRF Article 9.1.4: States should ensure that the livelihoods of local communities, and their access to fishing grounds, are not negatively affected by aquaculture developments.

³ CCRF Article 9.4.3: States should promote efforts which improve selection and use of appropriate feeds, feed additives and fertilizers, including manures.

in Aquaculture and its Implications to Food Security and Poverty Alleviation”, 16–18 November 2007, Kochi, India.

The guiding principles are arranged under five key issues as identified in the workshop: a) fisheries management considerations, b) ecosystem and environmental impacts, c) ethical issues and responsible use, d) aquaculture technology and development, and e) statistics and information needs for management. Each guiding principle is supported by an introductory explanation followed by a suite of technical guidelines for the implementation of and compliance with the principle.

1.3 Terms and definitions

For the purpose of these technical guidelines on the “Use of Wild Fish as Feed in Aquaculture”, the following terms and definitions apply:

Aquaculture: The farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated (FAO, 1997a). Also defined as the farming of aquatic organisms in inland and coastal areas, involving intervention in the rearing process to enhance production and the individual or corporate ownership of the stock being cultivated (FAO Glossary of Aquaculture, available at: www.fao.org/fi/glossary/aquaculture/).

Aquatic animals: All life stages (including eggs and gametes) of fish, molluscs, crustaceans and amphibians originating from aquaculture establishments or removed from the wild for farming purposes, for release into the environment, for human consumption or for ornamental purposes (OIE, 2010).

Artisanal fisheries: Traditional fisheries involving fishing households (as opposed to commercial companies), using relatively small amounts of capital and energy, relatively small fishing vessels (if any), making short fishing trips, close to shore, mainly for local consumption. In practice, definition varies between countries, e.g. from gleaning or a one-person canoe in poor developing countries, to trawlers, seiners, or long-liners longer than 20 m in developed ones. Artisanal fisheries can be subsistence or commercial fisheries, providing for local consumption or export. Artisanal fisheries are sometimes referred to as small-scale fisheries (FAO Fisheries Glossary, available at: www.fao.org/fi/glossary/default.asp).

Bait fish: Bait fish is a term used for small fish that are used as bait to catch larger fish or alternatively bait fish are small fish that attract larger predators. Other definition: live fish (e.g. minnows, tilapia, goldfish) that are produced commercially in aquaculture to be used as live bait.

Best/better management practices (BMPs): Management practices aimed at improving the quantity, safety and quality of products taking into consideration animal health and welfare, food safety, environmental and socio-economical sustainability. BMP implementation is generally voluntary. The term “better” is preferred rather than “best” because aquaculture practices are continuously improving (today’s “best” is tomorrow’s “norm”) (FAO, 2010d).

Biological diversity or biodiversity: The variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. Diversity indices are measures of richness (the number of species in a system); and to some extent, evenness (variances of species’ local abundance). They are therefore indifferent to species substitutions, which, however, may reflect ecosystem stresses (such as those due to high fishing intensity) (FAO, 1997b). Also defined as the variability among living organisms from all sources, including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part (CBD, 1992).

Biosecurity: Broadly speaking, “biosecurity” in food and agriculture describes the concept and process of managing – in a holistic manner – biological risks associated with food and agriculture (in the broadest sense, i.e. including agronomy, livestock husbandry, forestry, fisheries and related environmental aspects). This usage also implies that transboundary movements or the use of novel genotypes are involved in some way (Cock, 2003).

Bycatch: Part of a catch of a fishing unit taken incidentally in addition to the target species towards which fishing effort is directed. Some or all of it may be returned to the sea as discards, usually dead or dying (FAO Fisheries Glossary, available at: www.fao.org/fi/glossary/default.asp).⁴

⁴ It is not possible to develop a standard international definition of bycatch because of the very diverse nature of the world’s fisheries, historical differences in how bycatch has been defined nationally, ambiguities associated with bycatch-related terminologies, and choices of individual fishers on how different portions of their catch will be used (FAO, 2011).

Certification: Procedure by which an official certification body or officially recognized certification body gives written or equivalent assurance that a product, process or service conforms to specified requirements. Certification may be, as appropriate, based on a range of audit activities that may include continuous audit in the production chain (FAO, 2005a). Also defined as procedure by which accredited certification bodies, based on an audit, provide written or equivalent assurance that food safety management systems and their implementation conform to requirements (GFSI, 2007).

Commercial/industrial aquafeed: An aquafeed comprised of a number of ingredients that are mixed in various proportions to complement one another to form a nutritionally complete compound diet. Such feeds are manufactured in industrial feed milling plants and are distributed and sold using conventional market chains. Commercial aquafeeds are commonly produced in different forms: compressed sinking pellet, extruded floating pellet or crumble, extruded soft pellet (FAO, 2010c).

Complete feed: A nutritionally adequate feed for animals other than humans; by specific formula is compounded to be fed as the sole ration and is capable of maintaining life and/or promoting production without any additional substance being consumed except water (FAO, 2001).

Compound feed: A mixture of products of vegetable or animal origin in their natural state, fresh or preserved, or products derived from the industrial processing thereof, or organic or inorganic substances, whether or not containing additives, for oral feeding in the form of a complete feed (FAO, 2001).

Conservation: The management of human use of the biosphere so that it may yield the greatest sustainable benefit to current generations while maintaining its potential to meet the needs and aspirations of future generations; thus, conservation is positive, embracing preservation, maintenance, sustainable utilization, restoration and enhancement of the natural environment (WRI, 1992).

Crumbled, crumbling (process): Pellets reduced to granular form (FAO, 2001).

Diet: Feed ingredients or a mixture of ingredients including water that is consumed by animals (FAO, 2001).

Discards: That component of a catch thrown back after capture. Normally, most of the discards can be assumed not to survive (FAO, 1997b).

Ecolabel: A seal of approval (or certification) of a product, process or service complying with a particular set of agreed environmental criteria, usually awarded by an impartial third party (certification body). In fisheries, the label informs on the quality of the product itself as well as on the production and management processes (FAO, 2003).

Ecolabelling: A voluntary method of certification of environmental quality (of a product) and/or environmental performance of a process based on lifecycle considerations and agreed sets of criteria and standards (FAO, 2003).

Ecosystem: An organizational unit consisting of an aggregation of plants, animals (including humans) and micro-organisms, along with the non-living components of the environment (FAO, 2003).

Extrusion (process): A process by which feed has been pressed, pushed or protruded through orifices under pressure (FAO, 2001).

Farm-made aquafeed: Typically a feed that is produced by farmers or small-scale feed manufacturers using some form of processing on farm or in a small processing plant, resulting in a moist dough or a simple moist or dry pellet. Farm-made aquafeed produced by the farmers is often synonymously termed “home-made aquafeed”. Also defined as fish feed made by farmers as well as small- and medium-scale feed manufacturers (Hasan *et al.*, 2007).

Feed(s): Edible material(s) that are consumed by animals and contribute energy and/or nutrients to the animals' diet. Usually refers to animals rather than humans (FAO, 2001).

Feed additives: Chemicals, other than nutrients, that are required by the fish and that are approved for addition to their feed (FAO/WHO, 2009). Also defined as an ingredient or combination of ingredients added to the basic feed mix or parts thereof to fulfil a specific need. Usually used in micro quantities and requiring careful handling and mixing (FAO, 2001).

Feed conversion ratio (FCR): Ratio between the dry weight of feed fed and the weight of yield gain. Measure of the efficiency of conversion of feed to fish (e.g. $FCR = 2.8$ means that 2.8 kg of feed is needed to produce 1 kg of fish live weight). (FAO Glossary of Aquaculture, available at: www.fao.org/fi/glossary/aquaculture/default.asp). Two additional terms are used by the farmer, the biological FCR and the economic FCR. Biological FCR is the net amount of feed used to produce 1 kg of fish, while the economic FCR takes into account all the feed used, including losses through wastage and fish