

# Study and analysis of feeds and fertilizers for sustainable aquaculture development



**Cover photographs:**

*Left top to bottom:* Automatic silo feeders used in the intensive culture of tilapia in concrete tanks in Malaysia (courtesy of INFOFISH-Tarlochan Singh). Feeding semi-moist, farm-made feed to pangasiid catfish in ponds, Viet Nam (courtesy of L.T. Thanh Truc). Manual feeding of cultured fish at Barsiq Fish Farm, Behaira, Egypt (courtesy of Abdel-Fattah M. El-Sayed).

*Right:* Harvest of Indian major (catla, rohu and mrigal) and exotic (silver, grass and common) carps from a polyculture pond, Punjab, India (courtesy of Abhijit Paul).

# Study and analysis of feeds and fertilizers for sustainable aquaculture development

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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's (FIMA) on-going programme entity "Monitoring, Management and Conservation of Resources for Aquaculture Development". A number of country reviews and case studies from Asia, Africa and a regional review for Latin America were commissioned to provide an overview of aquaculture and an analysis of feed and fertilizer use for the sustainable development of the sector. To reflect the diversity of aquaculture systems and practices in these regions seven countries were selected from Asia (Bangladesh, China, India, Indonesia, the Philippines, Thailand and Viet Nam), six from Latin America (Brazil, Chile, Cuba, Ecuador, Mexico and the Bolivarian Republic of Venezuela) and eight from Africa (Cameroon, Egypt, Ghana, Kenya, Malawi, Nigeria, Uganda and Zambia). The country reviews for Asia and sub-Saharan Africa were synthesized, and a global synthesis was prepared on the basis of the three regional reviews (Asia, Latin America and sub-Saharan Africa). In addition and as part of the FIMA work programme, a targeted workshop on "Use of feeds and fertilizers for sustainable aquaculture development" was held in Wuxi, Jiangsu Province, China, on 18-21 March 2006. The workshop was organized by FIMA of FAO in collaboration with the Freshwater Fisheries Research Centre (FFRC) of China and the Network of Aquaculture Centres in Asia-Pacific (NACA).

Eight Asian and six African country reviews, a case study from Viet Nam, the three regional reviews and the global synthesis and the report of the workshop are included in this document. The report and recommendations of the workshop were circulated among the participants of the workshop and FAO FIMA technical officers for comment and the final report is incorporated in this technical paper.

The manuscripts in this technical paper were reviewed and technically edited by an editorial team led by Dr Mohammad R. Hasan. With a few exceptions, most of the reports included in the document were reviewed and edited in early 2007 before the FAO FishStat data for 2005 was released and hence data contained in most of the reports are for 2004. Updated aquaculture data for 2005 are available on FishStat (2007) ([www.fao.org/fi/statist/FISOFT/FISHPLUS.asp](http://www.fao.org/fi/statist/FISOFT/FISHPLUS.asp)). For consistency and conformity, scientific and English common names of fish species were used from FishBase (<http://www.fishbase.org/home.htm>). Most of the photographs in the country reviews and in the regional syntheses were provided by the authors. Where this is not the case, due acknowledgements are made to the contributors.

Much gratitude is due to the review and case study authors, who faced an enormous task and showed equally enormous patience with the editors. We acknowledge Ms Helen Nakouzi, Ms Hasini Wijesuriya, Ms Elena Irde and Ms Marika Panzironi for their assistance in word processing, Ms Tina Farmer, Ms Françoise Schatto and Ms Chrissi Smith-Redfern for their assistance in quality control and FAO house style and Mr José Luis Castilla Civit for layout design. The publishing and distribution of the document were undertaken by FAO, Rome.

Finally, Mr Jiansan Jia, Service Chief and Dr Rohana P. Subasinghe, Senior Fishery Resources Officer (Aquaculture), FAO Aquaculture Management and Conservation Service are gratefully acknowledged for providing the means, technical advice and moral support to initiate the study and to complete the publication.

# Abstract

This compendium provides a comprehensive overview of feed and fertilizer use for sustainable aquaculture development in developing countries. It comprises of a series of review papers, including eight country reviews from Asia (Bangladesh, China, India, Indonesia, the Philippines, Thailand and Viet Nam), six country reviews from Africa (Cameroon, Egypt, Kenya, Malawi, Nigeria and Uganda), one case study report from Asia, three regional reviews (Asia, Latin America and sub-Saharan Africa), a global synthesis as well as the final report of the FAO Expert Workshop on “Use of feeds and fertilizers for sustainable aquaculture development”, held in Wuxi, Jiangsu Province, China, on 18-21 March 2006.

The country reviews provide an overview of the current status of aquaculture, a synthesis of the availability, accessibility and use of feed and fertilizer resources in relation to the diversity of farming systems and practices and an analysis of the nutritional, economic and social constraints of using these inputs. The regional reviews provide a synthesis of the country reviews by considering production trends and feed and fertilizer use from a wider geographic perspective and also analysed the projected expansion of the aquaculture sector in relation to the future availability of input commodities. The global synthesis provides a general overview and summarizes the future challenges facing the sector with respect to the use of feeds and fertilizers. The reviews as well as the case study reports provided the background information for the working group sessions of the workshop.

The working groups focused on the important role of farm-made aquafeeds in Asia and the need to develop and promote the use of farm-made feeds in sub-Saharan Africa, considered issues pertaining to the production and safe use of aquafeeds and deliberated on the constraints faced by industrial and small-scale aquafeed producers. Several key issues and constraints were identified, categorized and prioritized and appropriate actions were recommended. The workshop recommended that FAO undertake the following actions to assist regional organizations and member country governments to address the following identified issues and constraints on a regional and global perspective:

- review existing national standards and legislation regarding nutrient specifications (where these exist) for the manufacture of industrial and farm-made aquafeeds, and to provide guidelines and advisory material for different farming systems, practices and feed types;
- review existing national incentive mechanisms, subsidies and taxes affecting the animal feed manufacturing sector and feed ingredient usage, including feed commodity imports and exports and developing domestic promotion strategies;
- compile synopses of the nutritional requirements of major cultured fish species and the feed ingredients currently used in compound/farm-made aquafeeds, including national/regional feed ingredient source books containing information on nutrient composition, quality control criteria, seasonal availability and market price;
- encourage the strengthening of national/regional dialogue, exchange of information and assist with the setting of research priorities between researchers, the public sector and the aquaculture sector (including farmers and feed manufacturers), by supporting the activities of national/regional organizations, implementation of joint research projects, establishment of national farmer/aquafeed associations, and the development of web-based information and research networks; and

- strengthen capacity of farmers, feed manufacturers, private service providers, researchers and extension workers in aquaculture nutrition and feed technology, including on-farm feed management in developing countries (particularly in sub-Saharan Africa), and promote interregional cooperation.

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# Contents

Preparation of this document	iii
Abstract	iv
Contributors	ix
Foreword	xi
Executive summary	xiii
Abbreviations and acronyms	xvi
<b>GLOBAL SYNTHESIS AND REGIONAL REVIEWS</b>	<b>1</b>
<b>Global synthesis of feeds and nutrients for sustainable aquaculture development</b>	<b>3</b>
ALBERT G.J. TACON AND MOHAMMAD R. HASAN	
<b>Feeds and fertilizers: the key to long-term sustainability of Asian aquaculture</b>	<b>19</b>
SENA S. DE SILVA AND MOHAMMAD R. HASAN	
<b>Feeds and fertilizers for sustainable aquaculture development: a regional review for Latin America</b>	<b>49</b>
A. FLORES-NAVA	
<b>Review of feeds and fertilizers for sustainable aquaculture development in sub-Saharan Africa</b>	<b>77</b>
THOMAS HECHT	
<b>COUNTRY REVIEWS AND CASE STUDY: ASIA</b>	<b>111</b>
<b>Analysis of feeds and fertilizers for sustainable aquaculture development in Bangladesh</b>	<b>113</b>
BENOY K. BARMAN AND MANJURUL KARIM	
<b>Analysis of feeds and fertilizers for sustainable aquaculture development in China</b>	<b>141</b>
M. WEIMIN AND L. MENGQING	
<b>Analysis of feeds and fertilizers for sustainable aquaculture development in India</b>	<b>191</b>
S. AYYAPPAN AND S. AHAMAD ALI	
<b>Development of the aquafeed industry in India</b>	<b>221</b>
A. VICTOR SURESH	
<b>Analysis of feeds and fertilizers for sustainable aquaculture development in Indonesia</b>	<b>245</b>
ABIDIN NUR	
<b>Analysis of feeds and fertilizers for sustainable aquaculture development in the Philippines</b>	<b>269</b>
NEILA S. SUMAGAYSAY-CHAVOSO	
<b>Analysis of feeds and fertilizers for sustainable aquaculture development in Thailand</b>	<b>309</b>
S. THONGROD	
<b>Analysis of feeds and fertilizers for sustainable aquaculture development in Viet Nam</b>	<b>331</b>
LE THANH HUNG AND HUYNH PHAM VIET HUY	

<b>Case study on the use of farm-made feeds and commercially formulated pellets for pangasiid catfish culture in the Mekong Delta, Viet Nam</b> LE THANH HUNG, LUU THI THANH TRUC AND HUYNH PHAM VIET HUY	<b>363</b>
<b>COUNTRY REVIEWS: AFRICA</b>	<b>379</b>
<b>Analysis of feeds and fertilizers for sustainable aquaculture development in Cameroon</b> VICTOR POUOMOGNE	<b>381</b>
<b>Analysis of feeds and fertilizers for sustainable aquaculture development in Egypt</b> ABDEL-FATTAH M. EL-SAYED	<b>401</b>
<b>Analysis of feeds and fertilizers for sustainable aquaculture development in Kenya</b> BEATRICE NYANDAT	<b>423</b>
<b>Analysis of feeds and fertilizers for sustainable aquaculture development in Malawi</b> S.K. CHIMATIRO AND B.B. CHIRWA	<b>437</b>
<b>Analysis of feeds and fertilizers for sustainable aquaculture development in Nigeria</b> OLAJIDE A. AYINLA	<b>453</b>
<b>Analysis of feeds and fertilizers for sustainable aquaculture development in Uganda</b> J. RUTAISIRE	<b>471</b>
<b>WORKSHOP REPORT</b>	<b>489</b>

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# Foreword

Aquaculture has shown significant growth over the last three decades and it is anticipated that global aquaculture production will continue to increase. Total global fish production in 2005 was 157.53 million tonnes, of which aquaculture contributed about 40.0 percent (FAO, 2007)<sup>1</sup>. The average annual growth rate (APR) of the aquaculture sector during the period 1990 and 2004 was 9.4 percent per year. Aquaculture has been the fastest growing food production sector in many countries of the world for the last two decades, while capture fisheries have experienced a declining trend. Aquaculture has therefore, contributed significantly to food security and poverty alleviation in different parts of the world in parallel with the development of profit-oriented entrepreneurship.

In intensive aquaculture feed accounts for 60-80 percent of operational cost, while in semi-intensive aquaculture systems feed and fertilizers account for about 40-60 percent of production costs. Feeds and fertilizers will continue to dominate aquaculture needs. The importance of feed in aquaculture is further emphasized by the fact that about 28.2 million tonnes (44.8 percent) of total global aquaculture production in 2005 was dependent on single dietary ingredients, farm-made aquafeeds and industrially manufactured aquafeeds (FAO, 2007). In 2006, approximately 25.4 million tonnes of compound aquafeed was produced (Gill, 2007)<sup>2</sup> and used mainly for the production of non-filter feeding carps, marine shrimp, salmon, marine finfish, tilapia, trout, catfish, freshwater crustaceans, milkfish and eels (Tacon, Hasan and Subasinghe, 2006)<sup>3</sup>.

It is estimated that in 2006 the aquaculture sector consumed about 3.06 million tonnes (56.0 percent) of world fishmeal production and 0.78 million tonnes (87.0 percent) of total fish oil production (Tacon, 2007)<sup>4</sup>, while aquaculture's share of global industrial feed output was only four percent (Gill, 2007). In addition to fishmeal and fish oil, low value fish or 'trash fish' is used in many parts of the world as a complete or supplementary feed for farmed fish, crustaceans and a few mollusc species. It is estimated that approximately 5 to 6 million tonnes of low value/trash fish is used as direct feed in aquaculture (Tacon Hasan and Subasinghe, 2006).

Considering the dependency of carnivorous finfish and shrimp aquaculture on finite marine resources, it is unlikely that this sector will show major expansion in the near future, unless significant breakthroughs are made on the efficient use of alternatives to fishmeal and fish oil. It is anticipated that the production of freshwater finfish and crustacean low on the food chain will be the major contributors to global aquaculture production in future. Much of the expansion is likely to take place in semi-intensive farming systems and feed and fertilizer availability and accessibility will be the major limiting factors to achieving regional and global production targets.

To address these issues the Aquaculture Management and Conservation Service (FIMA) of the FAO Fisheries and Aquaculture Department initiated a work programme

<sup>1</sup> FAO. 2007. FAO Fisheries Department, Fishery Information, Data and Statistics Unit. Fishstat Plus: Universal software for fishery statistical time series. Aquaculture production: quantities 1950-2005; Aquaculture production: values 1984-2005; Capture production: 1950-2005; Commodities production and trade: 1950-2005; Total production: 1970-2005, Vers. 2.30 (available at [www.fao.org/fi/statist/FISOFT/FISHPLUS.asp](http://www.fao.org/fi/statist/FISOFT/FISHPLUS.asp))

<sup>2</sup> Gill, C., 2007. World feed panorama: bigger cities, more feed. *Feed International*, 28 (1): 5-9.

<sup>3</sup> Tacon, A.G.J., Hasan, M.R. and Subasinghe, R.P., 2006. Use of fishery resources as feed inputs for aquaculture development: trends and policy implications. *FAO Fisheries Circular*. No. 1018. Rome, FAO. 99 pp.

<sup>4</sup> 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.

entitled “Study and analysis of feeds and nutrients (including fertilizers) for sustainable aquaculture development”. After reviewing the existing status of aquaculture in relation to feeds and fertilizers and based on the recommendations made by COFI Sub-committee on Aquaculture (Beijing, Peoples’ Republic of China and Trondheim, Norway<sup>5</sup>), the following key issues were prioritized and undertaken: a) an analysis of the status and trends in aquaculture production (with particular reference to fish and crustacean species that are dependent on feeds) and b) analyses of issues, trends and challenges in feed and fertilizer resource use for sustainable aquaculture development in developing countries in Asia, Africa and Latin America. The work programme is executed by FIMA in close collaboration with the FAO regional and sub-regional offices and in consultation with Regional Organization (e.g. NACA), government Department of Fisheries, Universities and National Research Institutions of FAO member countries.

To broaden the horizon of the consultative process and to review and analyze critical issues related to the use of feeds and fertilizers for sustainable aquaculture development, a targeted workshop on “Use of feeds and fertilizers for sustainable aquaculture development” was organized in Wuxi, Jiangsu Province, China on 18-21 March 2006 in collaboration with the Freshwater Fisheries Research Centre (FFRC) of China and the Network of Aquaculture Centres in Asia-Pacific (NACA). The workshop combined technical presentations and working group discussions. A number of country reviews from Asia and Africa, case studies, three regional syntheses (Asia, Africa and Latin America) and a global synthesis were commissioned prior to the workshop and selected reviews, case studies, syntheses were presented at the workshop. The workshop brought together 21 experts in the field of aquaculture nutrition and aquafeeds, including the authors of the country reviews, case studies, regional and global syntheses and experts from FAO, FFRC and NACA. The workshop identified several key issues and constraints in relation to the use of feeds and fertilizers for sustainable aquaculture development and recommended appropriate actions to address these issues and constraints.

This technical paper presents the report of the workshop, a summary of the working group discussions and the recommendations made by the workshop, the country reviews, case study reports as well as the regional and global syntheses. It is anticipated that the identified key issues and recommendations will assist policy makers on a regional and global level to promote improved aquaculture practices and farming systems through optimal use of feed and fertilizer resources and that this will help FAO member countries to implement the provisions of the Code of Conduct for Responsible Fisheries.



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<sup>5</sup> FAO, 2003. Report of the Second Session of the Sub-Committee on Aquaculture. Trondheim, Norway, 7–11 August 2003. *FAO Fisheries Report*. No. 716. Rome, FAO. 91 pp.

## Executive summary

For the last two decades aquaculture has been the fastest growing food production sector in many countries of the world and has contributed significantly to food security and poverty alleviation in different parts of the world in parallel with the development of profit-oriented entrepreneurship. The global average annual growth rate of the sector during the period 1990 and 2004 was 9.4 percent per year, while capture fisheries have experienced a declining trend.

Aquaculture in Asia, Latin America and Africa is growing rapidly and this presents significant growth opportunities for the aquafeed sector. Except for salmon in Chile, warm- freshwater, omnivorous fish contribute the bulk of aquaculture production in these regions. There are notable differences among the three continents in terms of production and the use of aquafeeds and each region has its own set of priorities for developing the aquafeed sector. In Asia, farm-made aquafeeds play a dominant role in fish production, although intensification of farming practices is driving the growth of the industrial aquafeed sector. In Latin America, industrial aquafeeds are widely used in most production systems. In sub-Saharan Africa, where aquaculture production is small, but actively growing, on-farm feed manufacturing by small- and medium-scale entrepreneurs is beginning to play an important role in aquaculture development. Understanding these differences and setting of priorities are critical to the future development of the aquafeed sector, particularly in the tropics.

Asia accounted for 92.1 percent of global aquaculture production in 2005 (57.97 million tonnes), to which China contributed 74.6 percent. Nine other countries contributed 22.7 percent. Aquaculture in Asia is primarily rural and pond-based semi-intensive farming of species low on the food chain, with the exception of shrimp and some freshwater and marine carnivorous species. Farm-made feeds are used throughout the region primarily for semi-intensive farming while nutritionally-complete, industrially manufactured feeds are used for intensive farming of high-value species.

In the seven major Asian aquaculture producing countries (China, India, Indonesia, the Philippines, Viet Nam, Thailand and Bangladesh) an estimated 19.33 million tonnes of farm-made feed and 10.30 million tonnes of industrial aquafeeds were used in 2003-04. It is predicted that feed usage over the next five years will increase to 30.73 million tonnes and 22.24 million tonnes for farm-made and industrial aquafeeds, respectively, representing a growth of 60 and 107 percent from current levels. The current and continuing importance of farm-made feeds in Asian aquaculture calls for increased efficiency in the production and use of farm-made feeds.

Increased production of high-value aquatic species and intensification of existing culture practices of freshwater finfish, has contributed significantly to the increased production and utilization of industrial aquafeed in the region. To sustain the predicted increase in the use of aquafeeds requires a concerted regional research and development initiative, improvements in production technology and feeding practices. In particular these initiatives should focus on the use of fishmeal and soybean meal. It is pertinent to note that the demand and use of fishmeal in some of the emerging aquaculture countries in Asia is increasing rapidly. For example, Viet Nam already uses approximately 62 500 tonnes of fishmeal per year, solely for aquaculture. Further, in 2004 China alone imported an estimated 20.2 million tonnes of soybean, accounting for over one third of world soybean imports. Intensification of aquaculture in Asia is likely to further increase fishmeal usage with China being a decisive factor with respect to supply and demand. The search for suitable and cost-effective alternative protein sources for use

in industrial aquafeeds will be the most critical factor in the development of intensive aquaculture in Asia.

Aquaculture in Latin America is dominated by Chile and Brazil (50.9 percent and 18.4 percent of Latin American production in 2005). The balance (30.7 percent) was produced by 30 other countries. On the species-group level, salmonids (primarily Atlantic salmon, *Salmo salar*), shrimp (Pacific white shrimp, *Litopenaeus vannamei*), and tilapia accounted for about 77 percent of regional aquaculture production. Freshwater aquaculture species includes tilapia (*Oreochromis* spp.), catfish, carps (common and Chinese carps), rainbow trout and a number of native species, such as tambaqui (*Colossoma macropomum*), and pacú (*Piaractus mesopotanicus*). Of these species, tilapia shows the highest growth rate in production with an annual average increase of 15.7 percent between 1999 and 2002 followed by other species such as tambaqui, and Pacú. The industry in the region is generally well developed, with production almost exclusively realized through semi-intensive and intensive farming systems.

Industrially manufactured feeds are readily available in most countries. Large feed manufacturers in Chile, Brazil, Mexico, Costa Rica and Colombia produce salmon, shrimp, tilapia and trout feeds. Farm-made feeds are rarely used in the region except in localized areas in selected countries where a small number of small-scale farmers occasionally utilize some agricultural by-products to replace or complement formulated complete diets. Opportunities to integrate aquaculture into the traditional agricultural systems by small-scale farmers is constrained by the high cost of formulated feeds, and the lack of knowledge on the use of locally available ingredients to produce low cost, farm-made aquafeeds.

The aquafeed industry in Latin America is largely dependent on conventional sources of protein and fishmeal and fish oil continue to be the core dietary protein and lipid sources, respectively. Other major protein sources include a number of ingredients such as soybean meal, maize gluten meal and rendered animal byproducts. A wide range of other agri-industrial by-products and other potential nutrient sources are readily available in countries like Brazil, Ecuador and Mexico, but their use in aquafeeds is constrained by limited research.

Total production in Africa in 2005 was estimated to be 656 370 tonnes, to which Egypt alone contributed about 82.2 percent. Sub-Saharan Africa accounted for 16.8 percent of the total African production. Aquaculture in sub-Saharan Africa (SSA) is dominated by Nigeria contributing about 51.5 percent, while the other nine top producers contributed about 41.0 percent of SSA production. Between 1999 and 2005, overall production in SSA increased by 99 percent from 54 997 tonnes to 109 446 tonnes. However, aquaculture in SSA is widely dichotomous: more than 70 percent of the regional total production is produced on commercial farms by less than 20 percent of farmers, while less than 30 percent is produced by small-scale subsistence farmers that comprise over 80 percent of all farmers. The systems used by the commercial sector range from semi-intensive to intensive pond, cage and tank culture of catfish (*Clarias* spp.) and tilapia (*Oreochromis* spp.) and high-value products such as shrimp (Madagascar and Mozambique) and abalone (South Africa) while non-commercial subsistence aquaculture primarily consists of small-scale pond culture of tilapia, catfish and common carp (*Cyprinus carpio*).

Large-scale commercial aquaculture is primarily dependent on industrially manufactured feeds. The feeds are either produced within country or imported. In most SSA countries, conventional aquafeed formulations rely heavily on imported fishmeal to provide much of the dietary protein. The price of fishmeal coupled with high import tariffs and taxes in most countries will affect the development of the aquafeed industry in and the development of the sector in the region as a whole. The situation therefore warrants careful evaluation of alternative, locally available protein sources of animal origin, as well as greater and improved use of agricultural by-products in aquafeed formulations.

Farm-made feeds are manufactured by individual farmers as well as small and medium-scale entrepreneurs. In some countries this is a rapidly emerging manufacturing sector and the technologies employed by these entrepreneurs are simple and the feed is generally affordable but has a limited shelf life. Country reviews of seven selected countries (Cameroon, Ghana, Kenya, Malawi, Nigeria, Uganda and Zambia) of SSA revealed that approximately 12 000 tonnes of industrial feeds were produced in 2005 contributing to a maximum of 15.6 percent of total fish production, while the production of farm-made aquafeeds produced by medium- and small-scale entrepreneurs as well as by farmers during the same period was 98 500 tonnes. The growth of the small-scale sector in the region is constrained principally by an inadequate knowledge base on the use of farm-made feeds. In addition, small-scale farmers are constrained by the availability of animal manure because of the free range nature of animal husbandry, and the cost of inorganic fertilizers. There is not much that can be done about the latter and hence there is a need to focus on farm-made feeds.

Already there is a substantial body of regional knowledge of the allowable inclusion levels for many locally available and on-farm feed ingredients but little has been done to evaluate these data with respect to farm economics and to translate the findings into practice. Further, information on appropriate feed mixes and preparation techniques for farm-made aquafeed, subregional databanks on seasonal availability of agricultural commodities and a suitable mechanism to disseminate this information are lacking. These needs must be addressed if the region is to realize its potential and production capacity. A greater degree of regional cooperation between Asia and Africa has been identified as one of the mechanisms to address these needs.

There are several pivotal issues related to feed and fertilizers that the aquaculture industry in Asia, sub-Saharan Africa and Latin America will have to address in the next few years. These are:

- reduced accessibility resulting from increasing costs of fishmeal and other conventional protein sources;
- tougher environmental protection measures, and stringent food safety requirements and quality standard imposed by local governments, regional and international agreements, consumer groups and importers;
- mono- and oligopoly of feed industries resulting in regionalization of markets, reduction of local competition and consequently restricting types, and quality of products, particularly in Latin American countries;
- assurance of national quality standards for raw materials, feed additives and feeds;
- safe and appropriate use of aquafeeds produced by small-scale manufacturers and support to improve their production technology; and
- development of on-farm feeding strategies and practices for improved utilization of agricultural and terrestrial by-products and capacity building of small-scale farmers to make more effective farm-made feeds.

These issues will have a profound impact on the future development of the aquaculture sector on the three continents and must be addressed if sustainable development is to be ensured.

## Abbreviations and acronyms

AARM	Aquaculture and Aquatic Resources Programme, AIT, Thailand
ADB	Asian Development Bank
ADiM	Aquaculture Development in Malawi
AFMA	Animal Feed Manufacturing Association of South Africa
AFSD-BAI	Animal Feed Standard Division-Bureau of Animal Industry (Philippines)
AIFP	Aquaculture and Inland Fisheries Project (Nigeria)
AIT	Asian Institute of Technology
APR	Average Percent growth Rate
ASA	American Soybean Association
ASEAN	Association of Southeast Asian Nations
BAI	Bureau of Animal Industry (Philippines)
BAS	Bureau of Agricultural Research (Philippines)
BBS	Bangladesh Bureau of Statistics
BCA	Bangladesh Census for Agriculture
BDT	Bangladesh Taka (currency)
BFAR	Bureau of Fisheries and Aquatic Resources (Philippines)
BFDC	Bangladesh Fisheries Development Corporation
BFRI	Bangladesh Fisheries Research Institute
BFS	Balance Fertilization Strategy
BRAC	Bangladesh Rural Advancement Committee
BSE	Bovine Spongiform Encephalopathy
CAPMS	Central Agency for Public Mobilisation and Statistics, Egypt
CAR	Cordillera Administrative Region (Philippines)
CBAD	Centre for Brackishwater Aquaculture Development (Indonesia)
CEPID	Centre d'Excellence pour la Production, l'Innovation et le Développement
CEPT	Common Effective Preferential Tariff
CLFMA	Compound Livestock Feed Manufacturers Association, India
CoC	Code of Conduct
CP	Charoen Pokphand Foods Co. Ltd., Thailand
DA	Department of Agriculture (Philippines)
DAE	Department of Agricultural Extension, Ministry of Agriculture, Bangladesh
DAP	Di-Ammonium Phosphate
DFID	Department for International Development (UK)
DoF	Department of Fisheries
DOST	Department of Science and Technology (Philippines)
DTI	Department of Trade and Industry (Philippines)
EEZ	Exclusive Economic Zone
FADINAP	Fertilizer Advisory, Development and Information Network for Asia and the Pacific
FCR	Feed Conversion Ratio
FEWS	Famine Early Warning System
FIAP	Fertilizer Industry Association of the Philippines
FISH	Fisheries Investment for Sustainable Harvest

FMB-DENR	Forest Management Bureau-Department of Environment and Natural Resources (Philippines)
FPA	Fertilizer and Pesticide Authority (Philippines)
FSR	Fisheries Sector Review, Bangladesh
GAFRD	General Authority for Fisheries Resources Development, Egypt
GAMP	General Authority of Milling and Polishing, Egypt
GAP	Good Aquaculture Practice
GDP	Gross Domestic Product
GIFT	Genetically Improved Farmed Tilapia
GI-Macro	Genetic Improvement of <i>Macrobrachium</i>
GNAEP	Greater Noakhali Aquaculture Extension Project, Bangladesh
ha	hectare
HACCP	Hazard Analysis Critical Control Point
HPAI	Highly Pathogenic Avian Influenza
HUFA	Highly Unsaturated Fatty Acid
IDRC	International Development Research Centre, Canada
IFFN	Innovative Fish Farmers Network, Malawi
IITA	International Institute of Tropical Agriculture
INCHEM	International Chemical Corporation
IRAD	Institut of Agricultural Research for Development, Cameroon
JICA	Jambi Initiative for Commercial Aquaculture
JICA	Japan International Cooperation Agency
LASADA	Lagos State Agricultural Development Agency (Nigeria)
LE	Egyptian Pound, LE (Egypt Pound, EGP)
LGU	Local Government Unit
LLDA	Laguna Lake Development Authority (Philippines)
MAAIF	Ministry of Agriculture, Animal Industries and Fisheries, Uganda
MBD	Microbound Diet
MBS	Malawi Bureau of Standards
MFN	Most Favoured Nations
MINEPIA	Ministère de l'Élevage, des Pêches et des Industries Animales, Cameroon
MOFL	Ministry of Fisheries and Livestock, Bangladesh
MPEDA	Marine Products Export Development Authority, India
NAC	National Aquaculture Centre of the Department of Fisheries, Malawi
NAMRIA	National Mapping and Resource Information Authority (Philippines)
NARO	National Agricultural Research Organization, Uganda
NASO	National Aquaculture Sector Overview, FAO
NCR	National Capital Region
NEDA	National Economic Development Authority (Philippines)
NFA	National Food Authority (Philippines)
NGO	Non Governmental Organization
NIFFR	National Institute for Freshwater Research, Nigeria
NIOMR	Nigerian Institute for Oceanography and Marine Research, Nigeria
NMIS	National Meat Inspection Service (Philippines)
NPK	Nitrogen Phosphate Potassium
NPKS	Mixed fertilizer containing nitrogen, phosphorus, potassium and sulfur
NSO	National Statistics Office (Philippines)
NSPFS	National Special Programme for Food Security (Nigeria)
PABEP	Potuakhali and Barguna Aquaculture Extension Project, Bangladesh
PCA	Philippine Coconut Authority

PCV	Peace Corps Volunteer (USA)
PL	Post Larvae
PMA	Plan for Modernization of Agriculture
PNVRA	Programme National de Recherche et de Vulgarisation Agricole, Cameroon
ppm	parts per million
ppt	part per thousand
QUEDANCOR	Quedan Rural Credit and Guarantee Corporation (Philippines)
RA	Republic Act
Rs	Indian Rupee (INR)
SEAFDEC	Southeast Asian Fisheries Development Center
SEAPB	Service d'Appui aux Populations à la Base, Cameroon
SIFAB	Société Industrielle de Fabrication des Aliments pour le Bétail, Cameroon
SIFAC	Syndicat de la Filière Avicole au Cameroun
SPF	Specific Pathogen Free
SSA	Sub-Saharan Africa
SSP	Single Super Phosphate
TSP	Triple Super Phosphate
UNDP	United Nations Development Programme of the United Nations
USAID	United States Agency for International Development
USGC	United States Grain Council
USh	Uganda Shilling
WFP	World Food Programme of the United Nations
WSSV	White Spot Syndrome Virus