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Report of the

GLOBAL CONFERENCE ON AQUACULTURE 2010
FARMING THE WATERS FOR PEOPLE AND FOOD

Phuket, Thailand, 22–25 September 2010

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2012

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PREPARATION OF THIS DOCUMENT

This is the final report of the Global Conference on Aquaculture 2010 – Farming the waters for people and food, which was held in Phuket, Thailand, from 22 to 25 September 2010.

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ABSTRACT

Organized by FAO and NACA and hosted by the Government of the Kingdom of Thailand, the Global Conference on Aquaculture 2010 – Farming the waters for people and food (Phuket Conference on Aquaculture) was held from 22 to 25 September 2010 in Phuket, Thailand. Its purpose was to review the present status and trends in aquaculture development, evaluate the progress made in the implementation of the *Bangkok Declaration and Strategy on Aquaculture Development Beyond 2000*, address emerging issues in aquaculture development, assess opportunities and challenges for future aquaculture development, and build consensus on advancing aquaculture as a global, sustainable and competitive food production sector. This event was a follow-up to the *Conference on Aquaculture in the Third Millennium*, which was organized by Network of Aquaculture Centres in Asia-Pacific (NACA) and FAO in February 2000, and the *Kyoto Conference on Aquaculture* organized by FAO in May and June 1976. Attended by 446 registered participants from 80 countries in Asia, Africa, Europe, Latin America and the Caribbean, the Near East, North America and Oceania, representing all stakeholder groups in aquaculture, it was organized in four sessions (introduction and opening, regional reviews and a global synthesis on aquaculture development, thematic sessions in six plenary lectures and 20 expert reviews, recommendations and conclusions based on these thematic reviews) and included three invited guest lectures, four side events and poster sessions (abstracts of 144 papers).

A main outcome of the Phuket Conference on Aquaculture is the "Phuket Consensus". This "Consensus" reaffirms commitment to the principles laid out in the *Bangkok Declaration and Strategy* adopted in the Global Conference on Aquaculture in 2000 and recommends additional actions to address contemporary priorities. These recommendations consist in: (i) increasing the effectiveness of governance of the aquaculture sector; (ii) encouraging and facilitating greater investments in scientific, technical and social innovations; (iii) conducting accurate assessments of the progress and contributions of aquaculture (including aquatic plants) to national, regional and global economies, poverty alleviation and food security; (iv) intensifying assistance to the small farmers; (v) supporting gender sensitive policies and implement programmes that facilitate economic and political empowerment of women through their active participation in aquaculture; (vi) increasing and strengthening collaboration and partnerships; and (vii) giving special emphasis on sub-Saharan Africa and the least aquaculturally developed countries and areas in order to allow them to develop their aquatic resource potentials.

This report summarizes the presentations, discussions and insights provided by the Conference. It includes five parts and one Annex section. Part 1 covers the introduction session of the Conference and provides an overview of the whole event. Part 2 recaps the presentations and discussions of the regional and global reviews on aquaculture development. Part 3 summarizes the presentations and discussions of the six thematic sessions. Part 4 summarizes the presentations and discussions of the three invited guest lectures. Part 5 reviews the recommendations from the six thematic sessions. The Annex section includes the list of participants, the Conference program, the abstracts of the two keynote addresses and the three invited guest lectures as well as the full text of the Phuket Consensus. Regional reviews, the global synthesis and the thematic reviews are published separately.

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Abbreviations

ANAF	Aquaculture Network of African Farmers
APR	average yearly growth
BMPs	best management practices
CCRF	Code of Conduct for Responsible Fisheries
COPs	Codes of Practice
DALYs	disability-adjusted life years
DG-RTD	Directorate General for Research and Innovation
EAA	ecosystem approach to aquaculture
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration
GAqfs	Gobierno de las industrias pesqueras
GTZ (GIZ)	Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)
IOC	International Organizing Committee
LAC	Aquaculture in Latin America and the Caribbean
NACA	Network of Aquaculture Centres in Asia-Pacific
NACEE	Network of Aquaculture Centres in Central Eastern Europe
NEPAD	New Partnership for Africa's Development
NGO	non-government organization
RAA	Aquaculture Network for the Americas
R&D	Research and development
SMEs	small and medium enterprises
SOFIA	Status of World Fishery and Aquaculture
SPADA	Special Programme for Aquaculture Development in Africa
TAC	total allowable catch
UNEP	United Nations Environment Programme
WTO	World Trade Organization

PART 1: INTRODUCTION

Background

1. The past four decades have recorded three events that had significant influence over global aquaculture development.

2. In May/June 1976, the FAO Technical Conference on Aquaculture was held in Kyoto, Japan. The Conference adopted two strategies of aquaculture development including bringing science into aquaculture and expanding aquaculture development through regional cooperation.

3. In February 2000, the Conference on Aquaculture in the Third Millennium was held in Bangkok, Thailand. The Conference adopted the *Bangkok Declaration and Strategy on Aquaculture Development Beyond 2000*. The Declaration addresses the role of aquaculture in alleviating poverty, enhancing food security, maintaining the integrity and sustainability of natural resources and environment; and the Strategy suggests measures that incorporate aquaculture into the development programs of the public and private sectors.

4. In September 2010, 496 people from 80 countries participated in the Global Conference on Aquaculture in Phuket to discuss the current status of the sector, emerging issues and strategies for its sustainable development in the coming decade. The list of Conference participants is provided in Appendix 1.[1]

Objectives

5. The aims of the Conference were to 1) review the present status and trends in aquaculture development; 2) evaluate the progress made in the implementation of the *Bangkok Declaration and Strategy on Aquaculture Development Beyond 2000*; 3) address emerging issues in aquaculture development; 4) assess opportunities and challenges for future aquaculture development; and 5) build consensus on advancing aquaculture as a global, sustainable and competitive food production sector.

Organization

Preparatory activities

6. The need to have a follow-up Conference to Aquaculture in the Third Millennium held in Bangkok, Thailand, February 2000, was conceived at the 19th Network of Aquaculture Centres in Asia-Pacific (NACA) Governing Council Meeting held in February 2008, Kathmandu, Nepal. This idea was almost immediately followed up by NACA in conjunction with the Fisheries and Aquaculture Department (FAO) and the Department of Fisheries, Kingdom of Thailand, when interim organizational committees were set up, and the idea communicated to the public on the respective web sites of these organizations. Key committees were formed to ensure that the representation to this event will be spread across globally and will portray, as much as possible, expertise from all the world's regions as well as national and organizations. This Conference reflects these committees' efforts coming to fruition.

[1] Some participants who did not provide information on their affiliations are not included in the list.

Opening ceremony

7. Dr Somying Piumsombun, Director General of the Department of Fisheries, Thailand, opened the Conference on the morning of 22 September 2010. Welcome remarks were successively delivered by Mr Hiroyuki Konuma, FAO Assistant Director-General and FAO Regional Representative for Asia and the Pacific (RAP); Mr Thammarat Wanglee, Advisor to the Minister of Agriculture and Cooperatives, Thailand; and Professor Sena De Silva, Director General of NACA. The audio materials of these speeches can be found at www.enaca.org/modules/aqua2010/presentations.php.

Inputs

8. The technical part of the Conference started with two keynote addresses, followed by the presentation of one global aquaculture synthesis and six regional reviews on Aquaculture. These reviews summarized the current state of aquaculture development in different areas of the world. The programme of the four-day Conference also included six thematic sessions that consist of 20 expert panel presentations, six plenary lectures and three guest lectures. Additionally there were poster sessions and side events. The detailed Conference program is provided in Appendix 2.

Keynote addresses

9. Two keynote addresses were given at the start of the Conference on the morning of 22 September 2010.

10. Professor M.S. Swaminathan, known as the Father of Green Revolution in India and World Food Prize awardee, delivered the first keynote address on "Aquaculture and sustainable nutrition security in a warming planet". He emphasized the concepts of food security and nutrition while pointing out that the "nutritional security" becomes more and more relevant for humans in a changing world subject to new and increasing climatic and environmental threats. The keynote address highlighted the renewed commitment of the United Nations and UN organizations to deliver "as one" ensuring a coordinated approach to food security and nutrition. He also pointed out that since agriculture and aquaculture are deeply connected, both sectors need to focus on the nutrition security system. The abstract of Professor Swaminathan's presentation is provided in Appendix 3.

11. Mr Jiansan Jia, Chief of the Aquaculture Service of the FAO Fisheries and Aquaculture Department made the second keynote presentation, on "Global Aquaculture development since 2000: progress made in implementing the Bangkok Declaration and Strategy for Aquaculture Development beyond 2000". He discussed the progress made in the aquaculture sector globally since 2000 and analyzed how such progress addressed the provisions of the Bangkok Declaration and Strategy, which was adopted during the Aquaculture in the Third Millennium Conference in 2000. The abstract of Mr Jia's presentation is in Appendix 4.

Global and regional reviews on aquaculture

12. Six regional reviews and one global synthesis on the current status and trends of aquaculture development were presented on the afternoon of 22 September 2010. The titles of the reviews and the names of the presenters are listed below.

- Aquaculture development in Africa: current status and future prospects, *Benedict Satia*
- Aquaculture development in Asia-Pacific: current status and future prospects, *Sena de Silva*
- Aquaculture development in Europe: current status and future prospects, *Laszlo Varadi*
- Aquaculture development in Latin America: current status and future prospects, *Carlos Wurman*
- Aquaculture development in the Near East: current status and future prospects, *Issam Krouma*
- Aquaculture development in North America: current status and future prospects, *Paul Olin*
- Global aquaculture development: a comprehensive analysis, *Imtiaz Ahmad*

Plenary lectures

13. Six thematic sessions were held from 23 to 25 September 2010. At the beginning of each session, one plenary lecture was organized. The aim was to provide an overview of the session. The six plenary lectures and their presenters are:

- Plenary lecture I: Resources and technologies for future aquaculture: a needs assessment for sustainable development, *Patrick Sorgeloos*
- Plenary lecture II: Sector management and governance in aquaculture: an overview, *Neil Ridler*
- Plenary lecture III: Maintaining environmental integrity through responsible aquaculture: constraints, opportunities and challenges, *Max Troell*
- Plenary lecture IV: Responding to market demands and challenges: making aquaculture a competitive food producing sector for the benefit of world consumers, *Lara Barazi-Yeroulanos*
- Plenary lecture V: Improving knowledge, information, research, extension and communication on aquaculture, *Gary Jensen*
- Plenary lecture VI: Enhancing the contribution of aquaculture to poverty alleviation, food security and rural development, *Modadugu Gupta*

Expert panel presentations

14. In each thematic session, three or four expert panel presentations were made after the plenary lecture. The titles of the thematic sessions and the expert panel presentations as well as the names of the presenters are listed as follows.

- *Thematic session I: Resources, technologies, and services for future aquaculture*
  - Expert panel presentation I.1: Responsible use of resources for sustainable aquaculture, *Barry Costa-Pierce*
  - Expert panel presentation I.2: Novel and emerging technologies: can they contribute to improving aquaculture sustainability? *Craig Browdy*
  - Expert panel presentation I.3: Providing high quality feeds for aquaculture and getting out of the fish meal trap: opportunities and challenges, *Albert Tacon*
- *Thematic Session II: Sector management and governance in aquaculture*
  - Expert panel presentation II.1: Improving aquaculture governance: what is the status and who is responsible for what? *Nathanael Hishamunda*

- Expert panel presentation II.2: Aquaculture and socio-economic growth and development: enabling policies and partnership for improved benefits, *Jolly Curtis*
- Expert panel presentation II.3: Investment, insurance and risk management for aquaculture development, *Clement Tisdell*

- *Thematic session III: Aquaculture and environment*

- Expert panel presentation III.1 Promoting responsible use and conservation of aquatic biodiversity for sustainable aquaculture development, *John Benzi*
- Expert panel presentation III.2: Addressing aquaculture-fisheries interactions through the implementation of the ecosystem approach to aquaculture (EAA), *Doris Soto*
- Expert panel presentation III.3: Improving biosecurity: a necessity for aquaculture sustainability, *Mike Hine*

- *Thematic session IV: Responding to market demands and challenges: ensuring food safety and quality, economic viability and sectoral diversity*

- Expert panel presentation IV.1: Facilitating market access for producers: addressing market access requirements, evolving consumer needs, and trends in product development and distribution, *Jonathan Banks*
- Expert panel presentation IV.2: Consumer assurance: market-based quality schemes, certification and traceability, eco-labelling, retailer specifications, *Lahsen Ababouch*
- Expert panel presentation IV.3: Organic aquaculture: the future of expanding niche markets, *Mark Prein*

- *Thematic session V: Improving knowledge, information, research & development (R&D) and regional cooperation in aquaculture*

- Expert panel presentation V.1: Investing in research, communication, training/extension for responsible aquaculture, *Brian Davy*
- Expert panel presentation V.2: Servicing the aquaculture sector: role of state and private sectors, *Michael Phillips*
- Expert panel presentation V.3 Progressing aquaculture in this knowledge economy through virtual technology and decision-making tools for novel management, *João Gomes Ferreira*
- Expert panel presentation V.4: Information and data needs: a strategy for improving aquaculture statistics, *Xiaowei Zhou*

- *Thematic session VI: Enhancing the contribution of aquaculture to poverty alleviation, food security and rural development*

- Expert panel presentation VI.1: Protecting small-scale farmers: a reality within a globalise economy? *Rohana Subasinghe*
- Expert panel presentation VI.2: Alleviating poverty through aquaculture: how can we improve? *David Little*
- Expert panel presentation VI.3: Addressing human capital development and gender issues in aquaculture sector, *Kyoko Kusakabe*
- Expert panel presentation VI.4: Supporting farmer innovations, disseminating indigenous knowledge and aquaculture success stories, *M.C. Nandeesha*

Invited guest lectures

15. Three invited guest lectures addressing several pressing issues in aquaculture were presented at the Conference. The abstracts of these lectures are provided in Appendix 3. The titles and presenters of the lectures are listed as follows.

- Invited guest lecture I: Is feeding fish with fish a viable practice? *Ulf Wijkstrom*
- Invited guest lecture II: The potential of aquaculture to improve human nutrition and health. *Shakuntala Haraksingh Thilsted*
- Invited guest lecture III: Coping with climate change: a real challenge for aquaculturists? *Sena de Silva*

Poster sessions

16. Totally, 144 paper abstracts were accepted by the Conference for poster presentation. These abstracts were published in the Conference handbook and/or displayed in the poster sessions of the Conference.

Side events

17. Four side events were organized on the evenings during the Conference. The titles and organizers of the side events are:

- *Side event 1*: Improving sustainability of seafood production and trade: opportunities and challenges, organized by GTZ and FAO
- *Side event 2*: Aquaculture Industry Dialogue, organized by the Thai Department of Fisheries in collaboration with the Norwegian Ministry of Fisheries and Coastal Affairs and FAO
- *Side event 3*: Introducing aquaculture research opportunities under the European Union's Seventh Framework Programme (FP7), organized by European Union (EU) Research Directorate-General DG-RTD and FAO
- *Side event 4*: Regional networking in aquaculture, organized by ANAF, NACA, NACEE, RAA and FAO

Outputs

Phuket Consensus

18. One of the key achievements of the Conference is the *Phuket Consensus: a re-affirmation of the commitment to the Bangkok Declaration*, which establishes the declaration on aquaculture development for the coming decade. The Phuket Consensus builds on and extends the *Bangkok Declaration and Strategy* adopted by the previous Global Conference on Aquaculture in 2000. While reaffirming commitment to the principles laid out in the *Bangkok Declaration*, the *Phuket Consensus* recommends additional actions to address contemporary priorities.

19. The Phuket consensus was developed through a series of discussions and consultations facilitated by the Conference's International Organizing Committee (IOC) that represents wide range of regions, expertise and regional and national organizations. The first draft of the consensus was developed by the IOC and discussed in an "Expert Workshop" held in Rome in January 2010. The second draft of the consensus developed by the IOC was further conferred with the experts at workshop in Hanoi in April 2010. The third draft, developed by the IOC, was shared among thirty experts representing government, social, technical, industry and academia spreading across the globe, and comments were solicited. In parallel, the draft was also informally shared widely among different stakeholders. Lastly, the final draft

consensus was distributed among all Conference participants along with twenty-three questions ranging from general to specific suggestions, comments and recommendations. All responses to these questions were synthesized into several clusters and presented at the final session of the Conference. After extensive discussions, the participants to the Conference adopted the Phuket Consensus. The complete text of the Phuket Consensus is provided in Appendix 4.

Report of the Conference

20. One of the publications emerging from this Conference is this *Report of the Phuket Conference on Aquaculture.* It provides a summary of the events, lectures, presentations and discussion that took place at the Conference. Preparation of this report is mainly based on the written materials submitted to the Conference (e.g. the abstracts of papers or lectures) and notes taken by Rapporteurs during the Conference sessions.

Other publications

21. The full texts of the six regional reviews and the global synthesis are documented in independent publications. The full texts of the 20 thematic reviews will be published as proceedings. The abstracts of all the presentations in the Conference were published in the Conference Handbook. The power-point slides and audio files of these presentations can be found at NACA's website: www.enaca.org/modules/aqua2010/presentations.php.

PART 2: SALIENT POINTS OF REGIONAL AND GLOBAL REVIEWS ON AQUACULTURE

Six regional reviews and one global synthesis on aquaculture development were presented and discussed at the Conference. The saline points of these presentations and discussion are summarized in the following sections.

Regional review: Aquaculture development in sub-Saharan Africa

Presenter: Benedict P. Satia
Rapporteurs: Matthias Halwart and Nathanael Hishamunda

Background

The contribution of sub-Saharan Africa to global aquaculture production remains very small but is increasing significantly. Between 1998 and 2008, there was a five-fold increase in production from 42 587 to 238 877 tonnes; the bulk of the production (near 95 percent) comes from fresh-water systems. The average yearly growth (APR) was 18.8 percent for the period and 19.90 percent for the years 2000 to 2008. This growth was mainly due to the emergence and intensification of private sector-led small and medium size enterprises, and the expansion of large commercial ventures. International awareness and interest in aquaculture spawned by the NEPAD Fish for All Summit in 2005 and implementation of the FAO Special Programme for Aquaculture Development in Africa (SPADA), also contributed to this development. There are opportunities for integrating aquaculture with other farming activities, for enhancing exports of high value species and for strengthening institutional capacity building. There is a need for research, technology development and investment to improve sustainability of existing farming systems. There is significant scope for improved human resources development, for better collaboration among farmers, and between science and practice and for international collaboration, within the region and with institutions and organizations outside the region.

Issues

The questions below were the focus of the presentation:

- Social and economic general background: agriculture and fisheries sector, fish consumption trends.
- General characteristics of the sector: main farming strategies, countries and regions, species, environments, integrated approaches.
- Resources, services and technologies: extension services, outreach, insurance, technology transfer, dissemination methodologies.
- Aquaculture and environment: climate change, land use, impact assessments, regulatory framework, public perception.
- Markets and trade: evolution, trends, processing, value chain, standards, certification, labelling.
- Contribution of aquaculture to food security, social and economic development.
- External pressures on the sector: climate change, civil unrest, political wills and political instability.
- The role of shared information: research, training, extension, dissemination and

- Networking: extension services, outreach, networking, farmers and professionals associations.
- Governance and management of the sector: regulatory frameworks, financial incentives.
- Implementation of Bangkok Declaration and Strategy.
- Conditions that have contributed to success in lead aquaculture countries: private led sector, public-private linkages, good governance, capacity building.

Priority actions

- Increasing aquaculture's contribution to food security, employment and economic development.
- Meeting growing demand for inputs of production.
- Strengthening the base for aquaculture management (research, capacity building, good governance, etc).
- Improvements in environmental management plus fish health management, risk management, food safety and product quality issues, (related to trade).
- Greater emphasis on private sector led initiatives (good governance, policies and limited regulations)
- Promote more self-regulatory governance (dynamic producer organizations, service providers Codes of Practice/Best Management Practices (COPs/BMPs).
- Improvement/refinement of technologies.
- Emphasis on better inputs: seeds and aqua-feeds.
- Greater importance on better communication/dissemination strategies and inter-regional cooperation.

Regional review: Aquaculture development in Asia-Pacific

Presenter: Sena de Silva
Rapporteurs: Weimin Miao, Melba Reantaso and Mohammad Hasan

Background

The Asia-Pacific region contributes the major share to global food fish supply from farming accounting for 91.4 percent of the global production in 2007. China continues to be the biggest producer and along with seven other countries (India, Indonesia, Thailand, Viet Nam, Bangladesh, the Philippines and Myanmar) in the region are in the top ten ranked aquaculture producers in volume and value. The region has a high average food fish consumption rate, estimated at 29 kg per person per year. To maintain this level for the next three decades would require producing 30 to 40 million tonnes more fish per year by 2050 to meet the demand from a growing population, albeit projected to begin decelerating around 2030. Aquaculture systems and species are very diverse in the region and are conducted in fresh, brackish– and marine– waters, and overall freshwater finfish production is the most dominant. Great bulk of aquaculture production in the region is of relatively low-value species, and most of its food fish output comes from a few species groups that include cyprinids, tilapia and catfish. The region remains to be the biggest producer of marine shrimp, with bulk of the production coming an introduced Latin American species, white leg shrimp *Penaeus vannamei*.

Issues

- The challenge of increased food fish production to meet the demand from a growing population.
- The structure of the sector in the region characterized by the predominance of small-scale, independent farms, distributed over wide areas with fragmented market, makes the management of its development complicated and underlines the importance of a strong progressive governance system.
- Concerns for food safety and quality, largely driven by a more health– and quality–conscious public whose purchasing power is becoming stronger.
- The relatively static farm-gate price of most cultured commodities in the region over the last ten years or so, often placing small-scale farmers at the brink of economic viability.
- Adverse public perception on aquaculture with specific reference to the use of wild fish as feed and perceived pollution caused by aquaculture practices.
- Rapid expansion of the culture of high-value finfish species raised in floating cages mostly small and located in protected inshore waters.
- Concerns for ecological and genetic biodiversity impacts of the introduction and movement of species for culture across countries/borders but still needing incontrovertible proof that it has happened.[2]
- The anti-dumping charges that have been levelled on shrimp and Pangasius Pangasius exports.
- Is the competitiveness of Asian aquaculture supported by its low-cost labour sustainable?
- Impacts of potential climate changes on aquaculture.

Priority actions

- Intensification of existing practices, more judicious and expansive secondary use of lentic waters in the region, effective use of non-perennial waters for culture-based fisheries development through community management, enhancing and improving upon the age old rice-fish culture practices to meet modern market demands.
- The need for better policy development and governance of the sector thereby further facilitating the sector's growth in the region.
- Increasing development and adoption of better management practices for major cultured commodities and farming systems including the organization of farmers into clusters to facilitate these farming communities to meet the modern market demands on food quality and safety, and challenges collectively.
- The need for necessary measures to enable small-scale farmers to access markets and obtain better prices.
- Increased communication among small-scale farmers in the region in disseminating knowledge, keeping vigil and informed of the fast changing global market place and adoption of technological innovations and use of modern technologies to do so.
- The need for improving public perceptions on aquaculture through better communication of successes and the impacts of such on nutrition, food security, and social well-being, contribution to biodiversity conservation.[3]

[2] Most of the introduced species developed for aquaculture have boosted productivity and profitability of farms and not shown evidence of adverse impact on biodiversity, as yet, except for Java tilapia *Oreochromis mossambicus* and a few ornamental fish and the golden apple snail.

- The need for better water and feeding management in aquaculture to lessen the volume and organic content of effluent to overcome the perceived threat of pollution.
- The need for study of ecological and genetic biodiversity impacts of introduced species not previously established in the country of introduction.
- Measures to bring about induction of scientific know-how on maintaining genetic diversity in broodstock management of established and newly emerging species.
- The need for development of mechanisms for access and benefit sharing (i.e. dissemination of improved strains) of the genetic resources.
- Closer and dispassionate study of contentious anti-dumping charges that have been levelled on shrimp and Pangasius exports if these charges are without science-based evidence or based on isolated cases.
- Closer scrutiny and adoption of appropriate strategies that would assist the sector to remain viable and competitive should the labour cost in the region increase.
- Development of mitigating measures for the potential climatic change impacts.

Regional review: Aquaculture development in Europe

Presenter: Laszlo Varadi
Rapporteurs: Alessandro Lovatelli and Devin Bartley

Background

In the past decade, European aquaculture doubled reaching approximately 2.5 million tonnes in 2007, mainly attributable to the growth of marine finfish aquaculture, while freshwater production declined. Europe produces only about four percent of the global aquaculture production, but European technologies and knowledge contribute significantly towards farming technologies and to the expansion of global aquaculture.

Issues

In Europe, aquaculture generally has a marginal contribution to national economies and employment. The total employment is currently around 150 000 full time equivalents, which is small, but may contribute locally to significant economic activities and employment. The region accounts for 14.5 percent of the world consumption of fish and fishery products the local market is increasingly dependent upon imports. The current focus of the sector is to increase it productive competiveness, ensure a sustainable growth and improve its image and governance. While Europe as a whole enjoys a rich aquaculture research environment, it is very diversified and fragmented between public and private institutions and companies. There is a considerable overlap in research. Dissemination and application of research outputs remain a challenge. Furthermore, the wider exploitation of its water resources for aquaculture is increasingly constrained by a growing competition from other users as well as by regulatory restrictions.

[3] An example to such success is the positive impact of aquaculture on the conservation of marine species and protection of their marine habitats, mainly the coral reefs. This refers to the increasing use of hatchery-bred seed of some of the species for the live food fish trade.

Priority actions

- In view of its international seafood imports and market competition, the region as a whole is conducting extensive consultations with all major sector stakeholders in order to support the industry. The EU launched its new "Strategy for the Sustainable Development of European Aquaculture" aiming to address the obstacles to growth faced by the industry. The new strategy aims to make EU aquaculture more competitive, ensure sustainable growth and improve the sector's image and governance. Special attention is being devoted to labelling of capture fishery and aquaculture products.
- The markets are responding to the interest of European consumers on issues such as traceability, fair trade, animal welfare and environmental impacts with voluntary certification and labelling schemes. There is however no single European eco-label as yet for aquaculture products. The protection of consumers and the responsible use of resources remain key challenges in the development of the sector.

Regional review: Aquaculture development in Latin America and the Caribbean

Presenter: Carlos Wurmann
Rapporteurs: Doris Soto and José Aguilar-Manjarrez

Background

Aquaculture in Latin America and the Caribbean (LAC) is mainly based on four species (salmon/trout, shrimp, tilapia and mussels). South America is responsible for 82.1 percent of the volumes and 86.3 percent of the values farmed. Salmon/trout represent the most outstanding production and exports. The Republic of Chile is the most important foreign supplier to the United States of America and Japanese markets for those products, while the Republic of Ecuador, the Republic of Honduras and the Republic of Costa Rica are the main suppliers of fresh tilapia fillets to the important and growing United States of America (USA) market.

Issues

- Only three countries – the Republic of Chile, the Federative Republic of Brazil and the Republic of Ecuador – account for 74.5 percent of the volumes and 77.9 percent of the values farmed in this last triennium. Adding Mexico and the Republic of Colombia, these five nations represent 86.8 percent of the total volume produced in the region and 88.5 percent of the total value of aquaculture products generated in the region in 2006–2008. This very high degree of concentration of production in a few countries is accompanied with a slow diversification process that involves the farming of up to 86 different species, though most of them are produced in very low quantities. An implication is that about 48 percent of all species farmed in the LAC region show an average annual off-farm value of less than US$1 million. About 73.4 percent of them were valued worth less than US$10 million between 2005 and 2007.
- In general, prevailing inequities discourage access to aquaculture production by small-scale farmers. Current norms and market conditions also tend to discourage their active participation in this industry.

Priority actions

- To enhance small-scale aquaculture, there is a need for governments support for providing technology, technical assistance including management, market and marketing, financial aspects, logistic, etc. However in providing this assistance, there is a need to avoid taking the paternalistic approach as has been followed in the past.
- Given the availability and high quality of water and coastal resources for the sector to develop, it is essential that governments have the will to improve the management and further promote the sector. In this way, aquaculture could realize the opportunities for food production, food security and socioeconomic development which it can offer to the region and to the world.
- Relevant aspects include reducing the gap between research and development, improving licensing processes to cope with development speed, improving health and environmental management and increasing control as well as reinforcing systems.

Regional review: Aquaculture development in the Near East and North Africa

Presenter: Issam Kruma
Rapporteurs: Alessandro Lovatelli and Mohammad Hasan

Background

Despite the modest production from the Near East and North Africa region, aquaculture increased six fold in the last decade reaching almost 850 000 tonnes in 2007. The main driving forces for this expansion include an increased awareness and interest in fish products and the enactment of appropriate sector development policies. Egypt, the Islamic Republic of Iran, Saudi Arabia, Iraq and the Syrian Arab Republic remain the top producers contributing almost the entire regional production.

Issues

The promotion of an economically sustainable aquaculture industry in the region has been challenging, particularly with regard to freshwater fish farming. Yet the region has a great potential to expand its industry through the employment of suitable and environmentally friendly technologies. Across the region, policies governing the use of freshwater are being revisited to some extent in order to ensure the optimal and rational management of this scarce resource. There is a general tendency to promote, particularly with reference to the use of freshwater, water-saving aquaculture practices as well as to strengthen integrated aquaculture systems. Mariculture in the region is still at an early stage, even though in recent years a growing number of commercial shrimp farms and fish-farming operations using floating and submerged cages have been established and are encouraging new investments. Efforts are generally being taken in the region to develop aquaculture plans, including zoning and the enactment of enabling policies and regulations to encourage the establishment of a competitive aquaculture industry.

Priority actions

- The region lags behind in terms of applied research in support of the industry with often inadequate farming know-how transfer services trough training and extension services. These shortcomings have been recognized and governments are focusing on

sector needs, supporting innovative research plans, engaging private farming operations and addressing responsible aquaculture practices and diversification to warrant proper use and conservation of existing natural resources. In view of the arid topography of the region strategic support is being given to the development of mariculture through the introduction and adaptation of technologies, policies and regulations.

- It appears that the sector will continue to expand, particularly as new technologies are introduced and institutional capacities strengthened. Consumption of fish and fish products is generally being promoted by the institutions, which may certainly lead to a stronger regional demand for farmed products. Further collaboration with developed countries and in the areas of quality assurance, product labelling and traceability will help pave the way for improved marketing of aquaculture products from countries of the Near East and North Africa both internationally and within the region.

Regional review: Aquaculture development in North America

Presenter: Paul Olin
Rapporteurs: José Aguilar-Manjarrez and Doris Soto

Background

Canada and the USA have observed growth in the aquaculture sector over the last decade but would like to see a more robust industry with greater production and product diversity. The aquaculture sector in North America has evolved into two broad industry types: finfish production which is dominated by salmon, catfish and to a lesser degree trout, and shellfish production, primarily oysters, mussels and clams.

Issues

- Unlike Canada, much of the American coastline is well developed and competition for space in the coastal and near shore environment has the real potential of creating user group conflicts. This is recognized as a challenge and a number of agencies and non-governmental organizations (NGOs) are supporting marine spatial planning as a means to reduce these conflicts.
- Opposition to aquaculture development has stymied industry development in the past and continues to do so today. Any new aquaculture ventures in North America will be required to perform comprehensive environmental review and monitoring to insure that proposed operations are sustainable and compatible with water quality and natural resource protection.
- Development and commercialization of new technologies in the culture of catfish, salmon, oysters and mussels, and the success of these industries is largely the result of past and ongoing government support through collaborations with industry, academia and extension. This research capacity applied to new species with promising culture potential should facilitate continued industry growth.

Priority actions

- Both Canada and the USA have ample areas for aquaculture expansion and the Canadian salmon example and expanded shellfish culture in the USA and Canada demonstrate the viability of these two approaches. However, in some regions there is considerable opposition and whether a significant industry sector develops will depend on the establishment of a regulatory regime that insures environmental protection while enabling the economic viability of aquaculture ventures.
- Over the last decade, governments in both Canada and the USA have made concerted efforts to improve aquaculture governance and increase financial support for research and development. This includes creation of national policies, strategic plans to support expansion, identification of priority goals and research topics, and efforts to establish national legislation addressing aquaculture. These efforts should improve regulation of the industry, balancing the needs to protect the environment, sustain fisheries, and enable a competitive industry to flourish.
- The Food and Drug Administration (FDA) is recommending people double their seafood consumption to take advantage of the numerous health benefits associated with seafood, particularly cardiovascular health benefits derived from consuming species high in Omega 3 fatty acids. If this occurs, then demand for aquaculture products could increase even more dramatically in the region.

Global aquaculture synthesis

Presenter: Imtiaz Amhad
Rapporteurs: Doris Soto and Nathanael Hishamunda

Background

Global production of fish from aquaculture has grown substantially during the past decade, reaching 52.5 million tonnes in 2008 compared with 32.4 million tonnes in 2000. Aquaculture continues to be the fastest growing animal food producing sector and currently accounts for nearly half (45.6 percent) of the world's food fish. Global aquaculture has not grown evenly around the world. There are marked intra and inter-regional and country variations in production level, species composition, farming systems and producer profile. The Asia-Pacific region continues to dominate the aquaculture sector globally, accounting for more than 90 percent of global production, with China alone contributing more than two-thirds of global production. Few countries dominate production of major species, such as carps by China, shrimps and prawns by China, Thailand, Vietnam, Indonesia and India, and salmon by Norway and Chile.

It is also apparent that aquaculture's contribution to poverty reduction, food security, employment, trade and gender opportunities increased over the past decade. Over the past decade, a number of developments have contributed to the significant growth of the global aquaculture sector, namely: formulation and implementation of policies, strategies, plans and legislations; dissemination and use of applied research; and emergence of new domestic and international markets.

Issues

- In the Asia-Pacific region, despite major technical developments in the aquaculture sector, small-scale commercial producers continue to remain the backbone of the sector for their significant contributions. Small-scale producers and small and medium entrepreneurs are also important players in the Africa region. However, capital and government empowering-support are still major constrains for small farmers especially in Africa, Asia and some countries in Latin America.
- The global aquaculture sector's long-term goal to achieve economic, social and environmental sustainability primarily depends on continued commitments by governments to provide and support a good governance framework for the sector. However, there is a need to improve such governance in many countries and regions.
- There are growing public concerns about the use of fishmeal and fish oil to feed aquaculture, however public opinion is too often driven by the most relevant commodities in the market such as salmon and shrimp which only represent a small proportion of the global aquaculture output.

Priority actions

- There is a need to better approach the environmental and social concerns, and make conscious efforts to address those in a transparent manner.
- Special efforts are also needed to improve aquatic animal health services. In the process, the sector should also prepare itself to face the potential impacts of climate change and global economic crisis, and make special efforts to assist small-scale producers by organizing them into associations and through promotion of better management practices, as has been successfully demonstrated in many countries.
- There is also a need to safeguard small-scale farmers, e.g. from stringent export requirements and provide adequate infrastructure development support, access to capital and to insurance.
- A systematic and precise assessment of aquaculture contributions (such as food security and poverty alleviation) is required in order to formulate well-informed development policies and strategies.
- With stagnating global capture fishery production and an increasing population, aquaculture is perceived as having the greatest potential to produce more fish to meet the growing demand for safe and quality aquatic food. As the new decade unfolds, a stronger and confident sector is needed if it has to face and overcome the future challenges and move further along the sustainability path.

Plenary discussion

Rapporteurs: Devin Bartley and Audun Lem

The participants appreciated the quality and comprehensiveness of the regional and global reviews. These reviews clearly demonstrated the important role aquaculture played in food production and economic development.

Participants noted that coverage of aquatic plants was missing from many of the analyses. Although it was pointed out that many aquatic plants are used in the pharmaceutical industry, it was explained that many do have uses as food. Although some aquatic plants are covered

in agriculture, there is a definite problem with how production is reported to and addressed by FAO that participants wanted addressed.

Aquaculture certification was cited as an emerging area. Concern was raised in regards to small-scale aquaculture and this sub-sector could be included in schemes.

Concern was raised that the image of aquaculture in some areas is not positive. This may require a change in strategy on how the sector is presented in these areas. However, participants noted that the image is very positive in many areas.

It is important that aquaculture development and management address food security and truly benefits the poor section of society. Policy should address this issue and look at more than simply tonnes of product produced, but also the affect on rural and poorer sections of the population. Requests were made to address social impacts along with environmental impacts of aquaculture.

The impacts of climate change on aquaculture were raised and it was noted that we have little concrete information at present. Participants asked for advice on how to cope with or adapt to climate change, e.g. should coastal areas plant mangroves?

Disease was recognized as a constraint to development and biosecurity was stressed as prevention is better than trying to cure disease.

Participants noted that the aquaculture sector did not set indicators at the last global Conference in order to track progress of the sector; these should be established now.

Participants noted the lack of adequate policy in some areas on illegal and unregulated aquaculture. This aspect was not mentioned in most of the global reviews.

The issue of alien species was raised and it was pointed out that alien species have been responsible for a tremendous amount of aquaculture production and is driving production in many areas. However, proper risk assessment and the precautionary approach will be required.

PART 3: SALIENT POINTS OF THEMATIC SESSIONS

The Conference organized six thematic sessions. Each session was initiated by a related plenary lecture and composed of three or four expert panel presentations. Summaries of the presentations and discussion during the sessions are provided as follows.

Thematic session I: Resources, technologies, and services for future aquaculture

Plenary lecture I: Resources, technologies and services for future aquaculture: a needs assessment for sustainable development

Lead author: Patrick Sorgeloos
Rapporteurs: Matthias Halwart and Thomas MothPoulsen

Background

By the late 1960s, modern "business" aquaculture had evolved, when the biology of a few high-market-value species could be practiced and intensive monoculture on-growing practices were developed. This soon resulted in a number of success stories, with the intensive culture of temperate species occurring first and as of the 1980s, with species grown in tropical and subtropical conditions. Nowadays, the responsible use of modern technology tools should make possible to let aquaculture evolve from an empirical science to a knowledge-based biotechnology with much more emphasis on fundamental research in order to unravel the underlying mechanisms in growth and product quality of aquatic species; application of proven experience from other disciplines in agriculture and animal production offers unique opportunities for significant progress in seafood production in the decades to come. Furthermore, and in view of future competition for freshwater resources, opportunities for integration of aquaculture with other food production systems, aquatic as well as terrestrial, needs to be better explored and their sustainability impacts better documented. Off-shore industries that combine energy generation, food and feed production and blue biotech innovations offer great potential for large-scale applications. On the other hand, aquaculture is frequently criticized for having a negative impact on the environment, which tends to overshadow its contributions to fighting hunger and alleviating poverty. However, it is unjustified to reject aquaculture – instead we should intensify our efforts to increase its sustainability. For that reason, a concerted multidisciplinary effort of oceanographers/marine biologists, fisheries scientists and aquaculture practitioners should better explore possible integration of aquaculture practices with fisheries management and eventually improve socio-economics of the fisheries sector in various regions of the world. Aquaculture is crucial in our pursuit of global food security and good human health, as it offers a source of food that is rich in protein, essential fatty acids and vitamins and minerals. Furthermore, it offers a way to boost development by providing jobs, improving people's incomes and increasing returns on natural resource use.

Issues

Calculations based on present per caput consumption and taking into account population numbers in 2020 reveal that aquaculture will have to provide more than 25 percent extra on an annual basis within the next ten years. When considering the available global resources for food production, it is clear that land for crops and pasture will come under serious pressure. In

future decades, we can expect a significant shift to farming the oceans and the seas. This needs to be achieved without posing environmental risks or human health problems. Overall, there is a need to develop a more knowledge-based bio-industry, and there is a need to understand the underlying mechanisms in all the biological processes responsible for the final production outcome.

Priority actions

- Complete independence from natural stocks through domestication
- Improved/more cost-effective seed production
- Better targeted species selection
- Development of more efficient stocks through selective breeding
- More microbial management for more sustainable production
- Better understanding of immune systems in vertebrates and invertebrates
- Need to think along ecological principles and promote more integrated production systems for plant and animal farming
- Coastal and off-shore farms for food and energy
- Full independence from fisheries stocks for lipid and protein ingredients in aquatic feeds
- More attention for integration of restocking activities with fisheries management
- Societal leverage

Expert panel presentation I.1: Responsible use of resources for sustainable aquaculture

Lead panellist: B.A. Costa-Pierce
Rapporteurs: Devin Bartley and Mohammad Hasan
Panel members: D.M. Bartley, P. Bueno, F. Greenhalgh, M. Hasan, R. Hashim, A.J. Hernández, D. Herrnandez, J. Hinshaw, J.K. Jena, S.J. Kaushik, D. Lemos, K. Rana, J. Rutaisire, A. Yakupitiyage

Background

Major resources used in aquaculture include land, water, energy, feed, and seed. Aquaculture faces increasing competition from other sectors in use of resources. Therefore it is important to continuingly improve aquaculture's resource efficiency. Species selection, site selection, farming system and technology, farm management and practices, among others, are key elements to improving resource efficiency in aquaculture.

Issues

- Severe water competition with alternative users; e.g. massive damming and urbanization in Asia diverting water to coastal cities and agriculture.
- Globalization and intensification of food production increase energy density and use in fed aquaculture in comparison to fishing and terrestrial agricultural protein production systems.
- Inadequate and unreliable supply of quality seed; e.g. poor genetic quality of seed.
- Lack of infrastructure, financial and business/marketing support, and policy and legal frameworks for artificial seed production.
- Environmental impacts of uncontrolled releases of cultured seed stocks.

- Overuse of marine meals/oils threatens the sustainability of pelagic fish stocks and lead to high feed costs.
- Concerns over the quality of fish feed ingredients (e.g. imported meals and bone meals).
- Social concerns (e.g. food security and equity) over the use of pelagics as feed instead of direct human consumptions.
- PCB and mercury contamination in fish meals or fish oils

Priority actions

- Promote multiple uses of water in landscape scale systems through more widespread use of integrated aquaculture.
- Explore more efficient ways to utilize resources; e.g. development of seawater farming systems in arid areas.
- Enhance land/water use planning to address growing land/water user conflicts.
- Improve resource and economic efficiency of intensified farming system (e.g. recirculation systems).
- Extend quality assurance measures beyond simple official zoo-sanitary certificates.

Expert panel presentation I.2：Novel and emerging technologies: can they contribute to improving aquaculture sustainability?

Lead panellist: Craig L. Browdy
Rapporteurs: Doris Soto, Alessandro Lovatelli, Matthias Halwart
Panel members: Geoff L. Allan, Thierry Chopin, Gideon Hulata, Alessandro Lovatelli, Zhanjiang Liu, Thales Passos de Andrade, Rui Pereira, Shawn Robinson, Muki Shpigel, Christina Sommerville, Vazhiyil Venugopal, Charles Yarish
Background

As aquaculture expands, examples demonstrate potential to improve economic and social wellbeing while producing needed wholesome food. On the other hand, some less responsible development has drawn attention to potential problems with social, environmental and/or financial sustainability. The scientific and business communities have responded to these challenges and opportunities with research efforts generating novel technologies mirroring the diversity of the industry.

Issues

More than 20 percent of aquaculture production today derives from selective breeding. Tools for exploring the genetic code including marker technologies, genome mapping, and genome sequencing are being applied to aquaculture species. Improvements in aquatic animal health are coming from new technologies such as better understanding of the genetic and physiological basis of immunity and vaccine developments. Diagnostic technologies have greatly improved speed, specificity and sensitivity. Regarding feeds, research has focused on shifting from formulations based on ingredients to strategies based on nutrient availabilities and specific requirements. Production systems technology advancements are also contributing. Recirculation technologies, reproductive control, disease free larval production, health. Cage production is benefitting from improved automation, improved pond and tank systems enable in-situ cycling of wastes, improving feed conversion efficiency, and reducing environmental impacts while enhancing biosecurity, health and cost efficiencies. Research work on integrated multitrophic aquaculture focuses on application of ecosystem-based

approaches to integrate fed aquaculture (e.g. finfish) with organic extractive aquaculture (e.g. shellfish) and inorganic extractive aquaculture (e.g. seaweeds).

Priority actions

These and other examples suggest some of the benefits that future scientific-based innovation will contribute towards meeting increasing food demands, while improving social, environmental and financial sustainability of aquaculture. However, more than ever, efforts must be made for society to accurately analyze and understand risks, strategies that focus on prevention to raise healthier fish faster with less environmental impact while improving economic stability and providing associated social benefits. Continuing cost pressures and the acute need to replace the high levels of fish meals and fish oils in many aquaculture feeds are also driving many technological efforts and a transition to more sustainable feeds. All production system technologies are benefitting from expanding information and communication systems that are enabling advances in every stage of production.

Expert panel presentation I.3：Providing high quality feeds for aquaculture and getting out of the fish meal trap: opportunities and challenges

Lead panellist: Albert G.J. Tacon
Rapporteurs: Mohammad Hasan and Alejandro Flores
Panel members: Geoff Allan, Simon J. Davies, Abdel-Fattah M. El-Sayed, Mohammad R. Hasan, Andrew Jackson, Sadasivam J. Kaushik, Santosh P. Lall, Sergio Nates, Wing-Keong Ng, Nguyen Thanh Phuong, Victor Suresh, Supis Thongrod, Maria Teresa Viana

Background

The rapid rise and growth of finfish and crustacean aquaculture has been due in-part to the availability and on-farm provision of feed inputs within the major producing countries. It is estimated that over 46 percent of the total global aquaculture production in 2008 was dependent upon the supply of external feed inputs. If the aquaculture sector is to maintain its current average growth rate of 8 to 10 percent per year to 2025, the supply of nutrient and feed inputs will have to grow at a similar rate. While this may have been readily attainable when the industry was still in its infancy, this may not be the case in the future as the sector matures and grows into a major consumer and competitor for feed resources.

Issues

- Continued increase of global aquafeed production to satisfy the need of expanding aquaculture.
- Continued use of fishmeal and fish oil as major dietary animal protein and lipid sources in aquafeed.
- Continued and potential use of plant protein meals and oils as dietary nutrient sources.
- Competition for ingredient with other users.
- Continued growing food safety risks associated with the use of aquaculture feeds.
- Rising prices of feeds and feed ingredients.

Priority actions

- Encourage to reduce developing countries' dependence upon imported feed ingredient and fertilizer sources within compound aquafeeds.
- Assist and train resource poor farmers and small/medium-scale local feed producers by encouraging the use of improved cost effective feed preparation and feed management techniques.
- Encourage diversification of sustainable feed and fertilizer resource.
- Place major emphasis of selection of feed ingredients that can be sustainably produced and can grow with the sector.

Minimize environmental and ecosystem impact of feeds and feeding regimes. This may include a) use of highly digestible feeds ingredient sources, b) integration of production with cultured species which can benefit from nutrient waste streams from the former and c) culture of fish under closed floc-based zero-water exchange culture conditions.

Thematic session II: Sector management and governance in aquaculture

Plenary lecture II: Sector management and governance in aquaculture: an overview

Lead author: Neil Ridler
Rapporteurs: Nathanael Hishamunda, Raymon VanAnrooy and Junning Cai

Background

Governance is important in aquaculture development as it affects its sustainability. Sustainability incorporates economic viability, environmental integrity, and social licence. In the absence of effective governance there will be misallocation or stagnation. Governance also affects all business, whether aquaculture or any other. As the driver of wealth creation, the private sector may face obstacles in doing business if governance is not proper or enjoy cost-effective and transparent procedures. Regulatory procedures can be conducive to investment as they can hinder all entrepreneurial initiatives in aquaculture. Without the rule of law there will be little predictability and security, so farmers have no incentive to take risks or to invest. An enabling environment therefore is important to stimulate entrepreneurship and investment because it reduces risk and costs. Governance will become increasingly important as aquaculture expands in an environment of deteriorating ecosystems, vocal and well-funded NGOs, climate change, consumer concerns over food safety and the environment, and internationalisation of regulations due to import requirements.

Issues

- Over the past decade, considerable progress has been made in aquaculture governance, but aquaculture governance remains an issue in many countries;
- There is widespread public mistrust of aquaculture (particularly marine cage culture) in some countries because of poor governance.
- Because of poor governance, there lack of development of aquaculture in certain jurisdictions, in spite of favourable demand and supply conditions.
- In some places, aquaculture has produced multi-faceted and sometimes conflicting impacts, one issue is how to understand and measure these impacts and reach an acceptable tradeoffs among them.

- Lack of data has been a major constraint on quantitatively assessing the impacts of aquaculture.
- Constraints such as availability of water, availability of suitable sites, and environmental/ecological impacts of aquaculture are impeding aquaculture development. As a result, greater regulation of aquaculture production has occurred, which poses new challenges for investment in aquaculture and the future growth of the sector.
- High levels of exposure to risk and uncertainty in aquaculture continue to restrict investment in aquaculture and stunt its development.
- Property rights in aquaculture are sometimes difficult to delineate, which poses challenges to the management of shared resources and common property in aquaculture, and limits the flow of investments.

Priority actions

- Encourage countries to establish an enabling environment for aquaculture development. This requires the rule of law and the secure right of property, economic and social stability.
- Protect property rights and enforce rule of law to reduce uncertainties and transactions in aquaculture.
- Promote models of good governance in the aquaculture sector including at least accountability, effectiveness and efficiency of government activities, predictability, stakeholder participation and equity as principles.
- FAO to document and share successful aquaculture governance models.
- FAO shall eestablish Technical Guidelines on Aquaculture Governance.

Expert panel presentation II.1: Improving aquaculture governance: what is the status and who is responsible for what?

Lead panellist: Nathanael Hishamunda
Rapporteurs: Cecile Brugère and Raymon VanAnrooy
Panel members: Imtiaz Ahmad, Pedro Bueno, Sloans Chimatiro, Geoff J. Gooley, Blaise Kuemlangan, Wilson Mwanja, David Percy, Neil Ridler, Ben Satia

Background

Aquaculture development cannot be sustainable (economically, environmentally and socially) without good governance. Accountability, effectiveness and efficiency of public services, equity and predictability (rule of laws) are some of the main pillars of good aquaculture governance. Good aquaculture governance instruments exist and are different from management instruments. Achieving good governance in the sector implies assignment and enforcement of duties and responsibilities to the public sector (governments), the private sector (producers and their organizations) and the civil society (communities, NGOs).

Issues

- Enabling institutional environments and arrangements, as well as participation are needed for protecting the interests of all stakeholders, including those of future generations through the prevention of environmental degradation. Yet such governance instruments are not always adequate.

- Over-regulation and limited resources (financial and time) often limit participation of stakeholders.
- Decisions based on inadequate or incomplete information, inequitable trade agreements and unrepresented stakeholder interests' often jeopardize the social acceptability of aquaculture.
- The dominance of market forces in the consolidation of the industry at the expense of producers or other stakeholders, and the legal vacuum in which some forms of aquaculture develop, warrant urgent action.
- Climate change and its implication on the future development of aquaculture add an additional pressure on all the sector's stakeholders to fulfil their responsibilities.

Priority actions

- Promote participatory governance: bottom-up, participatory decision-making processes to enhance community ownership of decision outcomes, which leads to the implementation of self-regulation mechanisms and the long-term sustainability of the sector.
- Increase both "vertical" coordination (between different institutional levels, e.g. between producers' organizations, provincial administrations, federal administration), and "horizontal" coordination (across government Ministries/departments, e.g. between fisheries/aquaculture departments, water/irrigation departments, agriculture departments sharing similar natural resources). A lead agency can perform the role of coordinator.

Expert panel presentation II.2: Aquaculture and socio-economic growth and development: enabling policies and partnership for improved benefits

Lead panellist: Jolly Curtis
Rapporteurs: Junning Cai, Nathanael Hishamunda, Cecile Brugère
Panel Member: Dror Angel, Cecile Brugere, Junning Cai, Geoff J. Gooley, Nathanael Hishamunda, Curtis Jolly, Blaise Kuemlangan, PingSun Leung, Charles Maguswi, C. V. Mohan, Krisna Ruangrai, Clement Tisdell, Premachandra Wattage and Ulf Wijkstrom

Background

Aquaculture development in the new millennium has made progress towards the goal of being economically viable, environmentally responsible, and socially acceptable. Improvement in institutional arrangements is a major contributing factor to this achievement. Despite the progress made, aquaculture development is expected to continue facing resource, environmental, economic, knowledge and institutional constraints. More efficient and effective institutional arrangements are needed to facilitate sustainable aquaculture development in the long run.

Issues

- Quantitative socio-economic impacts of aquaculture are important if the sector is to obtain suitable political and financial supports which are required for adequate development of the sector. Yet, efforts to assess these impacts, including case studies in this area, are limited.

- Improving aquaculture's contribution to the socio-economic wellbeing of poor communities, especially in rural areas, and through various means, is urgent. Yet, the limited financial resources remain one of the main hindrances to this improvement.

Priority actions

- Conduct a systematic review of Aquaculture's socio-economic impacts from a global perspective needed to provide guidance on aquaculture management and governance.
- Accelerate the development of a user-friendly model to quantify these impacts.
- Develop quantifiable and other indicators for the purpose of better assessing the performance of aquaculture development including its socio-economic impacts; the documentation of work done in similar disciplines could be a departure point.
- Evaluate and compare the impacts of different aquaculture productions (such as small-scale/subsistence vs. large commercial operations or high-trophic versus low-trophic species) on poverty alleviation and food security in order to facilitate proper design of aquaculture development strategies and policies.
- Find practical ways and means to allow resource-limited farmers to access credit to cover their investment and/or operating needs.

Expert panel presentation II.3: Investment, insurance and risk management for aquaculture development

Lead panellist: Clement Tisdell
Rapporteurs: Raymon VanAnrooy and Cecile Brugère
Panel members: Benedicto Bayaua, Terry Hanson, Nathanael Hishamunda, Curtis Jolly, Gunmar Knapp, Carel Ligeon, Tipparat Pongthanapanich, Eva Roth, Paddy Secretan, Susan Siar, Diego Valderrama, Raymon Van Anrooy, Maroti Upare, Mark Vos

Background

The Bangkok Declaration and Strategy for Aquaculture Development Beyond 2000 stressed that adequate investment in aquaculture is essential for its future development. It recognized that risk and uncertainty associated with returns from investment in aquaculture too is an important constraint to aquaculture investment. There are both critical constraints on investment in aquaculture (such as growing resource scarcity –particularly fresh water– and increased competition) and continuing constraints which have been evident for a long while. The latter constraints include the riskiness of aquaculture as an economic activity and the difficulties which individual aquafarmers face in managing and limiting their risks. As a consequence of general economic growth and the above constraints, the investment environment facing aquaculture is changing worldwide and the investment flow in aquaculture is currently less than socially optimal.

Issues

- Access to insurance by small– and medium–scale farmers is limited, which threatens the development of the sector.
- The extent of the difficulty in insuring farmers against all risks, especially under very limited resource conditions, is great.

- Some major risks cannot be insured as the economic costs would outstrip the benefits for the farmer (the insurance would not be profitable and, thus, economically not viable, for the private sector insurance industry.
- Access to a number of measures and tools, such as BMPs, risk analysis, development of low risk production technologies and systems, product and species diversification, aquaculture insurance and limiting indebtedness, which have been developed by individual aquafarmers, aquafarmer groups, NGOs and governments and are applied to reduce aquaculture risk and uncertainty, is generally difficult for small-scale and poor aquaculture farming households. This is particularly so for insurance.

Priority actions

- Increase and make investment more productive in order to make the growth of aquaculture production sustainable, and
- Countries to increase investment in:
  - Research and development to support greater intensification of aquaculture production; and in
  - Human capacity development.
- Countries to adopt a multi-pronged policy approach in order to reduce risks and uncertainty in aquaculture, which will require to think of measures of:
  - extending insurance coverage such as the Asian Aquaculture Insurance Pool,
  - developing techniques that lower risks while increasing the knowledge available to aquaculture farmers.
  - a concerted action in gathering and disseminating success and failure stories in aquaculture risk management and aquaculture insurance schemes that address the needs of small-scale and medium-scale farmers.
- Consider using government subsidies for aquaculture investment to help limited-resource farmers to reduce insurance costs.
- Strengthen the role of international and regional development banks in terms of supporting the sustainable development of the aquaculture sector as the access to credit, micro-finance and insurance services could be greatly increased by making funds available for these services. The establishment and provision of these services could benefit from the guidelines produced by FAO and others in the last decade.
- Limited-resource farmers to assess risks and set priorities when seeking an insurance service.
- Promote risk management tools in Aquaculture, which address a large variety of risks (production infrastructure, production, economic, social, environmental, pathogens, food safety and genetics) and have been developed recently, encourage their wide application.

Thematic session III: Aquaculture and environment

Plenary lecture III: Maintaining environmental integrity through responsible aquaculture: constraints, opportunities and challenges

Lead author: Max Troell
Rapporteurs: Doris Soto and Thomas MothPoulsen

Background

The world's ever-growing population is eating more and more fish and the production of the inland waters and oceans cannot keep up. The solution could follow the same development seen on land; that is, moving from "hunting and gathering" that is fishing, to farming, aquaculture. But aquaculture as any other food-producing sector has unwanted negative impacts.

Issues

- While aquaculture has provided economic and nutritional benefits to millions, there are concerns that unconstrained sector expansion and intensification, coupled with its ecological and social impacts, globalization and fluctuation of markets and resources, climate change, etc. may have undesirable impacts on the resilience of social-ecological systems.
- The development of aquaculture has directly contributed to the loss of important ecosystem functions through land and seascape transformation, and also more indirectly through pollution, for example.
- On the other hand, aquaculture has also enhanced provisioning services, both in the agriculture landscapes and in the seascape, thus leading to improved welfare.
- It also constitutes a substitute to today's terrestrial animal production, which for some sectors can be highly resource consuming.
- The question then is how to balance the negative and positive consequences from an environmental integrity perspective.

Priority actions

- To identify direct and indirect environmental effects from aquaculture activities, a wider system perspective is needed as trade in a globalized world connects farms to distant ecosystems (and markets).
- There is a need for an "ecosystem perspective" that extends far beyond the farm border (regional to global).
- A challenge is to improve our understanding of ecosystems functions and the services they provide.
- Integrated aquaculture should be looked upon as one of the potential tools facilitating sustainable development.

Expert panel presentation III.1: Promoting responsible use and conservation of aquatic biodiversity for sustainable aquaculture development

Lead panellist: John Benzie
Rapporteurs: Matthias Halwart and Ruth Garcia-Gomez
Panel members: Devin Bartley, Randall Brummett, Brian Davy, Ambekar Eknath, Matthias Halwart, G. Hulata, Zhu Jian, Graham Mair, Uthairat Na-Nakorn, Thuy T.T. Nguyen, R.S.V. Pullin, Igor Solar

Background

The world's wealth of aquatic biodiversity at gene, species and ecosystem levels provides great potential for the aquaculture sector to enhance its contribution to food security and meet

future challenges in feeding a growing human population. To realize and explore this potential, issues of access and use of aquatic genetic resources for aquaculture need to be considered. A global approach to responsible use and conservation, effective policies and plans, better information including characterization of aquatic genetic resources at different levels, and wider use of genetic applications in aquaculture are identified as some of the important elements needed towards an improved management of aquatic genetic resources. Salient issues regarding status and future trends on the sustainable use, conservation and exchange of aquatic genetic biodiversity should be adequately assessed if sustainable aquaculture development is to be promoted.

The projected increase in the world's human population over the next 50 years is thought to require an increase in food production of 1.5–2.0 times that currently achieved by food production systems. This increasing demand for fish as food in the face of static or declining production by capture fisheries can be met by increasing aquaculture production. However, the ability of aquaculture to achieve this will depend on accessing new areas of production, and increased efficiency of production from existing areas.

Issues

- Aquatic biodiversity contribution to food security and poverty alleviation.
- Characterization, utilization (including improvement and exchange) and conservation of aquatic genetic resources: main strategies of aquatic genetic resources management.
- Status and future trends towards sustainable use, conservation and exchange of aquatic genetic biodiversity.
- Access and fare and equitable benefit sharing of aquatic genetic resources.
- Information tools, including characterization of aquatic genetic resources at different levels.
- Genetic applications within the aquaculture sector.

Priority actions

- Improve information and data on the state of aquatic genetic resources at a global level, including wild populations, cultured strains, the state of application, and benefits of, genetic technologies; and the status of, and impacts on, wild populations including the effectiveness of technologies designed to mitigate such effects.
- This improved information should be shared through appropriate mechanisms, such as regional networks, reporting mechanisms to FAO, and FAO's work towards a State of the World on Aquatic Genetic Resources with the Commission on Genetic Resources for Food and Agriculture.
- Better focus investment in genetic R&D on establishing sound genetic resource management programs with clear objectives, and which provide the necessary foundation for application of a variety of other technologies and encourage their application to a) production and b) wild aquatic genetic resource protection.
- Encourage exchange among the diverse groups needed for better understanding of characterization, use and conservation activities, and improved technology transfer by, e.g. continued dissemination of sound resource material and advice already available.

- Strengthen the foundation for science based risk analysis and control (through increased understanding, capacities, knowledge, technology development and regulatory capability) of interactions between wild and cultured stocks.
- Continue access and exchange of aquatic genetic resources with adequate risk analysis and benefit sharing considerations taken into account.
- In formulating policies and laws, the unique character of aquatic genetic resources must be incorporated.

Expert panel presentation III.2: Addressing aquaculture-fisheries interactions through the implementation of the ecosystem approach to aquaculture (EAA)

Lead panellist: Doris Soto
Rapporteurs: Devin Bartley and Xiaowei Zhou
Panel members: Dr Doris Soto, Patrick White, Tim Dempster, Sena De Silva, Alejandro Flores, Yannis Karakassis, Gunnar Knapp, Javier Martinez, Weimin Miao, Yvonne Sadovy de Mitcheson, Eva Thorstad and Ronald Wiefels.

Background

The ecosystem approach to aquaculture (EAA) emphasises inter-sectoral complementarily by taking account of interactions between the activities within ecologically meaningful boundaries and multiple services of ecosystems. A main objective of the approach is to understand the status of aquaculture-fisheries interactions associated with the biological, technological, social, economic, environmental, policy, legal and other aspects of aquaculture development.

Issues

- Main issues include aspects of scoping, prioritising, management tools and plans (minimising negative effects and optimizing positive ones) within the context of the elements of ecosystem resilience, social and economic issues and the integration of aquaculture with other sectors.
- Aquaculture and culture-based fisheries have positive impacts including: establishment of new/additional fish resources for capture and recreational fisheries, provision of livelihoods, and conservation and improvement of certain fisheries through enhancement of overfished stocks. Potential negative impacts include: pressure on native fishery resources due to competition for food/habitat, predation and potential alteration of genetic diversity of native stocks. The issue is how to maximize positive benefits while minimizing negative of the sector.

Priority actions

- In order to ensure close integration between aquaculture and fisheries and the optimal management of multiple use of the same aquatic resources, the full set of ecosystem interactions needs to be considered.
- A priority area of study is stocking material from aquaculture facilities, which has been successfully used to inter alia mitigate nutrient overloading from aquaculture practices, thereby reducing fish kills and increasing the output from capture fisheries.

- Within the EAA, the identification of aquaculture/fisheries interactions as relevant issues is a first step. This must be done with the relevant stakeholders. The root of the issues must be recognised and operational objectives must be agreed upon within the existing policy frameworks. Concepts and indicators of environmental carrying capacity within ecosystem boundaries and a broader social and economic appraisal for both aquaculture and fisheries are required.
- Regular monitoring is required to assess the impacts and provide feed-back into management and control.

Expert panel presentation III.3: Improving biosecurity: a necessity for aquaculture sustainability

Lead panellist: Mike Hine
Rapporteurs: Melba Reantaso and Devin Bartley
Panel members: Sandra Adams, Richard Arthur, Devin Bartley, Melba G. Bondad-Reantaso, Cristina Chávez, Jesper Clausen, Tim Flegel, Roar Gudding, Eric Hallerman, Chad Hewitt, Iddya Karunasagar, C.V. Mohan, Ramesh Perera, Peter Smith, Rohana Subasinghe, Robin Wardle

Background

Biosecurity in aquaculture includes aquatic animal health, invasive species, genetic risks, public health and climate change impacts – prevention being the key objective and moving towards One Health integrating people, animals and environment as the overall goal. Risk analysis, an important decision-making tool, is a unifying concept across different biosecurity sectors. However, the focus of this report is limited to fish health issues. It should be supported with infrastructure, human capacity and information. An integrated strategy to manage biosecurity, business, environmental and social risks will better promote sustainable growth of the sector.

Issues

- Standards on aquatic animal health for known pathogens, aquatic pests and food safety are already available, but greater commitment by governments is needed to implement these standards which also need to better reach the grassroots levels of the industry and the community stakeholders. Efforts should be focused on prevention, and maintaining healthy and safe aquatic production.
- Effective implementation of biosecurity needs well-resourced governance framework (legislation, compliance and enforcement, infrastructure, human capacity and information).
- Development of veterinary medicines for aquaculture (e.g. pharmaceuticals and vaccines), while having an important role to overall health management requires huge investment. Research and documentation must demonstrate that the products are both effective and safe to the treated animal, the environment and to the consumer.
- An important research challenge will be multidisciplinary approaches to measure overall health status over a particular industry and to evaluate the relative contribution of individual or multiple policies/technologies to improve the health status.

Priority actions

- Strong government commitment to implement international standards through national strategies to manage biosecurity risks in aquaculture.
- Development of low-cost diagnostic and disease/pest identification tools designed for farmers/farmer clusters or local agencies supported by education/extension.
- Creation of a regulatory environment that ensures that the safety of consumers is protected while still allowing the veterinary medicinal product to be developed and sold in a cost effective manner. Economical barriers for vaccine development for lower value species need to be reconsidered to ensure that they can be treated safely; approaches are available in EU and the USA to assist in this process.
- Documentation of the occurrence of antimicrobial resistant bacteria in cultured products and their association with use of antimicrobials in aquaculture or other origins (water contaminated with faecal resistant bacteria from livestock and humans).
- Promotion of BMPs and GAqPs to address pre-harvest food safety issues to safeguard public health especially the rural communities.
- Development of international standards for emerging diseases of aquatic animals and aquatic pests compared to the terrestrial scenario, i.e. complementing the pathogen/pest specific approach to biosecurity with standards that deter high risk practices.

Thematic session IV: Responding to market demands and challenges: ensuring food safety and quality, economic viability and sectoral diversity

Plenary lecture IV: Responding to market demands and challenges: making aquaculture a competitive food producing sector for the benefit of world consumers

Lead authors: Lara Barazi-Yeroulanos
Rapporteurs: Audum Lem and Masanami Izumi

Background

Questions are raised about the environmental sustainability of aquaculture. However, for a sector to be fully sustainable, it also has to be economically viable and socially acceptable.

The aquaculture industry is characterized by strong cyclicality. This is disruptive in its social and economic repercussions. It also represents an obstacle to sustainable development because a producer in financial difficulties can less afford to be conscious of environmental issues.

Issues

- Understanding and responding to the market is essential. In a globalized market, a company will fail if it produces something the market does not want, in the wrong form, at the wrong price, or in the wrong quantities. In the same manner, companies must address consumer concern about the sustainability of aquaculture.

- The global aquaculture industry is a commodity market characterized by strong competition and high price volatility. Producers are mostly small and medium enterprises (SMEs) with limited resources to invest in the promotion of their products. The demand side is dominated by a few, large retail chains which request compliance to their own quality labels but offering declining prices which are not necessarily passed on to the consumer.
- Successful marketing communicates a targeted message to a specific audience. Understanding and evaluating the economic aspects of marketing is vital for building an effective marketing strategy and a coherent corporate vision. The role of information gathering, management and analysis for decision making is the key. In terms of effective market placement, the activity in question and its geographic origin can play an important role in the consumers' acceptability and familiarity with the product.
- The distance from producers to the consumers can be mitigated by voluntary clusters or production groupings. But this must be accompanied by reducing costs, improving production planning to better coordinate with demand and strengthen the negotiation position vis-à-vis the market channels Responses to market challenges must be based on a market focused strategy and not on production oriented approaches.
- Collective action can be an important tool for producers in communicating with their final consumers. Communication regarding producer activities, origin, and production methods is necessary for conveying the benefits of aquaculture to consumers and promote both the production and consumption of responsibly produced seafood.

Priority actions

- Governments should promote integration of the small-scale aquaculture sector into the globalized market economy.
- Governments should promote and increase the sector's competitiveness by facilitating intra-sectoral cooperation, collaboration and sharing of experience, facilitating economies of scale in purchasing, processing, certification and marketing.
- With a growing share of seafood consumption represented by aquaculture production, the aquaculture sector will increasingly influence price formation, product- and market development in the overall fisheries sector. This will present opportunities to producers, but in order to be successful, companies will need to analyze, interpret and adapt to changes in customer and consumer needs. To this purpose, policy makers are encouraged to promote transparency with improved data collection and dissemination throughout the value-chain.

Expert panel presentation IV.1: Facilitating market access for producers: addressing market access requirements, evolving consumer needs, and trends in product development and distribution

Lead panellist: Jonathan Banks
Rapporteurs: Audun Lem and Junning Cai
Panel members: Jimmy Young, Nobuyuki Yagi, Atle Guttormsen, John Filose, Dominique Gautier, Thomas Reardon, Roy Palmer, Ferit Rad, Jim Anderson, Nicole Franz

Background

The market for fish and fisheries products is increasingly globalized with close to 40percent of total production entering international trade. Access to markets is therefore crucial to producers as is their ability to adhere to formal import requirements and to produce according to evolving customer needs. The rise of aquaculture in production and trade is having a significant impact on prices, product development and distribution, and consumption patterns.

Issues

- There are large regional differences in fish consumption, and within regions. Urbanization and the growth of modern distribution channels have increased the availability of fish. Economic and cultural factors influence the level of consumption. Health and nutrition play a growing role in consumers' purchasing decisions.
- Increased demand offers opportunities to aquaculture producers but challenges their ability to find innovative ways to supply markets. Producers increasingly utilise new technology to provide more targeted portion sizes, taste varieties as well as innovative packaging and communication strategies. Suppliers are increasingly requested to adhere to more accurate and transparent product specifications including net edible weights.
- Adhering to market access requirements is a prerequisite for entering international markets. Their changing nature, including the emergence of private and voluntary standards and requests for certification and labels, put additional pressure on suppliers.
- Of particular importance is the need to facilitate market access for small-scale producers, whether in domestic, regional or international markets, and to increase their competitiveness through improved organizational and institutional arrangements.
- Over the next decade, aquaculture's share of supply for human consumption will rise to between 60 and 70 percent. This will have a profound impact on the sector's ability to shape world markets in areas of pricing, product development, distribution and consumption. It will also challenge the sector's ability to respond successfully to evolving consumer needs.

Priority actions

- Governments should promote integration of the small-scale aquaculture sector into the globalised market economy.
- Governments should promote and increase the sector's competitiveness by facilitating intra-sectoral cooperation, collaboration and sharing of experience, facilitating economies of scale in purchasing, processing, certification and marketing.
- With a growing share of seafood consumption represented by aquaculture production, the aquaculture sector will increasingly influence price formation, product and market development in the overall fisheries sector. This will present opportunities to producers, but in order to be successful, companies will need to analyze, interpret and adapt to changes in customer and consumer needs. To this purpose, policy makers are encouraged to promote transparency with improved data collection and dissemination throughout the value-chain.
- Governments should ensure that private standards do not result in unnecessary barriers to trade for developing country producers.

Expert panel presentation IV.2: Consumer assurance: market-based quality schemes, certification and traceability, ecolabelling, retailer specifications

Lead panellist: Lahsen Ababouch
Rapporteurs: Iddya Karunasagar
Panel members: Patrick Blow, Flavio Corsin, Flavio, Jon Harman, Ana Maria Echevarria, Gregory J. Morrow

Background

As the contribution of aquaculture to global fish production and international trade is increasing, there are concerns raised about environmental impacts; food safety and consumer protection; animal health and welfare; social responsibility; traceability and consumer information along the aquaculture supply chain. Several non-governmental organisations (NGOs) and major retailers are coming up with certification schemes and private standards to address these issues. Producers and processors are confronted with multiplicity of standards: public standards such as national standards and various market requirements of trading partner countries as well as private standards.

Issues

Proliferation of standards and certification schemes has led to additional burden on the producers and processors. Consumers are also confused regarding their value. There are three major issues to be addressed:

- If trade liberalisation is to bring benefits to all, including developing countries, raising market standards should not constitute a barrier or additional impediments for market access for producers and processors from developing countries.
- In the absence of regulatory frameworks, the setting/adoption of market standards by a company or retailers with significant market power may increase the risk of anti-competitive behaviour and the power could be used for lowering prices throughout the supply chain.
- When public standards or requirements are perceived as trade barriers, they can be challenged within the framework of World Trade Organization (WTO) agreements, but there are no mechanisms to deal with private standards that constitute technical barrier for trade.

Priority actions

- Strengthen the capacity of developing countries to meet Codex standards and guidelines. This may reduce some of the drivers for proliferation of private standards.
- There is a need for dialogue between public and private standard setting bodies. Private standard setting bodies should be encouraged to participate in the Codex process and harmonise their standards with Codex standards.
- Technical and scientific capacity of developing countries should be enhanced to demonstrate equivalence of their food safety management systems with market based requirements.
- There should be increased stakeholder participation, particularly of small producers and small food business operators in the process of development of market-based standards

- Private standard setting bodies should ensure proper distribution of benefits among the various stakeholders in the supply chain.

Presentation IV.3: Organic aquaculture: the future of expanding niche markets

Lead panellist: Mark Prein
Rapporteurs: Ruth Garcia-Gomez and Matthias Halwart
Panel members: Marcus Ballauf, Stefan Bergleiter, Deborah Brister, Matthias Halwart, Kritsada Hongrat, Jens Kahle, Tobias Lasner, Audun Lem, Omre Lev, Catherine Morrison, Marc Nolting, Ziad Shehadeh, Andreas Stamer, Alexandre A. Wainberg.

Background

There is unprecedented growth in the demand for organic food, and new areas of organic food production, such as fish, are proving increasingly popular. The term "organic" implies that certain standards for production and processing are adhered to and that impartial organizations take part in the inspection and certification process. Organic agriculture are holistic production management systems which promote and enhance agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. Organic production systems are based on specific and precise standards of production which aim at achieving optimal agro-ecosystems which are socially, ecologically and economically sustainable.
Regarding the aquaculture sector, a group of factors, such as diminishing fishery harvests, wild fish food-safety issues, environmental concerns, increased fish consumption and the increasing market share of organic foods, have combined to focus attention on "organic aquaculture." As a result, consumer demand has driven the organic production of finfish, shellfish, and other aquatic species into the mainstream during the last decade. Organic aquaculture has attracted the attention of researchers and experts from several academic disciplines, aquaculturists, as well as that of environmental advocates, entrepreneurial innovators and consumers. During the last decade a small number of "certified" and "non-certified" organic fish products have made it to the retail market place. While the regulatory specifics still need to be consolidated, and harmonized, this new organic market niche has significant potential for growth in the future. Presently, there are many contradictions and unresolved questions facing the organic aquaculture production and market sector.

Issues

The questions below were the focus of the presentation:

- Definition and principles of organic farming, what does it entail, what is organic aquaculture?
- Evolution of the concept of "organic" and of the definition of organic farming systems during the last 10 years.
- Production and demand of organic aquaculture products during the past 10 years: trends and fluctuations.
- Range of production systems and species, growth in production volume in the past 10 years.
- Potential status of various future markets associated with the biological, technological, social, economic, environmental, policy, legal and other aspects within the wider context of aquaculture development.
- Organic aquaculture markets: competition and localization.

- Post-harvest processing, value addition, issues of transport as well as overall characteristics of value chains in organic aquaculture.
- Consumer perception and major characteristics of the present clientele where organic aquaculture markets have developed. Diversifying consumer perceptions of organic aquaculture (ethics, health and lifestyle); consumer purchasing behaviour towards organic aquaculture products. New markets for organic aquaculture due to increasing consumer purchasing power in emerging economies.
- Organic aquaculture versus competing standards (e.g. continuous ongoing process of tightening of industry standards such as Aquaculture Certification Council/Best Aquaculture Practices (ACC/BAP), Good Agricultural Practice (GLOBALG.A.P.,) World Wildlife Fund Pangasius Aquaculture Dialogue (WWF-PAD), Aquaculture Stewardship Council (ASC) providing assurance on several of the demand categories of consumers) and labels.
- Existing legislation: new EU legislation: basic ideas and main gaps: What means the new EU regulation for the organic aquaculture production and market? How does it change the private sector?
- EU and USA organic aquaculture legislation: need for harmonization?
- Organizational standards, emerging national standards, national labels, private labels and their recognition in other countries.
- Feeds in organic aquaculture (supply bottlenecks, accepted fish meal sources, alternative protein and fatty acid sources, plant-based ingredients and limiting effects on sector growth) and alternative solutions. Main bottlenecks for further conversion to organic aquaculture, with special attention to developing countries.
- Profiles and illustrative case studies of organic aquaculture primary producers, including species and technologies. Success criteria for producers, processors, and retailers in organic aquaculture.
- Tolerance threshold for Genetically Modified Organism (GMO) trace contamination in feeds for organic aquaculture; trustworthiness and compliance: the heightened role for controls, their costs, the damaging effect of scandals and the role of independent consumer safety and testing organizations.

Priority action

- Increase efficiency of value chains.
- Address the feed bottleneck: implement pilot programs of contract farming of feed ingredients at national level to establish local supply of certified organic ingredients.
- Facilitate open discussions among relevant stakeholders in order to address the “feed bottleneck” problem.
- Joint ventures in the production chain from producers to retailers to foster successful operations and development of efficient value chains.
- Facilitate education and information sharing with consumers and decision makers.
- Encourage policy support by national programs to create enabling environment for the organic aquaculture sector to develop and foster expansion.
- Promote harmonization of international standards to reduce certification costs for producers.
- Benchmarking vs. Harmonization: Benchmarking of organic aquaculture standards to establish equivalence and opportunities for harmonization, as well as communicate comparative differences to consumers/stakeholders.

- Establish applied research and development, as well as demonstration facilities as there are no existing opportunities to learn technologies and procedures through hands-on experience and practical experience/training.
- Establish micro insurance schemes.

Thematic session V: Improving knowledge, information, R&D and regional cooperation in aquaculture

Plenary lecture V: Improving knowledge, information, research, extension and communication on aquaculture

Lead author: Gary L. Jensen
Rapporteurs: Xiaowei Zhou and Devin Bartley

Background

Aquaculture has become a critical source of nutritious and safe food. Aquaculture productivity in the future faces increasing pressures from land degradation, climate change, scarce water supplies, competition for input resources, and increasing global demand. Sustaining increase in aquaculture production to meet future food security needs will depend on the ability of institutions to protect aquatic ecosystems amidst strong pressures for increased local consumption and international trade. Research, extension, policy and information systems are powerful mechanisms that must address several dimensions of food security at once. Some challenges can benefit from reshaping research towards a new and different future and building new alliances and synergies to address many key elements articulated in the *Bangkok Declaration and Strategy*.

Issues

- Need to translate and synthesize pioneering scientific breakthroughs worldwide to create high-impact benefits from widespread adoption.
- Need more resources and investments in training and equipment to develop the human resources capacity for advancing technologies, tools and practices to meet the challenges of expanding sustainable aquaculture production.
- Need for collaboration among public and private services to integrate new discovery knowledge and information sharing.
- Need for public education to improve the image of and knowledge about responsible aquaculture.
- Need for new decision-making tools and effective communication of case studies and lessons learned to avoid unsustainable development strategies.
- Need for motivated extension and outreach to make impact-oriented research reach farmers and consumers.
- Need for accurate and timely statistics on production value and volume, species and locations at national levels (that can be aggregated for global trend analysis, market information systems and forecasting) to aid public and private investments, development and trade policies.

Priority actions

- Open solicitations for new ideas to accelerate creativity.
- Field-based or on-farm research and demonstration to engage farmers with realistic cost/benefit analyses for effective socioeconomic development processes.
- Rigorous evaluation and planning processes to align collective knowledge systems and limited resources across different programmes for strategic collaborative frameworks to solve complex and intractable problems.
- Bilateral and multilateral collaborations among scientific, technical and policy exchange programmes to narrow information and scientific knowledge gaps.

Expert panel presentation V.1: Investing in research, communication, training/extension for responsible aquaculture

Lead panellist: Brian Davy
Rapporteurs: Devin Bartley and Doris Soto
Panel members: V. Bhat, Yuan Derun, Sena De Silva, Courtney Hough, Rodrigo Infante, Brett Ingram, N. T. Phoung, Doris Soto and Guzel Yucel-Gier.

Background

Knowledge has been critically important to the development of aquaculture.
However, few scholarly investigations probe aquaculture development through a knowledge lens. Other sectors are examining knowledge in detail, but this issue seems to be a relatively untouched line of scholarly investigation by researchers in the aquaculture sector.

Issues

- Information generation is increasing exponentially in the field of aquaculture. Identifying and applying the needed knowledge, and just keeping up with present challenges is not an easy task. There is a clear recognition of the importance of networking and related forms of knowledge sharing and learning. The Network of Aquaculture Centres in Asia-Pacific and European Aquaculture Technology and Innovation Platform are ongoing knowledge sharing networks using knowledge platforms and different knowledge management activities. There are a number of issues that need to be addressed, such as whether aquaculture as a sector is adequately examining/managing available knowledge; for example, traditional knowledge sources or some of the new thinking in the social and information/communication sciences. Selected cases raise a variety of sector growth questions around knowledge production and particularly, its communication and use, and more importantly, its communication among the changing audiences, as aquaculture continues to attract an increasing variety of new stakeholders, as it attempts to deal with a widening set of change processes often involving a complex mix of governance and social change challenges.

Priority actions

- Close knowledge gap between stakeholders to accelerate multiple forms of knowledge transfer and foster stronger demand-driven and relevant research.
- Improve learning capabilities and competency on how to find, access and interpret information.

- Support strengthened knowledge transfer processes e.g. through extension and knowledge brokering; knowledge "platforms/brokers" allow improved interpretation and synthesis of information.
- Promote and support creation of aquaculture-based farmer associations, clusters, networks, etc.
- Improve cost effective access to use of information technologies (Internet, mobile phones) to facilitate knowledge transfer, including online training.

Expert panel presentation V.2: Servicing the aquaculture sector: role of state and private sectors

Lead panelist: Michael Phillips
Rapporteurs: José Aguilar-Manjarrez and Doris Soto
Panel members: William Collis, Alex Flores-Nava, Dominique Gautier, Courtney Hough, Le Thanh Luu, P.A. Padiyar, Roy Palmer, Jharendu Pant, Tim Pickering, Rohana Subasinghe, N.R. Umesh

Background

Aquaculture requires a diverse range of services that are important from planning through to operation of aquaculture enterprises, and throughout the whole "value chain" of aquaculture from input supplies, production systems, to post harvest handling, trading and processing, marketing and consumption. Services are relevant, in various ways, for all types of aquaculture systems and species, at all scales, from subsistence farming through the spectrum of aquaculture enterprises from micro and small-scale household managed farms, to medium and large-scale business. Services have been and always will be an essential part of aquaculture development and successful aquaculture development requires that the required services are in place.

Issues

- Growth in aquaculture over the past 10 years, under the influence of a range of global drivers, has changed not only the nature of services required but also the way in which these services are delivered. In less developed and newly emerging aquaculture countries, there remain considerable gaps in services required, particularly in rural areas.
- Market and competitive pressures, such as the recent moves towards certification and food safety and quality assurance, have created new requirements for services for aquaculture.
- There have been some major changes in the way that services are delivered to aquaculture farmers, and opportunities emerging for improvements in addressing new needs, and filling existing gaps, particularly with the rising role of communication technologies and internet.
- In many countries, the government role in extension services has reduced during the past 10 years while the role of private business has increased. Many rural farmers though still lack access to the necessary services, a problem widely felt throughout the agriculture sector in many developing nations.

Priority actions

- There is a need for equitable access, scaling up to reach large numbers of small rural farmers and getting the right mix of services delivered.
- There is a need particular to invest in sustainable approaches to delivery of services to the "bottom of the pyramid".
- There are concerns over reduced public expenditure, but need for more public and private sector investment in aquaculture services.
- Both state and private sector have roles to play. There is a need to define roles and responsibilities and to ensure coverage, complementarily and impact.
- Sustainability of servicing institutions is an important consideration and there is a need for business models that work for diverse range of services.
- Whilst private investment in services needs to be mobilized, public investment is also essential – particularly for assisting small-holders.
- Experience suggests that formation of farmer groups or associations is an entry point for improving the access of small-scale farmers to services. Such local-level farmers' organizations facilitate access to services, and empower for bargaining and influence on access to services. Successful models need to be shared, networks created and investments made to scale up.
- Modern Information and Communications Technologies (ICT) tools offer new ways to deliver services to a wide range of stakeholders at scale and should be further pursued.
- To facilitate investment in improving services, strategic plan(s) should be developed at country/regional level to prioritize needs/gaps and coordinated/complementary approach to service improvements.

Expert panel presentation V.3: Progressing aquaculture in this knowledge economy through virtual technology and decision-making tools for novel management

Lead panelist: Joao G. Ferreira
Rapporteurs: José Aguilar-Manjarrez and Matthias Halwart
Panel members: José Aguilar-Manjarrez, Cedric Bacher, Kenny Black, Dong Shuanglin, Jon Grant, Eileen Hofmann, Jim McDaid Kapetsky, PingSun Leung, Roberto Pastres, Oivind Strand, Zhu Changbo

Background

Attention is presently turning to the processes, methods, and tools that allow the principles of the ecosystem approach to aquaculture to be translated into practical implementation. An essential element for this is the use of virtual technology and decision-support tools, particularly if developing nations are to promote the key elements of aquaculture sustainability.

Issues

- The aquaculture industry is going to be affected by many different issues and trends over the coming years, often operating concurrently, sometimes in unexpected ways. Virtual technology and decision-support tools will play an important role in addressing many of these issues. Some of the directions and challenges are innovations that will drive virtual technology, information exchange and networking, links between industry and research centres, collaboration between developed and developing countries, strategic alliances in

developing countries, and making virtual technology tools more production- and management-oriented.

- Virtual tools will have to be adapted to local realities and conditions to effectively become useful (and used) in the future, in particular if they are applied for consensus generation and to encourage a participatory approach to management. This requires a compromise with respect to ease of use, data requirements, and scientific complexity.

Priority actions

- Make virtual technology tools more production– and management-oriented, fully accounting for socio-economic aspects.
- Adapt such tools to local realities and conditions with respect to ease of use, data requirements, and scientific complexity.
- Strengthen collaboration between developed and with developing countries, mainly through educational, research, and training programmes, including data quality and data sharing.
- Reinforce strategic alliances for the implementation of virtual technology in developing countries, ensuring the empowerment of local partners such as in ground-frothing and in modelling.

Expert panel presentation V.4: Information and data needs: a strategy for improving aquaculture statistics

Lead panellist: Zhou Xiaowei
Rapporteurs: Xiaowei Zhou and Devin Bartley
Panel members: Alan Lowther, Rohana Subasinghe

Background

As aquaculture development is changing from resource-based to knowledge-based, high quality aquaculture statistics are needed to monitor the sector performance and formulate sound policies and management strategies to guide aquaculture development in the future. Collection of world aquaculture statistics is FAO's global mandate. Aquaculture data are collected through questionnaires sent annually to over 230 countries and territories. On average, about 150 countries and territories return the questionnaires to FAO with data of varying degrees of detail, completeness, timeliness and consistency. Data validation and processing include communication with data providers, FAO in-house data processing and estimation for missing data using other information. World aquaculture statistics are available from FAO via Fishery and Aquaculture Statistics Yearbook, Status of World Fishery and Aquaculture (SOFIA) and internet-based aquaculture database such as FishStat Plus.

Issues

- Existing aquaculture statistics are insufficient or inadequate for quantitative measurement of aquaculture performance.
- Some data on aquaculture such as surface areas and hatchery production are collected but not disseminated because of their incompleteness and poor quality.
- Progresses in improving aquaculture statistics is scattered and without harmonized efforts and strategies.

- Need a global strategy in aquaculture data collection to cover all aquaculture production practices for both food and non-food uses, in fresh, brackish and marine waters, and including both commercial and small-scale aquaculture.
- Need information and data on socioeconomic aspects of aquaculture activities, including aquaculture's impacts on natural resources (especially land and waters), ecosystems and bio-diversities.

Priority actions

- Aquaculture statistics methodologies and standards need to address the increasing interest in aquaculture-capture inter-actions.
- Internationally accepted concepts, definitions and standards should be developed to guide Members to be able to measure statistically the contribution of aquaculture produced seeds to culture-based-fishery production and wild caught seeds used for aquaculture.
- FAO should promote among Member states the sense of ownership and the concepts that reporting governments are owners of reported data to FAO while FAO only compiles national data globally.
- FAO should collect feedback from data reporting governments periodically on FAO published data for their own respective countries.
- Build capacity in developing countries to ensure their full participation in and benefit from statistics collection.
- Facilitate inter-agency communication and coordination to ensure socio-economic data on small-scale aquaculture.
- States should facilitate provision and exchange of aquaculture information with FAO and ensure the sustainability of their aquaculture data systems in meeting the needs of aquaculture policy-making and management.

Thematic session VI: Enhancing the contribution of aquaculture to poverty alleviation, food security and rural development

Plenary lecture VI: Enhancing contribution of aquaculture to poverty alleviation, food security and rural development

Lead author: Modadugu Gupta
Rapporteurs: Matthias Halwart and Nathanael Hishamunda

Background

Aquaculture has grown tremendously in the last few decades, from less than a million tonnes per annum in the 1950s to over 50 million tonnes in 2008. However, the annual growth of aquaculture has declined from 11.8percent percent in 1985–1995 to 7.1 percent during the following decade and to 6.1 percent during 2004–2006.

Further, environmental problems are increasing and the number of small farms is decreasing, threatening the livelihood of small farmers. Since 75 percent of global aquaculture production comes from small-scale farms in developing countries, involving poor rural households and the landless requires addressing a number of issues to ensure that the livelihoods and food security of all those involved in the sector are not threatened, but that aquaculture also contributes to the food and nutritional security of the countries.

Issues

- **Science relevant to small-scale farmers' needs:** the observed high gap between realized fish production and the potential production because of use of f improved technologies indicates that it is necessary to develop technologies that can be easily adopted by small-scale farmers. It also suggests utilizing dissemination technologies that open new opportunities for knowledge and information sharing between researchers and farmers.
- **Aquaculture in the context of rural development:** small-scale rural aquaculture is often not seen from the perspective of rural development, but as a stand-alone activity and not incorporated with other farming activities.
- **Seed production and seed certification:** in spite of the availability of induced breeding technology for over five decades, aquaculture of some species still depends on the wild for seed supply.
- **Application of biotechnologies:** a broader and more responsible application of biotechnologies in aquaculture, mostly to genetic improvement in order to develop improved breeds for aquaculture is lacking, and, where this application is done, the improved breeds/strains are not always accessible to small-scale farmers.
- **Aquatic animal health and biosecurity:** with the expansion and intensification of aquaculture in the forthcoming years, fish health management and bio-security as a holistic approach needs to be given greater importance.
- **Feeds and feeding strategies:** Feeds constitute about 40–60 percent of total costs in aquaculture. There is a need to look for efficient and sustainable feed raw materials and alternate vegetable proteins to replace the animal proteins in the fish feeds and also to develop culture techniques for more herbivores and filter feeders.
- **Food safety and product quality:** Rising market standards in terms of food safety, quality, traceability and certification should not form a barrier or additional impediment for entry of products produced by small-scale farmers.
- **Access to credit:** Micro-credit delivery is needed in order to motivate small farmers to take up new technologies and increase production.
- **Involvement of landless:** Excellent opportunities exist for the involvement of rural landless in culture-based capture fisheries.
- **Culture of non-food species:** culture of ornamental fish and seaweed farming offer excellent opportunities for small farmers. Yet, these opportunities are extensively not exploited.
- **Markets and marketing:** small-scale farmers are not always able to get the needed inputs at reasonable prices and lack bargaining power to market their products. Further, stringent food safety and product quality requirements of domestic and export markets make individual small farmers vulnerable. As has been demonstrated in some of the countries of Asia, formation of farmers' associations/cooperatives/clubs has resulted in farmers being able to negotiate input prices, get better prices for their products and minimize environmental impacts.
- **Governance of the sector:** to encourage aquaculture growth, it is necessary for the governments to treat aquaculture on par with agriculture, for subsidies, tariffs for power and water, taxation, etc. Yet, this is not often the case.

Priority actions

- Specific information related to contribution of aquaculture to poverty alleviation and food security need to be generated.
- To empower and protect from shocks of globalisation both small-scale farmers and other stakeholders (who are relevant in the fish-food value chain) it is necessary to organize them into clusters/societies.
- Redefine all people within aquaculture value chains, in particular producers, by their vulnerability and their relationship to the activity.
- Document impacts and pathways of aquaculture on poverty alleviation at multiple levels, across public and private led initiatives.
- Focus support on adaptive approaches across a broadly defined range of aquaculture initiatives to where it has maximum impact for the most vulnerable and marginalized people in the chain (not necessarily producers).
- Focus support on adaptive approaches across a broadly defined range of aquaculture initiatives to where it has maximum impact for the most vulnerable and marginalized people in the chain (not necessarily producers). Forms of support should either:
  1) Be based on an expectation that they will cost-effectively *transform* poor livelihoods through sustained improvements in employment and result in measureable improvements in well-being or
  2) Promote significant *incremental* improvements to livelihoods that will prevent declines into poverty for people currently above locally perceived levels
- Include human capacity development and especially gender in the Phuket Declaration.
- Statistics need to be gender disaggregated. Data collection and documentation to include gender roles and relations throughout the aquaculture value chain and to assess training and educational needs at all levels in aquaculture.
- Promote the inclusion of social science disciplines in aquaculture curriculum and training.
- Support the formation of platforms/networks of professionals to enhance the sharing of information and experiences, and facilitate harmonization of curriculum and integration of women in the profession.
- Make assessment of institutional arrangements, organizational culture and practices and curriculum from a gender perspective to create enabling working environment for women and men professionals and farmers.
- Document indigenous technology and innovations prevalent in different countries, validate the technologies through scientist-farmer partnership and scale up good practices to bring better benefits to people.
- Promote responsible use and control of aquatic alien species (FAO technical guidelines on invasive alien species (IAS) development) in order to assure the conservation of aquatic biodiversity; which is a crucial resource for indigenous population and small-scale producers.
- Promote interaction between the scientific community, students and farmers at field level.
- Promote research, outreach and extension systems in partnership with policy makers, scientists and farmers in order to address the field problems.
- Invite policy makers to experience field realities with farmer innovators.
- Increase the role of farmers in research planning and implementation.
- Promote farmer-to-farmer exchange in all possible contexts and opportunities.

Expert panel presentation VI.1: Protecting small-scale farmers: a reality within a globalized economy?

Lead panellist: Rohana Subasinghe
Rapporteurs: Audun Lem and Thomas MothPoulsen
Panel members: Imtiaz Ahmad, John Arnold, Laila Kassam, Santhana Krishnan, Kirby Lanerolle, Leena Nair, Betty Nyandat, Arun Padiyar, Michael Phillips, Waraporn Prompoj, Melba Reantaso, Weimin Miao.

Background

As the fastest growing food sector in the world, aquaculture has the potential to play an important role in poverty alleviation and food security improvement, especially since small-scale farmers are the major contributors to aquaculture production in many countries. Small-scale aquaculture is a highly innovative sector important for rural development, communities, employment, poverty reduction and environmental sustainability. Under the trend of globalization and trade liberalization of aquaculture products, small-scale aquaculture faces the challenge of being marginalized. Whether and how small-scale aquaculture can remain competitive in global aquaculture has become an increasingly urgent issue.

Issues

- Small-scale aquaculture lacks economy of scale in both production and marketing.
- Small-scale farmers lack access to financial resources to invest in change.
- Small-scale farmers lack access to markets, technology, and business knowledge.
- Current institutional and policy orientation is unfavourable to small-scale aquaculture. e.g. commercial or government services are less oriented towards the small-scale farmer.

Priority actions

- Recognize the crucial role of small-scale farmers in aquaculture production and trade.
- Organize small-scale farmers into farmer groups.
- Assist small-scale farmers in exploring domestic and niche markets.
- Assist small-scale farmers in improving productivity.
- Provide technical and marketing services for small-scale farmers.
- Provide information and financial services to small-scale farmers.
- Encourage private investments in small-scale aquaculture production and services.
- Orient educational and technical institutions towards the small-scale aquaculture sector.
- Promote trade rules and guidelines that consider the needs and realities of the small-scale sector.
- Promote international cooperation across market chain to increase the competitiveness of small-scale aquaculture.
- Promote certification and quality assurance schemes that consider the needs and constraints of small-scale farmers.

Expert panel presentation VI 2: Alleviating poverty through aquaculture: how can we improve?

Lead panellist: David Little
Rapporteurs: Junning Cai and Melba Reantaso
Panel members: Imtiazuddin Ahmed, Benoy Barman, Ben Belton, Malcolm Beveridge, Randy Brummett, Simon Bush, Harvey Demaine, Peter Edwards, Gulam Kibria, Jack Morales, Francis Murray, Mudnakudu Nandeesha, Sugiyama Shunji, Rohana Subasinghe, Fatchuri Sukadi

Background

Aquaculture has grown strongly during the past two decades. Fish has become a major source of high quality animal protein in many poor countries. A large portion of aquaculture products is exported by developing countries to developed countries for foreign exchange earnings. Based on various case studies, aquaculture is found to contribute to poverty alleviation in both transformative and incremental modes and at various scales. Aquaculture is expected to continue and improve its contribution to food security and poverty alleviation.

Issues

The questions below were the focus of the presentation:

- Given conflicting and complementary characteristics of aquaculture activities within complex livelihood portfolios, how can aquaculture development become a strategy to reduce poverty of targeted groups?
- What are the positive and negative impacts of aquaculture on poverty alleviation? How can the positive impacts be facilitated and the negative impacts be mitigated? How can aquaculture be integrated in water and other resource management to achieve sustainable contribution to poverty alleviation?
- Should the “small-farm” development model be promoted as the way to realize the potential of aquaculture’s contribution to poverty alleviation? Are there alternative models? What are the impacts of industrialization and consolidation of commercial aquaculture on smaller-scale enterprises and poorer groups?

Priority actions

- Regarding certification in aquaculture, small farmers need assistance in choosing the right standards and complying with existing standards. The distribution of benefits and costs of certification should be measured to understand the social impacts of certification (e.g. whether small farmers benefit from certification programs). Government should also make sure that certifying bodies are competent.
- Government should provide clear property rights and hence long-term security to motivate long-term behaviours from small farmers (e.g. more responsible farming practices, investments, etc.)
- In some countries (e.g. Namibia), a majority of small fish farmers are part-time and seasonal fish farmers. Such farmers need assistance and motivation to make fish farming a sustainable livelihood source. The roles of government and NGOs in this respect should be explored.

- Poverty should be more clearly defined; the "one dollar a day" standard should be used in the right context. Determination of poverty lines should take into consideration of individual countries' specific situations.
- Aquaculture planning should help predict potential production expansion so that constraints (e.g. lack of seed) can be dealt with in advance. Aquaculture planning should also help identify who are the poor and what kind of help is needed.

Expert panel presentation VI.3: Addressing human capital development and gender issues in the aquaculture sector

Lead panel expert: Meryl Williams
Rapporteurs: Cecile Brugère and Melba Reantaso
Panel members: Rene Agbayani, Ram Bhujel, Cecile Brugere, Poh Sze Choo, Jean Dhont, Kibria Ghulam, Kyoko Kusabe, David Little, M.C. Nandeesha, Melba Reantaso Patrick Sorgeloos, Angel Galmiche Tejeda, Nireka Weeratunge, Stella Williams, Pao Xu

Background

Human capacity development and gender are closely related subjects. There has been progress in the provision of education and training in aquaculture and in the formation of intergovernmental networking. The number of women participating in the sector is lower compared to men but has been increasing at all stages of the chain, although women tend to get lower benefits. More women are also found in higher numbers in aquaculture educational courses.

Issues

- Rapid aquaculture development requires accelerated human capacity development. Discrepancies in education systems, communication barriers, attracting students and the inclusion of social sciences in aquaculture curricula constrain progress in human capacity development for aquaculture.
- Gender was not mentioned in the Bangkok Declaration and the challenge of creating greater gender equity in the aquaculture sector remains.
- In addition to hampering gender analysis and the potential of aquaculture to shake some social norms, lack of gender-disaggregated data and collection contributes to the continuous incorrect identification of women as 'poor'.

Priority actions

- Include human capacity development and especially gender in the Phuket Declaration!
- Make sure that statistics are gender disaggregated. Tackle data collection requirements to document gender roles and relations throughout the aquaculture value chain and to assess training and educational needs at all levels in aquaculture.
- Promote the inclusion of social science disciplines (including business administration, sociology, anthropology, geography development studies) in aquaculture curriculum and training to keep up with the broader needs of aquaculture development.
- Support the formation of platforms/network of professionals to enhance the sharing of information and experiences, and facilitate harmonization of curriculum and integration of women and men in the profession.

- Make assessment of institutional arrangements such as legal framework and entitlements, organizational culture and practices and curriculum from a gender perspective to create an enabling working environment for women and men professionals and farmers.

Expert panel presentation VI.4: Supporting farmer innovations, disseminating indigenous knowledge and aquaculture success stories

Lead panellist: Mudnakudu Nandeesha
Rapporteurs: Matthias Halwart and Junning Cai
Panel members: Carlos Alfonso Alvarez, Tunde Atanda, Ram Bhujel, R. Bosma, N.A. Giri, Christine M. Hahn, Matthias Halwart, David Little, Pedro Luna, Gabriel Márquez, R. Ramakrishna, Melba Reantaso, Ruth García Gómez, N.R. Umesh, Humberto Villareal, Wilson Mwanja, Derun Yuan

Background

It has been recognized that farmers' innovations are crucial, also within the aquaculture sector, in order to achieve cumulative growth, both economically and socially. Equally important is the recognition of indigenous knowledge; there are numerous examples that illustrate the good use of this knowledge in developing cost-effective and sustainable strategies in poverty alleviation and income generation in developing countries. Traditional knowledge is an important part of the lives of the poor: it is the basis for decision-making of communities in food security, health, education and natural resource management. Regarding dissemination strategies, studies clearly reflect that wherever farmers have had access to adequate basic knowledge on the science of a technology, they have been able to constantly improve the production systems, assuring sustainability and adaptation to local conditions.

Farmers' innovations promotion, traditional knowledge validation and coherent ways of proven technologies' dissemination are key factors if sustainable both small scale and commercial aquaculture want to be promoted globally. After 10 years since the last global Conference on aquaculture and the Bangkok declaration, FAO and its partners consider that it is crucial to assess the role that innovative approaches, indigenous knowledge and technology transfer have played in small scale aquaculture development, and the role they should play in the future of the sector. The aim of this panel expert is to raise awareness and encourage all stakeholders, including policy makers, involved in aquaculture to take into account farmers' innovation, traditional knowledge and technology transfer at a small scale.

Issues

- The concept of fish farmers' innovations has been in place for these last 10 years, but its application remains limited.
- Main factors, including environmental, socio-economical, political, cultural, ignite or hamper farmers' innovations.
- Case studies regarding farmers' innovations from a broader spectrum of geographical areas and farming systems/strategies remain limited.
- The concept of indigenous knowledge within the aquaculture sector has been in place for these last 10 years, but its validation, dissemination and preservation strategies remain limited.

- Case studies regarding indigenous knowledge from a broader spectrum of geographical areas and farming systems/strategies are scarce.
- Fish farmer technology transfer and assessment of innovations dissemination systems are limited.
- Documentation of indigenous knowledge, farmers' innovations and innovative dissemination strategies such as their contribution to food security and poverty alleviation and to the rapid growth of the aquaculture sector in different parts of the world is poor.

Priority actions

- Document indigenous technology and innovations prevalent in different countries, validate the technologies through scientist-farmer partnership and scale up good practices to bring better benefits to people.
- Promote interaction between the scientific community, students and farmers at field level.
- Promote research, outreach and extension systems in partnership with policy makers, scientists, farmers to address the field problems.
- Invite policy makers to experience field realities with farmer innovators.
- Increase the role of farmers in research planning and implementation.
- Promote farmer- to- farmer exchange in all possible contexts and opportunities.
- Place emphasis on capacity building skills with knowledge of extension staff.
- Disseminate documented examples of indigenous knowledge and innovations through new technologies and institutions particularly through regional networks and their websites.
- Recognize innovations/innovators on occasions such as World Food Day.
- Encourage relevant stakeholders, including policy makers, involved in aquaculture, to incorporate farmers' innovation, traditional knowledge and technology transfer at a small scale, and to incorporate these concepts into their project proposals, feasibility studies, food production strategies, implementation plans and projects affecting local communities.

PART 4. SALIENT POINTS OF THE INVITED GUEST LECTURES

Three invited guest lectures were presented and discussed at the Conference. The abstracts of these Lectures are provided in Annex 5.5-5.7. The salient points of these presentations and discussion are summarized as follows.

Invited guest lecture I: Is feeding fish with fish a viable practice?

Presenter: Ulf Wijkstrom
Rapporteurs: Devin Bartley and Mohammad Hasan

Background

Capture fisheries produces some 90 to 95 million tonnes of fish and other aquatic species per year. Of these, somewhere between 20 and 25 million tonnes are regularly processed into fishmeal and oil. The overall amount of fish available to humans is reduced as more than one kg of fish – in the form of feed – is needed to grow one kg of carnivorous fish or shrimp in captivity. Also, the ever expanding demand for fish as feed is thought to endanger the long term sustainability of fish stocks harvested to provide raw material for fishmeal and oil. Most of the 25 to 30 million tonnes of capture fisheries that are used for fishmeal/fish oil production are obtained by industrial fisheries in the North Atlantic and in the Pacific Ocean off the West Coast of South America.

In China, South East and South Asia by-catch, particularly from trawl fisheries for shrimps, are used as fish feed and it is believed that they may be of the order of 6 million tonnes/fish per year. Annually about 0.3 to 0.4 million tonnes of whole or chopped fish are used to feed captured juveniles of blue-fin tuna in the Mediterranean, off Baja-California in Mexico and along Australia's South Coast.

Modern farming of carnivorous fish and shrimp uses more fish as feed than is produced as finfish or shrimps and the ratio between fish used and fish obtained (FIFO) is higher than one.

The practice of using by-catch as fish/shrimp feed has apparently led to a decrease in the availability of fish as food for the very poor in some regions of South, South-east and East Asia.

Most of the species that are fed with feeds that include substantial portions of fishmeal and fish oil are not low-cost items and these species will not become a regular component in the diet of the poor, and particularly not of the poor in developing countries.

On the other hand, aquaculture today contributes about half of all the seafood eaten in the world. Doubtlessly the real price of all fish would have been substantially higher today, had not aquaculture existed.

Issues

- The use of fish as feed for aquaculture is not uncontroversial. Some say that the practice should be reduced, if not stopped. They argue that the practice is not in the interest of those consumers who otherwise would have eaten the fish used to make fish feed.

- Shrimp and some fish farming practices are labour intensive activities which provide employment to millions of unskilled workers in developing economies. In the absence of fishmeal/ fish oil most of those employment opportunities most likely would cease to exist. Thus, employment in feed fisheries, fishmeal/fish oil industries, fish/shrimp feed industries, and aquaculture are positive contributions to global economy.

Priority actions

- Fishmeal and oil industry needs a sustainable fishery as a source of resources. Continued responsible management of these fisheries needs to be maintained or improved where applicable.
- Although many of the major industrial fisheries for small pelagic species are subject to an array of fishery management mechanisms (*inter alia*, TAC[4], area catch limits, minimum mesh size and Satellite tracking), there is concern that many of these management measures are not enforced appropriately and hence public resources must be deployed to enforce these regulations.
- Some of the artisanal fisheries in Southeast and East Asia are directed fisheries primarily destined for direct feed in aquaculture and such fisheries should be subject to local regulations to ensure their sustainability.
- Aquaculture should continue to search for alternative raw materials to replace fishmeal so that more of forage fish are available on food fish markets for direct human consumption.

Invited guest lecture II: The potential of aquaculture to improve human nutrition and health

Presenter: Shakuntala Haraksingh Thilsted
Rapporteurs: Cecile Brugere and Masanami Izumi

Background

Small fish are a common food and an integral part of the everyday carbohydrate-rich diets of many undernourished people in poor countries. They represent a rich source of animal protein, essential fatty acids, vitamins and minerals. In areas with fisheries resources and customary fish intake, there is good scope to include micronutrient-rich small fish in agricultural policy and programmes, thereby increasing intakes, which can lead to improved nutrition and health.

Issues

While it is well recognized that aquaculture can contribute to food security through providing high quality animal protein and fatty acids, the role of aquaculture in enhancing nutrition security through providing micronutrients has received relatively less attention. Being a vital source of important micronutrients to many undernourished people, small fish are usually less favoured in aquaculture because of their relatively low yield and economic value. However, evidence shows that polyculture of small and large fish species can greatly improve the

[4] Total allowable catch.

nutrition quality of fish production without sacrificing the yield. Thus, aquaculture has a large, untapped potential to combat hidden hunger.

Priority actions

- To enhance aquaculture's contribution to nutrition security, further data on nutrient bioavailability, intra-household seasonal consumption, nutrient analyses, cleaning, processing and cooking methods of small fish species are needed.
- Advocacy, awareness and nutrition education on the role small fish can play in increasing diet diversity and micronutrient intakes must be strengthened.
- Measures to develop and implement sustainable, low-cost technologies for the management, conservation, production, preservation, availability and accessibility of small fish must be undertaken.
- Analysis of the cost-effectiveness of micronutrient-rich small fish species in combating micronutrient deficiencies using the Disability-Adjusted Life Years (DALYs) framework should be carried out.

Invited guest lecture III: Coping with climate change: A real challenge for aquaculturists?

Presenter: Sena de Silva
Rapporteur: Doris Soto

Background

In general, consensus has been reached that climate change would produce increased global temperature, sea level rise, more frequent occurrence of extreme weather events, change in weather patterns such as the monsoonal rain patterns, among others. These changes will have an impact on food production systems including aquaculture. Aquaculture could be particularly affected because the organisms cultured are all poikilotherms, the production occurs in fresh-, brackish- and marine waters, and aquaculture activities are spread across all climatic regimes from temperate to the tropics.

Issues

- The challenges facing aquaculture could vary significantly across climatic regimes. In some parts of the tropics, the main challenges will be encountered by those farming activities that occur in deltaic regions. These will be mostly impacted by sea level rise, and increased saline water intrusion. Elsewhere in the tropics, inland cage culture and other aquaculture activities could be impacted upon by extreme weather conditions, increased eutrophication in reservoirs, etc.
- The reproductive cycle of a great majority of species could be affected and, therefore, affecting seed production. Equally, such impacts will be felt on the culture those species that are based on natural spat collections, such as that of many cultured molluscs.
- In the temperate regions, global warming could raise the culture temperatures of some species to the upper tolerance range(s), thereby endangering such culture systems.
- With increase in water temperature, new or dormant pathogens could become virulent. One of the most important indirect impacts of climate change could be the reduction in the availability of fishmeal and fish oil for feeds due to diminishing fisheries.

Priority actions

- Limitations of supplies of fishmeal and fish oil should lead to more innovative and pragmatic solutions on ingredient substitution of aquatic feeds also with lower green house gas (GHG) contributions.
- Adaptive and mitigating measures will entail both technological and socio-economic approaches to disseminate the potential impacts of climate change on small- farmers communities, the backbone of the sector, in the most vulnerable areas and the most feasible adaptive options as well as to bring about the policy changes required to implement those adaptive measures economically and effectively.

APPENDIX 1

List of participants

Algeria

Bounouni, Abdelkader. Sous-Directeur de l'aménagement des sites aquacoles, Ministère de la pêche et des ressources halieutiques.

Australia

Allan, Geoff. Fisheries Program Consultant, ACIAR.
Collins, Harry. Global Head, BD and L and Lead Finding, Novartis Animal Health.
Davis, Amanda. Journal Publishing Manager, Wiley-Blackwell.
Don, Johannes. CEO, Fish Protech Pty Ltd.
Gooley, Geoff. Key Project Manager, Fisheries and Aquaculture, Dept. Primary Industries, Victoria.
Ingram, Brett. Senior Scientist, Fisheries Victoria, Department of Primary Industries.
James, Michael. Medical Scientist, Royal Adelaide Hospital.
Jarau, Maureen. Manager R&D, Fish Protech Pty Ltd.
Nguyen, Thuy Thi Thu. Research Academic, Deakin University.
Oliver, Mark. Director, Australian Aquaculture Support Services Pty Ltd.
Palmer, Roy. CEO, Seafood Experience Australia Ltd.
Perera, Ramesh. Principal Scientific Officer, Biosecurity Australia.
Sen, Sevaly. Director, Ferms.
Tisdell, Clement. Professor Emeritus, University of Queensland.

Azerbaijan

Akhundov, Mehman. Chairman, Azerbaijan Fisheries Institute (AzerFRI).
Hajiyev, Rauf. Director, Department for Protection Water Bioresources.

Bahrain

Sankarasubbu, Murugadass. Operations Manager, Asmak B.S.C. Company.
Shaheen, Saqer. Managing Director, Asmak B.S.C. Company.
Shams, Abdulredha, J. Director, National Mariculture Centre.

Bangladesh

Collis, William. Director, WorldFish.
Faruk, Md. Ali Reza. Professor, Bangladesh Agricultural University.
Islam, Md. Tanveer. Business Consultant, Swisscontact- Katalyst.
Maung, Johny. Project Management Specialist, Innovision Consulting Private Ltd.
Mohammad, Pear., Ministry of Fisheries and Livestock.
Portal, Christian. Director Industrial and Rural Sectors Group, Katalyst Swisscontact.
Sarker, Ashoke. Market Coordinator-Prawn Market, Winrock International.
Sarwar, Rubaiyath. Managing Director, Innovision Consulting Private Limited.
Schirm, Berthold. Principal Advisor,Wetland Biodiversity Rehabilitation Projec, GTZ.

Sumon, Md. Abul Hashem. Project Director,Wetland Biodiversity Rehabilitation Project, Department of Fisheries,Govt. of Bangladesh.
Wahab, M.A. Professor, Faculty of Fisheries.

Belgium

Dhont, Jean. Researcher and Project manager, Ghent University.
Hough, Courtney. General Secretary, Federation of European Aquaculture Producers.
Lavens, Patrick. Innovations Director, Inve Technologies.
Leger, Philippe. Business Unit Director Aquaculture, INVE.
Sorgeloos, Patrick. Director, Labouratory of Aquaculture and Artemia Reference Centre.
Van Aken, Peter. Regional Business Manager Antifouling Paints, Arch Chemicals.
Varsamos, Stamatios. Research Programme Officer, European Commision, DG RTD.

Brazil

Lemos, Daniel. Associate Professor, University of São Paulo.

Brunei Darussalam

Ali, Haji Ideris Haji. Senior Marketing Manager, Brunei Economic Development Board.
Lai, Jessica. Assistant Marketing Manager, Brunei Economic Development Board.

Bulgaria

Hubenova, Tania. Head, Aquaculture Department, Institute of Fisheries & Aquaculture.

Cambodia

Da, Chin. Deputy-Chief, Aquaculture Division.
Labarga Hermengildo, Amagoia-Olatz. Project Coordinator, AIDA Association (NGO) Serrano 226 dpdo. Madrid. G-82484882.
Lim Song, Srun. Deputy Director General, Fisheries Administration (FiA).
Phala, Chea. Officer, Fisheries Administration.
Savin, Hang. Vice Director, Freshwater Aquaculture Research and Development Centre.
Savry, Chhy. Provincial Advisor, Ratanak Kiri Province, Department of Aquaculture Development.
Savudthy, Neang. Provincial Advisor, Stung Treng Province, Departement of Aquaculture Development.

Canada

Bexten, Angela. Assistant Director / Global Fisheries and Marine Governance, Fisheries and Oceans Canada.
Brian, Davy. Senior Fellow, International Institute for Sustainable Development.
Carolsfeld, Joachim. Executive Director, World Fisheries Trust.
McLaren, Michelle. Analyst, Fisheries and Oceans Canada.
Parsons, Jay. Director, Fisheries and Oceans Canada - Aquaculture Science Branch.
Percy, David R. Professor of Law, University of Alberta.
Ridler, Neil. Professor, Department of Economics, University of New Brunswick.

Schuele, Gunter. Director Aqua Health R&D and Marketing, Novartis Animal Health.
Winsby, Malcolm. Environmental Specialist, Winsby Environmental Services.

Chile

Echeverria, Ana Maria. Director, South Star International.
Infante, Rodrigo. Vice President, ISFA (International Salmon Fisheries Association).

China

He, Xugang., College of Fisheries, Huazhong Agricultural University.
Lai, Qifang., East China Sea Fisheries Institute.
Li, Zhongjie., State Key Laboratory of Freshwater Ecology and Biotechnology.
Li, Yongfang., College of Life Science, Henan Normal University.
Liping, Liu. Associate Professor, College of Fisheries and Life Science.
Liu, Jiashou., Institute of Hydrobiology, Chinese Academy of Sciences.
Lu, Weiqun. Professor in Aquaculture, Shanghai Ocean University.
Ningsheng, Yang. Director, Information Centre, China Academy of Fisheries Science.
Shenyao, Tang. Director, Dept. of International Cooperation.
Wang, Chunfang. Teacher, The College of Fisheries.
Xiaoming, Ding. Director, Division of Aquaculture.
Xie, Congxin., College of Fisheries, Huazhong Agricultural University.
Xu, Pao. Chief, Freshwater Fisheries Research Centre.
Yao, Zongli., East China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences.
Yuan, Xinhua., Freshwater Fisheries Research Centre, Chinese Academy of Fishery Sciences.
Zhang, Tanglin. Associate Professor, Institute of Hydrobiology, Chinese Academy of Sciences.

China, Hong Kong SAR

Chan, King. Fisheries Officer, Agriculture, Fisheries and Conservation Department, HKSAR.
Chu, Jim., Aberdeen Fisheries Office.
Man, So Ping. Assistant Director (Fisheries), Agriculture, Fisheries and Conservation Department.
Situ, Yingyi. Fisheries Officer, Agriculture, Fisheries and Conservation Department.

Cook Islands

Raumea, Koroa. Director, Inshore Fisheries and Aquaculture.

Croatia

Glamuzina, Branko. Vice Rector for Science and scientific projects, University of Dubrovnik.

Denmark

Clausen, Jesper Hedegaard. , Faculty of LIFE sciences, University of Copenhagen.
Dalsgaard, Anders. , Department of Veterinary Microbiology, The Royal Veterinary and Agricultural University.
Roth, Eva. Associate Professor, University of Southern Denmark.

Ecuador

Piedrahita, Yahira. Directora Nacional de Acuicultura, Subsecretaría de Acuicultura, Ministerio de Agricultura, Ganadería, Pesca y Acuicultura.

Egypt

Sadek, Sherif, Aquaculture Consultant Office.

Fiji

Billings, Gerald. Head of Aquaculture, Ministry of Fisheries and Forests.
Pickering, Timothy. Inland Aquaculture Officer, Secretariat of the Pacific Community.

France

Dabbadie, Lionel., CIRAD.
Jérôme Jean, Lazard. Senior Scientist, CIRAD.
Kaushik, Sadasivam. Director of Research, INRA.
Metian, Marc., Hawaii Institute of Marine Biology.
Philippe, Tacon. Market Manager, Aquaculture, Lesaffre Feed Additives.
White, Patrick. Senior Aquaculture Consultant, Akvaplan-niva AS.

Germany

Bergleiter, Stefan. Aquaculture Section, Naturland - association for organic farming.
Hanel, Reinhold. Head of Institute, VTI / Institute of Fisheries Ecology.
Prein, Mark. Senior Scientist, Aquaculture Systems and Animal Nutrition in the Tropics and Subtropics.

Ghana

Awity, Lionel. Deputy Director of Fisheries, Directorate of Fisheries.
Jacques, Magnee. Aquaculture Expert, Directeur Commercial, Raanan Fish Feed.
Joseph Kitson, Ofori. Member, Science Group, Fisheries Commission.

Greece

Barazi-Yeroulanos, Lara. Managing Director, Kefalonia Fisheries S.A..
Chatzopoulos, Achillefs. Chief Technician, Dept Aquaculture and Fisheries Tei of Epirus.
Despoina, Tsoutsouli. Student, Tei of Ghoumenitsa.
Ergolavou, Anna. Research fellow, Dept Aquaculture and Fisheries, T.E.I. of Epirus.
Fasoulas, Theodoros. Laboratory Assistant, Tei of Thessaloniki.
Filou, Varvara. Master student, University of Thessaly, Greece.
Gouva, Evangelia. Research fellow, Dept Aquaculture and Fisheries, T.E.I. of Epirus.
Karipoglou, Kostantinos. Production Manager, LAKY S.A..
Paschos, Ioannis. Director, Dept Aquaculture and Fisheries, T.E.I. of Epirus.
Perdikaris, Costas. Research Fellow, Dept Aquaculture and Fisheries, T.E.I. of Epirus.
Xenos, Stratos. Student, Veterinary School, University of Thessalias, Kardista.

Hungary

Gyalog, Gergo. Scientist, Research Institute for Fisheries, Aquaculture and Irrigation.
Gál, Dénes. Senior Scientist, Research Institute for Fisheries, Aquaculture and Irrigation.
Jeney, Zsigmond. Senior Scientist and Deputy Director, Research Institute for Fisheries, Aquaculture and Irrigation.
Lengyel, Peter. Foreign Relations Officer, NACEE Coordinator, HAKI, NACEE.
Moth-Poulsen, Thomas. Fisheries and Aquaculture Officer, FAO Subregional Office.
Varadi, Laszlo. General Director, Senior Scientist, Research Institute for Fisheries, Aquaculture and Irrigation.

Iceland

Helgason, Arni. Director - Natural Resources Desk, ICEIDA.

India

Eknath, Ambekar. Director, Central Institute of Freshwater Aquaculture.
Jena, Joykrushna., Central Institute of Freshwater Aquaculture.
Mangalagiri, Sudarsana Swamy. Managing Director, Santir Aquatic Private Ltd.
Meenakumari, B. Director, Central Institute of Fisheries Technology (CIFT), CIFT Junction, Willingdon Island.
Modadugu, Vijay Gupta. Biologist, Winner of World Food Prize.
Nandeesha, M.C. Dean, Fisheries College and Research Institute.
Nandurkar, Hemlata Pradeep. Lecturer in Zoology, Sant Gadge Baba Amravati University.
Panigrahi, Ashis Kumar. Reader, University of Kalyani.
Parashar, Alka. Professor, Sarojini Naidu Govt.Girls P.G.Autonomous College.
Ponniah, A.G., National Bureau of Fish Genetic Resources.
Ramaswamy, Umesh. Chief Executive, National Centre for Sustainable Aquaculture.
Richard, Carmel Gerald. Director, Lighthouse Trade Links Pvt. Ltd..
Swaminathan, M.S. Chairman, M.S. Swaminathan Research Foundation.
Thakur, Dhanrajsingh. Student, College of Fisheries.
Totad Mallappa, Shivakumar. Director, Dept of Commerce, Ministry of Commerce and Industry, Govt of India.

Indonesia

Iba, Wa. Lecturer. Haluoleo University.
Insan, Irsyaphiani. Research Centre Institute for Aquaculture Agency for Marine and Fisheries Research.
Kartamihardja, Endi Setiadi. Researcher, Ministry of Marine Affairs and Fisheries
Kokarkin, Coco. Director, Brackishwater Aquaculture Development Centre.
Latt, U Win. Vice President - Aquaculture and R&D (AWS), PT. Central Proteina Prima Tbk.
Maskur, Maskur. Head of Main Centre Freshwater Aquaculture Development, Ministry of Marine Affairs and Fisheries, Rep. Indonesia.
Nurdjana, Made. Director General of Aquaculture, Ministry of Marine Affairs and Fisheries.
Rantetondok, Alexander. Invitation, Hasanuddin University, Departmen of Fisheries.
Sukadi, Fatuchri. Research Institute for Freshwater Aquaculture.
Surono, Agus. Kantor Pusat DEPTAN, Gedung B Lt. 4.
Utami, Retna. Research Institute for Freshwater Fish Breeding and Aquaculture.

Ireland

Benzie, John. Professor, University College Cork.

Islamic Republic of Iran

Abdolhay, Hossein Ali., Iranian Fisheries Organization.
Alishahi, Mojtaba. Assistant Professor, Shahid Chamran university.
Amrolahi Biuki, Narges. PhD Student, Khoramshahr Marine Science and Technology University.
Askari Hesni, Majid. PhD Student, Khoramshahr Marine Science and Technology University.
Dadolahi-Sohrab, Ali. Lecturer, Khorramshahr University of Marine Science and Technology.
Gharaei, Ahmad. Student Ph.D., Zabol University.
Heydarnejad, M. Saeed. Assistant Professor, Shahrekord University.
Johari, Sayed Ali. Student, Tarbiat Modares University.
Movahedinia, Abdolali., Khorramshahr Marine science and Technology University.
Peyghan, Rahim. Professor, Shahid Chamran University.
Zolgharnein, Hossein. Assistant Professor, Khorramshahr University of Marine Science and Technology.

Italy

Gardiner, Peter R. Acting Director ISPC, CGIAR.
Micciche, Luca. PhD student, University of Palermo Italy.

Japan

Ishbashi, Tomoko. Senior Deputy Regional Representative, OIE Regional Representation for Asia and the Pacific.
Maeda, Mitsuho. Nippon Suisan Kaisha, Ltd..
Miyazaki, Masahiro. Professor, Atomi University.
Nguang, Siew Ing. PhD student, Kinki University.
Nyuji, Mitsuo. Student, Kyushu University.
Okada, Ayako. Tokyo University of Marine Science and Technology.
Sabate, Francisco de la S. Post Doctoral Fellow, Kinki University.
Sethu, Selvaraj. Student, Kyushu University.
Sugiyama, Shunji. Senior Advisor, Japan International Cooperation Agency.
Syed Muhammad, Sharifah Rahmah. PhD Student, Kinki University.

Kazakhstan

Timirkhanov, Serik. Director of the Monitoring Department, Kazakhstan Agency on Applied Ecology.
Zhanseitov, Galym. Head of Fisheries and Aquatic Bioresources, Management of Fisheries Committee, Ministry of Agriculture.

Kenya

Nyandat, Betty. Fisheries Department.

Republic of Korea

Abdelkader, Tamer Said. Student, Seoul National University.
Chang Su, Kim. Student, College of Ocean Sciences.
Dong Hwi, Kim., Dept. Marine Biomedical Sciences.
Han, Yong-Jae. Researcher, Jeju National University.
Heo, Moon-Soo. Professor, Jeju National University.
Jang, Ik-Soo. Researcher, Jeju National University.
Lee, Sukkyoung. Student, Jeju National University.
Ramasamy, Harikrishnan. Researcher, Jeju National University.

Kyrgyz Republic

Baitemirov, Baialin. Head, Departmental Fish Inspection, Ministry of Agriculture, Water.
Dogachiev, Dogdurbek. Director, Department of Fisheries, and Processing Industry.

Lao PDR

Choulamany, Xaypladeth. Programme Coordinator, MRC Fisheries Programme.
Hortle, Kent. Technical Advisor, MRC Fisheries Programme.
Ingthamjitr, Suchart. Programme Officer and AIMS Component Coordinator, Fisheries Programme, MRCS.
Khamsivilay, Lieng. Director, Living Aquatic Resources Research Centre.
Pham, Mai Phuong. Programme Officer, MRC Fisheries Programme.
Phomsouvanh, Akhane. Head, Fisheries Management Section, Fisheries Division, Department of Livestock and Fisheries.
Phouthavongs, Kaviphone. Programme Officer, MRC Fisheries Programme.
Saphakdy, Bounthong. Head, Technical Division, Department of Livestock and Fisheries.
Somboon, Somboon. Senior staff, Living Aquatic Resources Research Centre.

Madagascar

Rasolonjatovo, Norosoa Alice. Director of Aquaculture, Ministry of Fisheries and Halieutic Resources.
Razafindrazaka, Tony Harilala. Chief of Services Aquaculture Promotion, Ministry of Fisheries and Halieutic Resources.
Tsukii, Yoshifumi. Agronomist, JICA.

Malaysia

Abd Rashid, Zulkafli. Head of Centre, Freshwater Fisheries Research Centre.
Abdullah, Siti Zahrah. Research Officer, National Fish Health Research Centre.
Abol-Munafi, Ambok Bolong. Lecturer, Universiti Malaysia Terengganu.
Abu Bakar, Khairul Rizal. Research Assistant, WorldFish Centre.
Alsaid, Milud. Student, Universiti Putra Malaysia.

Ayub, Muhammad. Director, INFOFISH, 1st Floor, Wisma PKNS, Jalan Raja Laut.
Azmai, Mohammad Noor Amal. Student, University Putra Malaysia.
Ching, Fui Fui. PhD Student, Kinki University.
Hoong Yip, Yee. Research Assistant, WorldFish Centre.
Ibrahim, Sharina., Universiti Kebangsaan Malaysia.
Ighwela, Keri Alhadi. Universiti Malaysia Terengganu.
Kruijssen, Froukje. Post-Doctoral Fellow, The WorldFish Centre.
Mahmood, Ahamad Sabki bin. Director-General of Fisheries Malaysia, Department of Fisheries, Ministry of Agriculture.
Mansor, Nur Nazifah. Student, Universiti Putra Malaysia.
Muhamad Shaleh, Sitti Raehanah. Lecturer, Borneo Marine Research Institute.
Musa, Che Utama bin Che. Open Sea Cage Culture Project Office.
Pant, Jharendu. Aquaculture Scientist, The WorldFish Centre.
Raja Ariffin, Raja Adib. Manager, ARTI Group of Companies.
Raja Ariffin, Raja Azmi. Director, ARTI Group of Companies.
Saad, Mohd. Zamri. Lecturer, Faculty of Veterinary Medicine.
Tibin, Mubarak Eisa Abdelrahman. Student, Universiti Malaysia Terengganu.
Yusoff, Fatima Md. Professor, Universiti Putra Malaysia.
Zainal, Zuhair. Manager, ARTI Group of Companies.
Zainalaludin, Zumilah. Senior Lecturer, Universiti Putra Malaysia.

Mexico

Codero, Javier Martinez. Centro de Investigación en Alimentación y desarrollo (CIAd), A.C.
Unzueta Bustamante, Marco Linné. Director General de Investigación en Acuacultura, Instituto Nacional de Pesca.

Mozambique

Omar, Isabel., Institute of Aquaculture.

Myanmar

Lwin, San. Assistant Director, Department of Fisheries.
Soe, Khin Maung. Deputy Director, Department of Fisheries.
Win, Kyaw Myo. Deputy Director General, Department of Fisheries.

Namibia

Bayer, Wilhelm Konrad Konwil. Technical Committe Member, Ministry of Fisheries and Marine Resources.
Du Plessis, Henning Vorster. Oyster farm manager, Ministry of Fisheries and Marine Resources.
Elago, Panduleni N. Ministry of Fisheries and Marine Resources (MFMR).
Hitula, Alushe Tulka Herry. Acting Deputy Director, Ministry of Fisheries and Marine Resources.
Kibria, Md. Ghulam. Special Aquaculture Adviser (Commonwealth) to Hon Minister, Ministry of Fisheries and Marine Resources (MFMR), The Gove.
Mapfumo, Blessing. Regional Aquaculture Advisor, INFOSA.
Ndivayele, Elizabeth. Senior Fisheries Biologist, Ministry of Fisheries and Marine Resources.
Nguvauva, Kilus Munjuku Karaerua. Deputy Minister, Ministry of Fisheries and Marine Resources.
Shuuluka, Olivia Itaveleni. Aquaculture Economist, Ministry of Fisheries and Marine Resources.

Nauru

Depaune, Monte. Ag. Deputy Chief Executive Officer, Nauru Fisheries and Marine Resources Authority.

Nepal

Gurung, Tek Bahadur. Director, Livestock and Fisheries Research, Nepal Agricultural Research Council.
Swar, Deep Bahadur. Department of Agriculture.
Upadhyaya, Kishore Kumar. Senior Fisheries Development Officer, Directorate of Fisheries Development.

Netherlands

Bosma, Roel. Researcher / Manager, Aquaculture and Fisheries Group Wageningen University.
Bush, Simon. Assistant Professor, Wageningen University.
Verreth, Johan. Chair, Aquaculture and Fisheries Group, Wageningen University.

New Zealand

Manukau, Nicholas. Manager Aquaculture Settlement, Ministry of Fisheries.

Nigeria

Atanda, Akintunde Nureni. National Facilitator, Aquaculture, National Programme for Food Security.
Madu, Chukwukadibia Titus. Director (Aquaculture and Biotechnology), National Institute for Freshwater Fisheries Research.
Raji, Aminu. Executive Director / Chief Executive Officer, National Institute for Freshwater Fisheries Research.

Norway

Brun, Edgar. Head of Section, National Veterinary Institute.
Munkejord, Svein Magnus. Senior Adviser, Directorate of Fisheries, Norway.
Tavornpanich, Saraya. Researcher, National Veterinary Institute.
Yngve, Torgersen. Deputy Director General, Ministry of Fisheries and Coastal Affairs.

Oman

Al-Rashdi, Khalfan Mohamed. Head of Hatcheries Technology, Oman Aquaculture Centre.
Ibrahim, Fahad Saleh. Ministry of Fisheries Wealth, Aquaculture Centre.

Pakistan

Ahmed, Najeeb. Liaison Officer to Minister (MoLDD), Ministry of Livestock Dairy Development and Fisheries.
Asif Riaz, Muhammad. Fisheries Development Commissioner, Ministry of Livestock and Dairy Development.

Panama

Morales, Reinaldo. Ministerio De Desarrollo Agropecuario, Dirección Nacional de Acuicultura.

Philippines

Agbayani, Renato. Head, Training and Information Division, SEAFDEC Aquaculture Department.
Macas, Rosa. Regional Director, Bureau of Fisheries and Aquatic Resources, BFAR 4-A.
Manalac, Levy Loreto. Technical Manager - Aquaculture, USSEC/American Soybean Association - International Marketing.
Morales, Ernesto Jack. Aquaculture Program Director, Sustainable Fisheries Partnership.
Toledo, Joebert. Chief, SEAFDEC Aquaculture Department.
Toledo-Mueda, Rose. University Research Associate, University of the Philippines Visayas.
Uwe, Scholz. Chief Programme Adviser, German Technical Cooperation-GTZ.
Velayo, Isidro. Senior Aquaculturist, BFAR.
Villamayor, Maritess Lydia. Business Director-Indonesia/Vietnam, Pfizer Animal Health.

Portugal

Ferreira, Joao., IMAR (Institute of Marine Research).

Qatar

Falamarzi, Mohammad. Head, Fisheries Development Section, Ministry of Environment.

Samoa

Izumi, Masanami. Fisheries Officer, FAO Subregional office, SAP.

Senegal

Badiane, Abdoul Aziz. Technical Director - Aquaculture, Aquaculture National Agency.
Basse, Mame bator. Trade Attaché, Aquaculture National Agency.
Daffe, Mamina. Directeur Technique, l'Agence Nationale de l'Aquaculture (ANA).
Homma, Ken. Expert, JICA.
Wade, Amath. General Manager, Aquaculture national Agency.

Serbia

Markovic, Zoran. Professor, Faculty of Agriculture University of Belgrade.
Poleksic, Vesna. Professor, Faculty of Agriculture University of Belgrade.
Spiric, Aurelija. Principal Research Fellow, Institute of Meat Hygiene and Technology.

Singapore

Bal, David. R&D Manager, GENOMAR ASA.
Bocquillet, Xavier. Managing Director, Qualasa PTE LTD.
Komar, Cedric. Business Manager Asia, Intervet / Schering-Plough Animal Health.
Lim, Kian Wei James. Student, Nanyang Technological University.
Neo, Chin Heng. Senior Scientific Officer, Agri-Food and Veterinary Authority of Singapore.

Ng, Yue Ling Fiona. Scientist, Applied Biosystems.
Wendover, Neil. Technical Services Manager - Asia, Intervet / Schering-Plough Animal Health.

South Africa

Salie, Khalid. Student, Stellenbosch University.

Sri Lanka

Amarasinghe, Upali S.. Professor, University of Kelaniya.
de Zoysa, Damitha. Secretary, Ministry of Fisheries and Aquatic Resources Development.

Sweden

Max, Troell. Researcher, Beijer Institute/ Stockholm Resilience Centre.

Switzerland

Benguerel, Rene. Founder and Managing Partner, Blueyou Consultancy.
Thompson, Ian. Lead Finding Manager, Aqua, Novartis Animal Health Inc.

Syrian Arab Republic

Krouma, Issam. Director, Department of Fisheries Resources, Ministry of Agriculture and Agrarian Reform.

Taiwan Province of China

Chuang, Whae-Ling. Exe. Nutritionist, Total Nutrition Technologies Co., LTD.
Lee, An-Chin. Associate Professor, National Chiayi University.
Liu, Huang-Ming. Marketing Specialist, Total Nutrition Technologies Co. Ltd.
Yen, Jay (Chih Chieh). Director, Nustyle Co.

Tajikistan

Akhmadzhon, Gafurov. Head of Agriculture Department, Ministry of Agriculture.
Balkhova, Svetlana. IFAD Presence in Tajikistan, 44/195 Rudaki.

Thailand

Baumgartner, Urs. Project Manager, Blueyou AG - Consultancy for Sustainable Aquaculture and Fisheries.
Bhujel, Rama. Senior Scientist and Affiliated Faculty, Asian Institute of Technology.
Boonliptanon, Paiboon. Krabi Coastal Aquaculture Station, 141 Moo 6, Sai-thai.
Boonyaratpalin, Mali. Advisor on Research Development System, Department of Fisheries.
Bundit, Jatuporn, Researcher/Lecturer, King Mongut's Institute of Technology Ladkrabang.

Chainark, Pitchaya. Fisheries Professional Level, Department of Fisheries.
Chamsai, Sawitree. Policy and Program Officer, SEAFDEC.
Chansong, Nisit. Technical Service, Novartis (Thailand) Ltd.
Chawpaknum, Choltisak. Fisheries Biologist, Department of Fisheries.
Chitanuwat, Rungphech. Business Development Manager, Novus International (Thailand) Co., Ltd.
Chompradist, Chatchom. Irrigation Engineer, Royal Irrigation Department (Thailand)
Chonchuenchob, Pradit. Director, Coastal Aquatic Feed Research Institute.
Decamp, Olivier. Product Manager, INVE Aquaculture.
Dulyapurk, Varunthat. Dept. Fishery Management, Faculty of Fisheries, Kasetsart U.
Edwards, Peter. Emeritus Professor, Asian Institute of Technology.
Gallardo, Wenresti G. Associate Professor, Asian Institute of Technology.
Garriques, David Christopher. Vice President, Charoen Pokphand Foods PCL.
Giessinger, Lawrence. Regional Sales Director, INVE Aquaculture.
Jarit-ngam, Teerawat. Fisheries Biologist, Phuket Coastal Fisheries Research and Development Centre.
Jumnongsong, Sirisuda. PhD student (AARM), Aquaculture and Aquatic Resources Management.
Juntubtin, Vinai. Director, Freshwater Aquaculture Research Institute.
Kaewnern, Methee. Assistant Prof., Faculty of Fisheries, Kasetsart University.
Kasornchandra, Jiraporn. Expert on Fish Diseases, Department of Fisheries.
Khemadham, Sayamol. Product and Raw Materials Development Manager, Mars Petcare (Thailand) CO.,Ltd.
Kiriruangchai, Achiravit. Sourcing Representative, Lyons Seafoods Limited (UK).
Kusakabe, Kyoko. Associate Professor, Asian Institute of Technology.
Lawonyawut, Khamchai. Senior Technical Marketing Manager (South East Asia), CJ CheilJedang Corporation (Bangkok Office).
Limthammahisorn, Suttinee. Senior Fisheries Biologist, Coastal Fisheries Research and Development Bureau.
Looi, Kae Wen. Senior Commercial Manager, Mars Inc.
Meteekunaporn, Suchada. Sector Manager, GTZ.
Nayak, Ramakanta. Regional Aqua Marketing Manager, Novus International (Thailand) Co., Ltd.
Ngamwongchon, Somsri. Aquaculture Expert, Department of Fisheries.
Nietes-Satapornvanit, Arlene. PhD Student, Institute of Aquaculture, University of Stirling.
Nisapakul, Tammarat. Thawee Farm.
Nukwan, Sujin. Director of Aquatic Plant and Ornamental Fish Research Institute, Department of Fisheries, Bangkok Thailand.
Pasugdee, Sontipan. Head of Technical Group, Department of fisheries.
Pongchawee, Kanchanaree. Chief of Aquatic Plant Research Group, Department of Fisheries, Thailand.
Pongmaneerat, Juadee. Senior expert, Department of Fisheries.
Pourpornpong, Panarat. Commercial Manager - Raws, Mars Inc.
Prompoj, Waraporn. Director, Fisheries Foreign Affairs Division.
Rodrarung, Decha. Fisheries Biologist, DOF, Thailand.
Ruensirikul, Jirayuth. Fishery Biologist, Coastal Aquaculture Research Institute.
Satapornvanit, Kriengkrai. Associate Dean for Research, Faculty of Fisheries, Kasetsart University.
Sato, Akito. Expert, SEAFDEC.
Somsiri, Temdoung. Director, Inland Aquatic Animal Health Research Institute.
Soonson, Patcharee. Fisheries Biologist, Krabi Coastal Fisheries Research and Development Centre.

Tanasomwang, Varin. Director, Coastal Fisheries Research and Development Bureau.
Tangprakhon, Thipsuda. Chief of Srisaket Inland Fisheries Station, Department of Fisheries.
Tansuwan, Supon. Director of Marine Shrimp Culture Research Institute, Coastal Fisheries Research and Development Bureau.
Tejavanija, Sukhothai. Commercial Manager – Co-Manufacturing, Mars Inc.
Thakur, Dhirendra Prasad. Senior Research Specialist and Affiliated Faculty, Asian Institute of Technology
Thawonsuwan, Jumroensri. Fisheries Biologist, Department of Fisheries (DOF).
Thuwadaratrakool, Chantana. Assistant Technology Deployment Manager, Cargill Animal Nutrition, Cargill Siam Limited.
Udomkarn, Jaroen. Director of Nakhonratchasima IFRD, Department of Fisheries.
Unprasert, Nanthiya. Deputy Director-General, Department of Fisheries.
Van Ballaer, Erik. Director, SIAM KULADUM CO., LTD.
Venero, Jesus. Regional Aqua Feed and Nutrition Specialist, APEC, Novus International (Thailand) Co., Ltd.
Viputhanumas, Thavee. Senior Biologist, Department of Fisheries.
Wongkaweewit, Kittiwat. Faculty of Veterinary Science, Chulalongkorn University.
Yakupitiyage, Amararatne. Associate Professor, Asian Institute of Technology.
Yashiro, Renu. Director, Rayong Coastal Aquaculture Development Centre.

Tonga

Ngaluafe, Poasi. Head, Research Division, Ministry of Fisheries.

Tunisia

Hmida, Leila. Department of Biotechnology.
Romdhane, Mohamed S. Institut National Agronomique de Tunisie.

Turkey

Aksungur, Muharrem. Central Fisheries Research Institute.
Deniz, Hayri. Aquaculture Department.
Gokoglu, Mehmet. Assistant Professor, Akdeniz University.
Gokoglu, Nalan. Dean, Akdeniz University.
Savas, Sevgi. Lecturer, SDU Egirdir Fisheries Faculty / Aquaculture Department.
Ünlüsayn, Mustafa. Associate Professor, Akdeniz University, Faculty of Fisheries.

Ukraine

Bekh, Vitaliy. Deputy Director, Institute for Fisheries of the Ukrainian Academy of Agricultural Sciences.

United Kingdom of Great Britain and Northern Ireland

Banks, Jonathan. Business Insight Director, ACNielsen.
Belton, Ben. PhD Student, University of Stirling.
Gautier, Dominique. Technical Executive, Aqua Star.
Haacke, Christopher. Marketing Manager, Intervet / Schering-Plough Animal Health.
Hill, Barry. Cefas.
Katoh, Emi. PhD Student, University of Hull.

King, Andrew. KDS.
Little, David. Professor, Institute of Aquaculture.
Rana, Krishen. Lecturer in Aquaculture, Institute of Aquaculture.
Wardle, Robin. Director Technical Services and Customer Support, Intervet / Schering-Plough Animal Health.
Wattage, Premachandra. Senior Research Fellow, Centre for the Economics and Management of Aquatic Resources.

United States of America

Ahmad, Imtiaz. Consultant, FAO.
Browdy, Craig. President, World Aquaculture Society.
Costa-Pierce, Barry. Director, Rhode Island Sea Grant, University of Rhode Island.
Ferro, James. Aquaculture Policy Analyst, Ocean Conservancy.
Field, John. Senior Foreign Affairs Officer, U.S. Department of State.
Fitzsimmons, Kevin. Professor and Director of International Programs, University of Arizona.
Fong, Lindsey. Program Coordinator, Conservation International.
Garza de Yta, Antonio. Director of International Training and Outreach, Auburn University.
Heng, Guan Chin Daryl. Quality Control and Production Specialist - Pacific Rim, Ocean Beauty Seafoods LLC.
Jensen, Gary. National Program Leader for Aquaculture, US Department of Agriculture's Cooperative State Research.
Jolly, Curtis, M.. Professor of Agricultural Economics and Rural Sociology, Auburn University.
Leonard, Don. CEO, Great Salt Lake Artemia.
Ligeon, Carel. Associate Professor, Auburn University in Montgomery.
Montwill, Barbara. Consumer Safety Officer, FDA/CFSAN.
Moss, Shaun. Vice President of Research and Development, Oceanic Institute.
Olin, Paul. CASGEP advisor, University of California Sea Grant Extension Program.
Rioux, Danielle. Sea Grant Fellow, National Oceanic and Atmospheric Administration.
Satia, Benedict., Inland Fisheries/Aquaculture Development.
Suresh, Arul Victor. Director of Nutrition, Integrated Aquaculture International.
Tacon, Albert. Aquaculture Research Director, Aquatic Farms Ltd.

Uzbekistan

Karimov, Bakhtiyor. Head of the Laboratory of Hydroecology and Fisheries, Institute of Water Problems.
Kimsanov, Zoirjoh., Ministry of Agriculture.

Viet Nam

Banh, Thi Quyen Quyen. , Nha Trang University.
Bui Minh, Tam., Can Tho University.
Do, Thi Thanh Huong. Head of Department of Aquatic Nutrition and Products Process, Can Tho University.
Doan Xuan, Diep. Student, Can Tho University, Viet Nam.
Fezzardi, Davide. Consultant, IFAD - ICAFIS.
Huynh Huu, Ngai. National Component Director, Research Institute for Aquaculture Number II.
Joachim, Hofer. Project Advisor, GTZ.
Lai, Hung Van. Dean, Nha Trang University.
Ngo, Van Hai. Vice Director, Minh Hai Sub-institute for Fisheries Research.

Nguyen, Phuong Thanh. Dean, College of Aquaculture and Fisheries.
Ngyuen Van, Hao. Director, Research Institute for Aquaculture Number II.
Pham, Hung Quoc. Lecturer, Nha Trang University.
Pham Ba Vu, Tung. Researcher, Research Institute for Aquaculture No. 2.
Phan Thanh, Lam. , Research Institute for Aquaculture No. 2.
Phung Ha, Tran Thi. PhD student, Wageningen University.
Truong Hoang, Minh. Lecturer, Can Tho University.
Dien, Nguyen Huy. Project Manager, UNDP/FAO Project.
Luu, Le Thanh. Director, Research Institute for Aquaculture No. 1 (RIA No. 1).

Zambia

Maguswi, Charles. Director of Fisheries, Zambian Department of Fisheries.

Institutions and Organizations

Food and Agriculture Organization of the United Nations

Aguilar-Manjarrez, José. FAO. Aquaculture Officer, Aquaculture Service (FIRA), Fisheries and Aquaculture Department.
Bartley, Devin. Senior Fishery Resources Officer, FIRF Marine and Inland Fisheries Service, Fisheries and Aquaculture Department.
Cai, Junning. FAO. Consultant. Aquaculture Economics.
Chen, Lei. FAO. Consultant, Aquaculture Service (FIRA), Fisheries and Aquaculture Department.
Garcia, Gomez. FAO. Associate Professional Officer, Aquaculture Service (FIRA), Fisheries and Aquaculture Department.
Halwart, Matthias. FAO. Senior Aquaculture Officer, Aquaculture Service (FIRA), Fisheries and Aquaculture Department.
Hasan, Mohammad Rezaul. Aquaculture Officer, Aquaculture Service (FIRA), Fisheries and Aquaculture Department.
Hishamunda, Nathanael. FAO. Senior Aquaculture Officer, Aquaculture Service (FIRA), Fisheries and Aquaculture Department.
Jia, Jiansan. FAO. Chief, Aquaculture Service (FIRA), Fisheries and Aquaculture Department.
Karunasagar, Iddya. FAO. Senior Fishery Officer (Quality Assur.), Products, Trade and Marketing Service (FIPM), Fisheries and Aquaculture Department.
Lem, Audun. FAO. Senior Fishery Industry Officer, Products, Trade and Marketing Service (FIPM), Fisheries and Aquaculture Department.
Lovatelli, Alessandro. FAO. Fishery Resources Officer (coastal aquaculture), Aquaculture Service (FIRA), Fisheries and Aquaculture Department.
Nakouzi, Helen Louise. FAO. Aquaculture Service, FIRA, FAO.
Reantaso, Melba. FAO. Fishery Resources Officer, Aquaculture Service (FIRA), Fisheries and Aquaculture Department.
Soto, Doris. FAO. Senior Aquaculture Officer, Aquaculture Service (FIRA), Fisheries and Aquaculture Department.
Subasinghe, Rohana. FAO. Senior Aquaculture Officer, Aquaculture Service (FIRA), Fisheries and Aquaculture Department.
Zhou, Xiaowei. FAO. Fishery Statistician, Statistics and Information Service (FIPS).
Miao, Weimin. Aquaculture Officer, FAO Regional Office for Asia and the Pacific.

NACA Secretariat

Abery, Nigel William. Project Coordinator, Network of Aquaculture Centres in Asia-Pacific (NACA).
Chaocheawchan, Surapong. Information and Communication Technology Specialist, NACA.
De Silva, Sena. Director General, NACA.
Derun, Yuan. Training Manager, NACA.
Kongkeo, Hasanai. NACA Coordinator, NACA.
Leano, Eduardo. Coordinator, Aquatic Animal Health Programme, NACA.
Mohan, CV. Regional Aquatic Animal Health Specialist, NACA.
Phothimon, Lyn. Administrative Clerk, NACA.
Udomlarp, Wella. Administrative and Finance Officer, NACA.
Wilkinson, Simon. Communications Manager and Editor of Aquaculture Asia, NACA Secretariat.
Phillips, Michael John. Senior Scientist, Network for Aquaculture Centres in Asia-Pacific (NACA).
Yamamoto, Koji. Research Associate, Network for Aquaculture Centres in Asia-Pacific (NACA)

APPENDIX 2

Conference programme

Tuesday 21 September 2010	
13.00 – 18.30	Arrival of participants; registration
Day 1 Wednesday 22 September 2010	
SESSION 1: INTRODUCTION AND OPENING	
08.45 – 09.30	Opening ceremonies Welcome Remarks • Dr. Somying Piumsombun, Director General, Department of Fisheries, Thailand • Assistant Director General, Regional Representative for Asia and the Pacific (RAP), FAO of the UN • Director General Sena de Silva, Network of Aquaculture Centres in Asia and the Pacific Opening of the Conference by Hon. Minister of Agriculture and Cooperatives of Thailand
09.30 – 10.15	**Opening keynote address 1**: Aquaculture and Sustainable Nutrition Security in a Warming Planet – Professor Monkombu Sambasivan Swaminathan (India)
10.15 – 11.00	**Opening keynote address 2**: Global aquaculture development since 2000: progress made in implementing the Bangkok Declaration and Strategy for Aquaculture Development Beyond 2000 – Mr Jiansan Jia (FAO)
11.00 – 11.30	Coffee break
SESSION 2: REGIONAL AND GLOBAL REVIEWS ON AQUACULTURE	
11.30 – 12.00	Aquaculture development in Africa: current status and future prospects – Dr Benedict Satia (USA)
12.00 – 12.30	Aquaculture development in Asia-Pacific: current status and future prospects – Dr Sena de Silva (Thailand)
12.30 – 13.00	Aquaculture development in Europe: current status and future prospects – Dr Laszlo Varadi (Hungary)
13.00 – 14.30	Lunch – Sponsored by Intervet Schering-Plough Animal Health
14.30 – 15.00	Aquaculture development in Latin America: current status and future prospects – Dr Carlos Wurman (Chile)
15:00 – 15.30	Aquaculture development in the Near East: current status and future prospects – Dr Issam Krouma (Syria)
15.30 – 16.00	Aquaculture development in North America: current status and future prospects – Dr Paul Olin (USA)
16.00 – 16.30	Coffee break
16.30 – 17:15	Global aquaculture development: a comprehensive analysis – Dr Imtiaz Ahmad (USA)
17.15 – 18.00	Plenary Discussion
18.00 – 20.00	**Side event 1**. GTZ and FAO - Improving sustainability of seafood production and trade: opportunities and challenges **Side event 2**. Thai Department of Fisheries in collabouration with the Norwegian Ministry of Fisheries and Coastal Affairs and FAO – Aquaculture Industry Dialogue

Day 2 Thursday 23 September 2010		
SESSION 3: THEMATIC SESSIONS		
Thematic sessions I and II		
08.30 – 09.15	**Plenary lecture I**: Resources, technologies, and services for future aquaculture: a needs assessment for sustainable development – Dr Patrick Sorgeloos (Belgium)	
09.15 – 10.00	**Plenary Lecture II**: Sector management and governance in aquaculture: an overview – Dr Neil Ridler (Canada)	
10:00 – 10.30	Coffee break	
10.30 – 11.30	**Thematic session I**: Resources, technologies, and services for future aquaculture	**Thematic session II**: Sector management and governance in aquaculture
	Expert panel presentation I.1: Responsible use of resources for sustainable aquaculture – Dr Barry Costa-Pierce (USA)	**Expert panel presentation II.1**: Improving aquaculture governance: what is the status and who is responsible for what? – Dr Nathanael Hishamunda (FAO)
11.30 – 12.30	**Expert panel presentation I.2**: Novel and emerging technologies: can they contribute to improving aquaculture sustainability? – Dr Craig Browdy (USA)	**Expert panel presentation II.2**: Aquaculture and socio-economic growth and development: enabling policies and partnership for improved benefits – Professor Jolly Curtis (USA)
12.30 – 14.00	Lunch break	
14.00 – 15.00	**Expert panel presentation I.3**: Providing high quality feeds for aquaculture and getting out of the fish meal trap: opportunities and challenges – Dr Albert Tacon (USA)	**Expert panel presentation II.3**: Investment, insurance and risk management for aquaculture development – Dr Clement Tisdell (Australia)
15.00 – 15.45	**Invited guest lecture I**: Aquaculture feeds: Is feeding fish with fish a viable practice? – Mr Ulf Wijkstrom (Sweden)	
15.45 – 16.15	Coffee break	
Thematic sessions III and IV		
16.15 – 17.00	**Plenary lecture III**: Maintaining environmental integrity through responsible aquaculture: constraints, opportunities and challenges – Dr Max Troell (Sweden)	
17.00 – 17.45	**Plenary lecture IV**: Responding to market demands and challenges: making aquaculture a competitive food producing sector for the benefit of world consumers – Ms Lara Barazi-Yeroulanos (Greece)	
17.45 – 19.30	Poster viewing with authors	

Day 4 Saturday 25 September 2010		
Thematic sessions V and VI continued		
08.30 – 09.15	**Invited guest lecture III**: Coping with climate change: a real challenge for aquaculturists? – Dr Sena de Silva (Thailand)	
09.15 – 10.15	**Expert panel presentation V.3** Progressing aquaculture in this knowledge economy through virtual technology and decision-making tools for novel management – Dr João Gomes Ferreira (Portugal)	**Expert panel presentation VI.3:** Addressing human capital development and gender issues in aquaculture sector – Dr Kyoko Kusakabe (Japan)
10.15 – 10.45	**Coffee break**	
10.45 – 11.45	**Expert panel presentation V.4:** Information and data needs: a strategy for improving aquaculture statistics – Mr Xiaowei Zhou (FAO)	**Expert panel presentation VI.4:** Supporting farmer innovations, disseminating indigenous knowledge and aquaculture success stories – Dr M.C. Nandeesha (India)
11.45 – 13.30	Lunch break	
SESSION 4: SUMMARY PRESENTATIONS, RECOMMENDATIONS AND CONCLUSIONS		
13.30 – 14.00	**Thematic I:** Resources, services, and technologies for future aquaculture	
14.00 – 14.30	**Thematic II:** Sector management and governance issues in aquaculture	
14.30 – 15.00	**Thematic III:** Maintaining environmental integrity through responsible aquaculture	
15.00 – 15.30	Coffee break	
15.30 – 16.00	**Thematic IV:** Responding to market demands and challenges; making aquaculture a safe and diverse food producing sector for the benefit of world consumers	
16.00 – 16.30	**Thematic V:** Improving knowledge, information, research, extension and communication on aquaculture	
16.30 – 17.00	**Thematic VI:** Enhancing the contribution of aquaculture to poverty alleviation, food security and rural development	
17.00 – 18.30	Presentation and discussion on the Draft Consensus and Strategy for Global Aquaculture Development	
20.00	Farewell dinner and closing	

APPENDIX 3

Abstract of keynote address I: Aquaculture and sustainable nutrition security in a warming planet, by M.S. Swaminathan, Chairman, Research Foundation

Fisheries and aquaculture contribute significantly to food and nutrition security. About 20 percent of per capita intake of animal protein for more than 2.8 billion people is from fish and for over 400 million people fish meets 50 percent of the requirement for animal protein and minerals. Malnutrition is still the number one killer compared to other diseases and fish with its affordable protein and essential nutrients scores over other forms of animal protein. It is a rich source of micronutrients, minerals, essential fatty acids and proteins and is particularly important for the pregnant mother and in child health and development.

An estimated 42 million people, the majority of which is from developing countries, work full or part time as fishers and fish farmers. The potential for further improving livelihoods is huge, since aquaculture is the fastest growing food sector with seven percent annual growth and with 37 percent by volume of world production traded internationally. For developing countries in relation to the combined earnings from the major agricultural commodities of rice, coffee, bananas, rubber, sugar and tea, the net earnings from fishery products are greater. Production from capture fisheries is not expected to increase much further, as most stocks have reached or exceeded their harvestable limits. On the other hand, aquaculture is growing more rapidly than all other animal food producing sectors, with an average global growth rate of 8.8 percent year since 1970.

Of the total global aquaculture production of 68.3 million tonnes (valued at US$106 billion), in 2008 from 340 plant and animal species, 93 percent was from developing countries and this underscores its importance in increasing the income of poor farmers. The importance of aquaculture in meeting the protein requirements from fish is evident from the fact that while kg per capita fish consumption rose from 14.9 in 1995 to 17.1 in 2008, the percentage contribution of aquaculture increased from 29 to 46percent for the same period. If the current growth can be sustained, it is estimated to meet more than 50 percent of the total fish requirements by 2015.

However, the growth in aquaculture can be derailed by climate change unless mitigating and adaptation measures are put in place. Investments in aquaculture compared to other animal protein sources would bring better returns with regard to climate change in view of its considerable limited greenhouses gas and wastes produced per kg of meat.

Climate change is likely to increase the frequency and intensity of climate processes, such as El Niño-Southern Oscillation and there are indications that all surface waters of oceans with some geographical variations are warming and increasing in salinity. Global sea level which has been rising due to climate change has accelerated after 1993. Many lakes especially those in Africa have shown moderate to strong warming since the 1960s. The likelihood of wetlands completely drying out more completely in dry seasons due changes in temperature and precipitation is increasing. The timing, duration and areas flooded are also expected to change. All these are expected to increase the frequency and intensity of extreme floods and droughts. These would increase the risk of livelihood loss and personal security. For example, the thriving catfish farming in Mekong which provides 150 000 livelihoods with a production of 1 million tonnes valued at 1 billion dollars per year would be jeopardised by saline

intrusion due sea level rise. African countries which depend greatly on fish for protein and have the least capacity to adapt to climate change like Angola, Congo, Mauritania, Mali, Niger, Senegal and Sierra Leone are semi-arid with significant coastal or inland fisheries – it means higher vulnerability to future increases in temperature and linked changes in rainfall, hydrology and coastal currents. Island nations and others like Bangladesh would be greatly hit by the increase in frequency and intensity of storm and resulting flooding. Since all farmed fishes are poikilothermic, climate changes will significantly alter metabolism resulting in reduced, growth rate, total production, reproduction seasonality and increase vulnerability to diseases. Hence increase in temperature due to climate change will have a much stronger impact on aquaculture productivity and yields.

Aquaculture provides opportunities to adapt to climate change by integrating aquaculture and agriculture, which can help farmers cope with drought while increasing livelihood options and household nutrition. Water from aquaculture ponds can help sustain crops during periods of drought while at the same time the nutrient rich waters can increase productivity. Farmers can use saline areas no longer suitable for crops that are expected to increase due to sea level rise to cultivate fish. Taking advantage of the short generation time and high fecundity, it would be possible to selectively breed fishes to tolerate higher temperature, salinity and increased diseases that are likely to impact aquaculture due to climate change.

Aquaculture depends heavily on capture fisheries for fish meal and in certain areas for seed and hence there is an urgent need to find plant protein based alternatives to fish meal and to domesticate species for which there is still a dependence on wild broodstocks. The adaptive response of different communities to Asian tsunami needs to be evaluated to derive valuable lessons for future such extreme events that are likely to increase.

To meet climate change there is a greater emphasis on renewable energy like offshore wind, wave and tidal energy and greater nuclear power capacity being proposed with coastal or inland water cooling and these can adversely affect coastal and inland aquaculture unless strategies to mitigate their effect are inbuilt.

Finally, it is necessary to increase the awareness on the potential to develop adaptive livelihoods, improve the governance and build institutions that can help people, integrate aquaculture in the overall climate change and rural development policies. To adapt to sea level rise, we should promote agri-aqua farms. Seawater can be converted into potable water through mariculture cum agro-forestry involving mangroves Salicornia, Atriplex, Sesuvium and Casuarina. Coastal aquaculture will then become an important component of sea water farming, thereby opening up new windows of opportunity for using sea water as an important ingredient of sustainable food and nutrition security system.

Abstract of keynote address II: Global aquaculture development since 2000: progress made in implementing the Bangkok Declaration and Strategy for Aquaculture Development Beyond 2000
by Jiansan Jia, Chief, Aquaculture Service (FIRA)

In 1976, FAO assisted in adopting the Kyoto Strategy for Aquaculture Development, which facilitated the transformation of aquaculture from a traditional to a science-based economic activity. It promoted technical cooperation among developing countries to expand national, regional and global aquaculture development.

In 1995, promulgation of the FAO Code of Conduct for Responsible Fisheries enshrined the principles of sustainability and responsibility in the practice of fisheries and aquaculture. It sparked the development and increasing adoption of practical guidelines for responsible fishing, fish farming and trade in aquatic products. Subsequently, in 2000, the "*Conference on Aquaculture in the Third Millennium"* adopted the Bangkok Declaration and Strategy. This Strategy reconciled the development and management of global aquaculture into five key areas of sustainable aquaculture including the fundamental need for a responsible farmer to be justifiably rewarded, the social ideal of equitable sharing of costs and benefits, society's desire to benefit from aquaculture without being harmed by its practices and products, the pragmatic economic goal of providing livelihood and enough and affordable food to everyone and the moral obligation to conserve the environment for the next generation.
It has been recognised that the principles and strategies advocated by the Kyoto Declaration on Aquaculture in 1976, the Code of Conduct for Responsible Fisheries in 1995, and the Bangkok Declaration and Strategy in 2000 have served well the process and goals of aquaculture development. The aquaculture sector has further expanded, intensified and diversified during the past decade. The expansion of the sector is mainly due to research and development breakthroughs, compliance to consumer demands and improvements in aquaculture policy and governance, in keeping with the guidance provided in the 2000 Bangkok Declaration and Strategy. Efforts to develop the sector's full potential and increase global seafood supplies have been aggressively pursued in recent years, and have resulted in industry expansion and growth. The aquaculture sector has been developed in a more sustainable manner in keeping with the principles of ecosystem-based management and in accordance with the FAO Code of Conduct for Responsible Fisheries. However, these trends did not occur equally throughout the regions.

The aquaculture sector continued to enhance environmental performance through a combination of improved legislation and governance, technological innovations (water and discharge treatment) and better management practices. There is evidence of efforts towards application of ecosystem approach to aquaculture development in all regions. Many countries expanded their sea-farming activities and began to promote multi-trophic aquaculture with reduced environmental impact. Aquaculture networking improved and communication expanded. Technology strengthened, several new species emerged (catfish, tuna, cod, etc.) and some reached adequate production rates for an established market. The quantity and quality of seed and feed increased globally, taking into further consideration consumers' concerns as well as resource availability. Significant improvements in feed conversion and fishmeal reliance have been achieved in several species. In general, aquaculture health management improved. The use of veterinary drugs and antimicrobials came under increased scrutiny, and legal frameworks for controlling their use have been established in many

countries, although effective enforcement of such laws is still constrained by a shortage of financial and human resources.

Although precise figures are lacking, aquaculture's contribution to poverty alleviation, food security, gender opportunities and employment and trade has increased over the past decade. This is reflected in the increase in volume and value of production and through the growing presence of aquaculture products in world markets, in particular as raw material to the processing sector and through the availability of aquaculture products to world consumers, including domestic markets. Various related issues such as ownership by the beneficiaries, people-centred approaches, growing species that feed low on the food chain, targeting all household members, use of farmer field schools-type methodologies and the use of technologies that are developed according to the local context with network approaches have all contributed to this outcome.

Unlike many other sectors of the economy worldwide, aquaculture has been resilient to the global economic crisis. However, an extended crisis could damage the sector's growth, especially by limiting funds available for research and support to vulnerable groups such as small-scale farmers. Governments, in particular those in developing countries, need to have sound macroeconomic and public-sector management programmes in place in order to cope with the likely impacts. Governments also need to consider providing safety-net support to vulnerable groups, including those engaged in aquaculture activities, particularly as an adaptive response to the possible impacts of climate change. In addition, the continued support of donor partners would be useful to sustain the economic and social achievements.

Two assessments of progress made by FAO in responsible aquaculture development and trade within the current decade, the first in 2005 and published as the State of World Aquaculture 2006, the second in 2009 and appearing as the Global Aquaculture Review 2010, have shown that: (a) the progress has been largely achieved by efforts made in line with the Bangkok Declaration and Strategy, (b) the Strategy remains relevant to the aquaculture development needs and aspirations of States, and (c) there are elements of the Strategy that require strengthening in order to enhance its effectiveness to achieve development goals and deal with persistent and emerging threats.

This Keynote elabourates the achievements made during the past decade, in keeping with the Bangkok Declaration and Strategy, which brought the aquaculture sector to the current level.

Abstract of invited guest lecture I

Title: Aquaculture feeds: Is feeding fish with fish a viable practice?
Author: Ulf N. Wijkström

The use of fish as feed for aquaculture is not uncontroversial. Some say that the practice should be reduced, if not stopped. They argue that the practice is not in the interest of those consumers who otherwise would have eaten the fish used. The amount of fish available is reduced as more than one kilogramme of fish – in the form of feed – is needed to produce one kilogramme in captivity. Also, the ever expanding demand for fish as feed is thought to endanger the long-term sustainability of targeted fish stocks.

Capture fisheries produces some 90 to 95 million tonnes of fish and other aquatic species per year. Of these, somewhere between 20 and 25 million tonnes are regularly processed into fishmeal and oil. During the last two decades, a growing portion of the world's fishmeal and oil has been bought by the fish/shrimp feed industries and converted into fish and shrimp feed. Most of the 25 to 30 million tonnes are obtained by industrial fisheries in the North Atlantic and in the Pacific Ocean off the west coast of South America.

In China, Southeast and South Asia, by-catch, particularly from trawl fisheries for shrimps, are used as fish feed. There are no precise estimates of the quantities involved, but it is believed that they may be of the order of six million tonnes of fish per year. Also, whole or chopped fish is used in growing quantities to feed captured juveniles of blue fin tuna.

It is an undisputable fact that modern farming of carnivorous fish and shrimp uses more fish as feed than is produced as finfish or shrimps; that is, the ratio between fish used and fish obtained is higher than one. However, if the fish used as feed is not consumed as food (for whatever reason: not appetizing, too bony, too small or because it is not economically viable to preserve it for later consumption), then, in the end, might not its use as feed lead to more food fish?

The author shows that industrial fishing for forage species in the North Atlantic and in the Pacific, off the coast of South America, via manufacture of fishmeal and fish/shrimp feeds, brings about a net contribution of food fish supplies, without causing a systematic collapse of the exploited forage species. However, the practice of using by-catch as fish/shrimp feed has apparently led to a decrease in the availability of fish as food for the very poor in some regions of South, Southeast and East Asia, although this affirmation needs to be substantiated with hard data.

Furthermore, it should be recognized that, a large part of the "forage fish" used to produce fishmeal is edible fish. If this fish could be made available as low-cost food to the poor, no doubt their food security would improve. The obstacles for such a development are economic and legal. On one hand, a global agreement under the World Trade Organization (WTO) would be needed authorizing the sale of "food grade" subsidized food-quality forage fish and, secondly, an internal fund would have to be created to finance (at the rate of billions of US$ per year) the production, storage and transport of cheap fish products based on "food forage fisheries" in the North Atlantic and South-eastern Pacific.

True, the practice of feeding fish to fish/shrimps leads to more food fish being available for human consumption, but who will be able to afford the additional supplies? Most of the species that are fed with feeds that include substantial portions of fishmeal and fish oil are not low-cost items. It can be safely argued that these species will not be become a regular component in the diet of the poor, and particularly not of the poor in developing countries.

On the other hand, aquaculture today contributes about half of all the seafood eaten in the world. Doubtlessly, the real price of all fish would have been substantially higher today, had not aquaculture existed. This will have benefited also the very poor. Naturally, all the merit of this development does not lie with the use of fish as feed, as not all aquaculture systems use feed or fish, in one form or another, as feed.

The author ends by considering an aspect that is often neglected in the discussion of the use of fish as feed for fish: employment. Most governments see unemployment as a problem. They work to support the creation of employment. Thus, employment in feed fisheries, fishmeal/fish oil industries, fish/shrimp feed industries and aquaculture is a positive contribution.

The author identifies shrimp farming as a labour-intensive activity that provides employment to millions of unskilled workers in developing economies. In the absence of fishmeal/ fish oil, most of those employment opportunities most likely would cease to exist.

Abstract of invited guest lecture II

Title: The potential of aquaculture to improve human nutrition and health.
Author: Shakuntala Haraksingh Thilsted

Small fish are a common food and an integral part of the everyday carbohydrate-rich diets of many population groups in poor countries. These populations also suffer from under-nutrition, including micronutrient deficiencies – the hidden hunger. Small fish species, as well as the little oil, vegetables and spices with which they are cooked enhance diet diversity. Small fish are a rich source of animal protein, essential fatty acids, vitamins and minerals.

Studies in rural Bangladesh and Cambodia showed that small fish made up 50–80 percent of total fish intake in the peak fish production season. Although consumed in small quantities, the frequency of small fish intake was high. As many small fish species are eaten whole; with head, viscera and bones, they are particularly rich in bio-available calcium, and some are also rich in vitamin A, iron and zinc.
A traditional daily meal of rice and sour soup, made with the iron-rich fish, "trey changwa plieng" (Mekong flying barb, *Esomus longimanus*), with the head intact can meet 45 percent of the daily iron requirement of a Cambodian woman.

Small fish are a preferred food, supplying multiple essential nutrients and with positive perceptions for nutrition, health and well-being. Thus, in areas with fisheries resources and habitual fish intake, there is good scope to include micronutrient-rich small fish in agricultural policy and programmes, thereby increasing intakes which can lead to improved nutrition and health. The results of many studies and field trials conducted in Bangladesh with carps and small fish species have shown that the presence of native fish in pond polyculture and the stocking of the vitamin A-rich small fish, "mola" (mola carplet, *Amblypharyngodon mola*), did not decrease the total production of carps. However, the nutritional quality of the total fish production improved greatly. In addition, mola breeds in the pond, and partial, frequent harvesting of small quantities is practiced, favouring home consumption. A production of only 10 kg/pond/year of mola in the estimated four million small, seasonal ponds in Bangladesh can meet the annual recommended intake of six million children.

Successful aquaculture trials with polyculture of small and large fish species have also been conducted in rice fields and wetlands. Thus, aquaculture has a large, untapped potential to combat hidden hunger. To make full use of this potential, further data on nutrient bioavailability, intra-household seasonal consumption, nutrient analyses, cleaning, processing and cooking methods of small fish species are needed. Advocacy, awareness and nutrition education on the role small fish can play in increasing diet diversity and micronutrient intakes must be strengthened. Measures to develop and implement sustainable, low-cost technologies for the management, conservation, production, preservation, availability and accessibility of small fish must be undertaken. Also, an analysis of the cost-effectiveness of micronutrient-rich small fish species in combating micronutrient deficiencies using the Disability-Adjusted Life Years (DALYs) framework should be carried out.

Abstract of invited guest lecture III

Title: Coping with climate change: a real challenge for aquaculturists? The potential of aquaculture to improve human nutrition and health.

Author: Sena De Silva

In spite of all the debates and controversies, a global consensus has been reached that climate change is a reality and that it will impact on food production systems, among others. These impacts will occur in diverse manifestations, ranging from increased global temperature to sea level rise, to more frequent occurrence of extreme weather events, to change in weather patterns such as the monsoonal rain patterns. In this regard, aquaculture is no exception. Aquaculture – farming in the waters – is also characterized by the fact that the organisms cultured, the most diverse of all farming systems, are all poikilotherms. It occurs in fresh-, brackish- and marine waters, and is spread across all climatic regimes from temperate to the tropics. Consequently, there are bound to be many direct impacts on aquatic farming systems brought about by climatic changes. The situation is further exacerbated by the fact that certain aquatic farming systems that also happen to be significant in high commodity value, such as salmonid and shrimp farming, as well as those of relatively low commodity value but undergoing increasing intensification, are dependent, to varying degrees, on products, subjected to reduction processes, from the wild. All of the above factors will impact on aquaculture in the decades to come and accordingly, the aquatic farming systems will begin to encounter new challenges to maintain sustainability.

The challenges that aquaculture will face will vary to a significant degree between climatic regimes. In the tropics, the main challenges will be encountered by those farming activities that occur in deltaic regions, which also happen to be hubs of aquaculture activities, such as in the Mekong Delta and the Red River Delta in Viet Nam and the Ganges-Brahamaputra Delta in Bangladesh. Aquaculture activities in tropical, deltaic areas will be mostly impacted by sea level rise, and hence increased saline water intrusion and reduced water flows, among others. Perhaps, as a mitigating measure there could be a need to shift to more salinity-tolerant species or to develop higher salinity-tolerant strains, as the case may be. Elsewhere in the tropics, inland cage culture and other aquaculture activities could be impacted upon by extreme weather conditions, increased upwelling of oxygen poor waters in reservoirs, etc., requiring greater vigilance and monitoring, and even perhaps readiness to move the operations to more conducive areas in a water body.

Other indirect impacts of climate change on tropical aquaculture could be manifold and perhaps largely unknown. The reproductive cycles of a great majority of tropical species are dependent on the monsoonal rain patterns, which are predicted to change. Consequently, irrespective of whether cultured species are artificially propagated or not (the great bulk are), the change in the reproductive cycle will impact on seed production and thereby, the whole grow-out cycle and modus operandi and management of farm activities. Equally, such impacts will be felt on the culture those species that are based on natural spat collections, such as molluscs.

In the temperate region, global warming could raise the culture temperatures of some species to the upper tolerant range and thereby make such culture systems vulnerable to high temperatures, the mitigating measures available being either to shift to other species with high

temperature tolerance and/or to develop strains tolerant to higher temperatures. In the temperate regions, there is a high possibility of new or dormant pathogens becoming virulent with increase in water temperature, confronting the sector with the need to combat new or hitherto un-manifested diseases.

Climate change may also cause indirect effects on aquaculture via impacts on production of those fish species that are used for reduction and which, in turn, form the basis for feeds in aquaculture, particularly for cultured carnivorous species. This is likely to have a major impact on some key aquaculture practices, spread across all climatic regimes. Limitations of supplies of fishmeal and fish oil, and the resulting expected exorbitant price hikes of these commodities, will lead to more innovative and pragmatic solutions on ingredient substitution of aquatic feeds, which perhaps will be a positive result arising from a dire need to sustain a major sector.

The sector has to be proactive and start working on adaptive and mitigating measures, sooner rather than later. Adaptive and mitigating measures to sustain the sector in the wake of climate change impacts will entail both technological and socio-economic approaches. The latter will be more applicable to small-scale farmers, the great bulk of producers in developing countries who constitute the backbone of the sector, contributing perhaps in excess of 70 percent of the global aquaculture production. The sociological approaches will entail the challenge of mitigating the potential climate change impacts on small farming communities, in the most vulnerable areas, such as in deltaic regions, and weighing the most feasible adaptive options and bringing about the policy changes required to implement those adaptive measures economically and effectively.

Global food habits have changed over the years. We are currently in an era where food safety and quality, backed up by eco-labelling are paramount; it was not so 20 years back. We will, in the very foreseeable future, move into an era where consumer consciousness will demand that farm foods of every form, when they reach the table, should have a minimal green house gas (GHG) emission level; the price and demand will be determined by such a factor. Perhaps, the greatest challenge faced by aquaculture is to meet these aspirations, and even as it is today, to impress upon the public that the great bulk of aquaculture produce, for example about 70 percent of all finfish and almost 100 percent of all molluscs and seaweeds are minimally GHG emitting. The challenge is also to continue the trend to drive aquaculture as the most green house gas friendly food source that is before us, and that the sector could still conform to such needs and continue to meet the increasing food fish supply needs of the globe.

APPENDIX 4

The Phuket Consensus: a re-affirmation of commitment to the Bangkok Declaration

Preamble

The Kyoto Strategy for Aquaculture Development adopted in 1976 facilitated the transformation of aquaculture from a traditional to a science-based economic activity. It promoted technical cooperation among developing countries to expand aquaculture development.

The UNEP Convention on Biological Diversity that came into effect in 1993 reflected the world community's commitment to manage biodiversity for the welfare of present and future generations

The FAO Code of Conduct for Responsible Fisheries promulgated in 1995 enshrined the principles of sustainability and responsibility in the practice of fisheries, aquaculture and trade in aquatic products.

The Bangkok Declaration and Strategy adopted in 2000 articulated 17 strategic elements for aquaculture development. These could be broadly summarised as: (i) a responsible farmer is justifiably rewarded; (ii) costs and benefits are shared equitably; (iii) society benefits from the practice and products of aquaculture; (iv) adequate, affordable and safe food is available and accessible to everyone; (v) the environment is conserved for the next generation, and (vi) the development of the sector is orderly.

At the threshold of this millennium, in September 2000 in New York, the global community adopted the United Nations Millennium Declaration which set the eight Millennium Development Goals.

The Paris Declaration adopted in March 2005, provides the guidelines for the correct targeting, effective coordination and efficient management and utilization of external assistance.

In the third World Food Summit on food security held in November 2009 in Rome, the leaders of nations pledged their renewed commitment to eradicate hunger at the earliest possible date.

Towards the end of the first decade in December 2009, the world agreed, in Copenhagen, to meet with resolve and a common purpose the challenges of climate change.

These global accords, with the Bangkok Declaration and Strategy as the core instrument for aquaculture development, shall continue to guide the development and management of aquaculture beyond 2010 through the first quarter of this century.

Re-affirmation of the Bangkok commitment

In line with the above and recognizing that:

1. The principles and strategies advocated by the Kyoto Strategy for Aquaculture Development, the FAO Code of Conduct for Responsible Fisheries, and the Bangkok Declaration and Strategy have served well the processes and goals of aquaculture development;
2. The two assessments of progress made in responsible aquaculture development and trade conducted in this first decade of the millennium – the first, completed in 2005 and published as the State of World Aquaculture, the second in 2010 and appeared as the Global Aquaculture Review -- have shown that:
   - the progress has been made possible largely by efforts made in line with the Bangkok Declaration and Strategy;
   - the Strategy continues to be relevant to the aquaculture development needs and aspirations of States; and
   - there are elements of the Strategy that require further strengthening in order to enhance its effectiveness, achieve development goals and address persistent and emerging threats;

Recommendations

We, the participants at the Global Conference on Aquaculture 2010 re-affirm our commitment to the Bangkok Declaration and Strategy for Aquaculture Development and recommend these actions:

1. ***Increase the effectiveness of governance of the aquaculture sector,*** recognizing the crucial need for sound policies, strategies and plans in sustained development incorporating the principles of an ecosystem approach to aquaculture; and recognizing further that stronger institutions, improved capacity and more effective mechanisms of governance, including rules and regulations, the market, economic incentives, voluntary codes of practices, and responsible self-management, have enabled a more orderly and responsible development of aquaculture.

2. ***Encourage and facilitate greater investments in scientific, technical and social innovations,*** recognizing that these assist in the resolution of productivity and sustainability issues that had earlier been deemed intractable, extremely costly or impossible to solve.

3. ***Conduct accurate assessments of the progress and contributions of aquaculture to national, regional and global economies, poverty alleviation and food security,*** recognizing that this will enable the aquaculture sector to formulate better-informed development policies, strategies and plans that governments and development partners will favourably consider for support and funding.

4. ***Intensify assistance to the small farmers***, recognizing that the small (resource-limited and/or subsistence) farmers comprise the vast majority of aquaculture producers in the world and recognizing further that they are the most vulnerable to impacts of natural and economic risks.

5. ***Support gender sensitive policies and implement programmes*** that facilitate economic, social and political empowerment of women through their active participation in aquaculture development, in line with the globally accepted principles of gender equality and women's empowerment.

6. ***Increase and strengthen collabouration and partnerships,*** acknowledging the many economic and technical benefits to nations, governments and people, of Technical Cooperation among Developing Countries (TCDC), inter-regional cooperation, and institutional collabouration and partnerships; and further acknowledging that the capacities for sustainable aquaculture development and trade among regions and countries have been cost-effectively improved by economic and technical cooperation facilitated by appropriate investments in development assistance from donors and technical assistance from international development organizations.

7. ***Give special emphasis on Sub-Saharan Africa and the least aquaculturally developed countries and areas,*** recognizing the need to urgently develop their vast aquatic resource potentials to accelerate their social and economic development, and recognizing further that this will narrow the disparities among regions and countries and contribute to increased global aquaculture growth. In this regard, we recognize that technical cooperation should be further intensified using international and regional mechanisms.

Implementation

The implementation strategy and mechanisms for the Bangkok Declaration and Strategy continue to be valid and relevant.

We note and commend the immediate initiative taken after the adoption of the Strategy in February 2000 to establish the FAO Subcommittee on Aquaculture of the Committee on Fisheries, and the subsequent support provided by FAO Member countries and other organizations and institutions to the formation of regional aquaculture network organizations.

We note and appreciate the stronger collabouration that was fostered among several regional and international agencies and bodies; the formation of a global consortium on shrimp aquaculture and the environment; establishment of several regional aquaculture networks; and an increasing number of partnerships and alliances among government agencies, non government organizations, industry associations and farmer organizations. These cooperative mechanisms are illustrative of the increasing importance of cooperation in improving growth and enhancing the institutional environment for the sustainable development of the sector. These should be further strengthened and made sustainable with appropriate technical assistance and investments.

We recognize that a holistic approach to aquaculture development will promote effective and efficient synergies and linkages among the various economic sectors and leads to sustainable use of resources that are becoming scarce or increasingly demanded by other competing sectors.

We recognize that the lessons from the natural disasters and economic crises of this and the past decades could be an indication of impending threats to aquaculture development, which make us believe that the implementation of Bangkok Strategy shall benefit from the following considerations:

1. The rehabilitation of livelihoods from the tsunami of 2004 and other natural calamities, and the mechanisms adopted to cope with the global economic crises during the past decade have underlined the critical role of biodiversity in sustaining the flow of ecosystems services that enable rapid recovery and sustained development of aquaculture, the importance of infusing social and biological resilience into aquaculture systems and strengthening farmers' capacity to positively adapt to changes beyond their control; and the usefulness of risk management as a tool to reduce, mitigate and cope with the threats to farmers' livelihoods.
2. Economically viable and responsible aquaculture systems are resilient systems, better management practices enhance productivity and social and environmental responsibility; their net impact is to strengthen the ability of the aquaculture sector to successfully face the uncertainties and risks wrought by economic crisis and climate change.
3. The implementation of the Strategy should be guided by a governance mechanism that recognizes the power and limitations of the market promoted through intensified results-based consultations, public-private partnerships and cooperation, and monitored by FAO, in collaboration with member countries, through progress reporting on CCRF.

The "Global Conference on Aquaculture 2010 – Farming the Waters for People and Food" was organized by FAO and NACA, hosted by the Government of Thailand and attended by about 450 people from 80 countries and all the world's continents. It resulted in the "Phuket Consensus", which reaffirms the commitment to the principles laid out in the 2000 *Bangkok Declaration and Strategy* and recommends (i) increasing the effectiveness of governance of the aquaculture sector; (ii) encouraging and facilitating greater investments in scientific, technical and social innovations; (iii) conducting accurate assessments of the progress and contributions of aquaculture (including aquatic plants) to national, regional and global economies, poverty alleviation and food security; (iv) intensifying assistance to the small farmers; (v) supporting gender sensitive policies and implement programmes that facilitate economic and political empowerment of women through their active participation in aquaculture; (vi) increasing and strengthening collaboration and partnerships; and (vii) giving special emphasis on sub-Saharan Africa and the least aquaculturally developed countries and areas in order to allow them to develop their aquatic resource potentials.

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