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Research Solutions for a Win-Win-Win

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Research Solutions for a Win-Win-Win

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Global fish production, consumption trends, and the trade in seafood products are dominated by the developing world, particularly Asia. The importance of fish to the poor as an affordable and readily available staple food and as a source of livelihood opportunities is rarely well documented and all too often under-weighted in the development decision-making process. The rapid pace of change in Asia renders the poor particularly vulnerable under such circumstances

The world's seas now appear to have reached their production limits, with most of the major capture fisheries assessed as fully exploited or operating beyond sustainable limits. With future prospects for further sustained growth in landings at best limited, aquaculture is being targeted as the engine for growth in fish supplies to meet the growing gap between supply and demand. The recent performance of the aquaculture sector has been outstanding and expectations for future performance remain very high. Sustainability is critical to both sectors, and research has a major role to play in helping individual countries, communities and farmers meet and maintain their production goals for both sectors.

There is an important ongoing role for Australia in helping the developing world to find workable and

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sustainable solutions to many of these problems and challenges. The ACIAR partnership model provides a good example of research that can deliver real impacts in the development context. ACIAR, an element of Australia's overseas aid program, is broadly engaged across many of the identified areas of research need in fisheries and aquaculture, with a primary focus on Asia, PNG, and the Pacific islands regions. Areas of past and ongoing research where significant community impacts have been achieved include assessment and management of shared fish stocks; reservoir fisheries, combating Illegal, Unreported and Unregulated (IUU) fishing; the fostering of new livelihood opportunities in mariculture and disease control for sustainable smallholder shrimp farming.

Introduction

Fish and the poor

The importance of fish to the poor as an affordable and readily available staple food and as a source of livelihood opportunities is often stated but rarely well documented, and all too often under-weighted in the development decision-making process. Per-capita consumption figures tend to understate the importance of fish both as a source of animal protein and essential nutrients and in the provision of livelihoods. Few developing countries accurately record participation levels in the subsistence and artisanal sectors of their capture fisheries: official statistics, where they are available and reliable, tend to report on licensed operators and cover records of landings at larger commercial markets. Similarly, the significant contribution of fish and other aquatic produce gleaned from paddy fields and seasonal water bodies are unrecorded and their contribution to household nutrition under-valued by policy-makers and national planners. In many Asian countries the focus has long been on rice as the keystone for food security, with the critical role of fish and fish products in enriching the dominant rice diet, particularly in more remote

rural areas, poorly understood. Apart from providing protein and calories to the diet, fish is a rich source of a number of essential fatty acids and calcium, which are difficult to secure from other sources including many meats. Poverty is more likely to equate to hunger for those who purchase rather than produce food, and the most vulnerable groups in this respect are the landless, the urban poor and small-scale producers, all of whom have a limited capacity to secure entitlement to food (NACA/FAO 2004). As the productivity of wild fisheries falls, the ease of access to fish by the poor is subject to a disproportionate and growing threat, exacerbated by allocation and access conflicts, the greater application of fish to animal and aquaculture feeds and the increased trade in fish produce, all of which lead to the twin effects of rising prices and reduced availability. The rapid pace of change in Asia renders the poor in this region particularly vulnerable in this respect.

Fish supply

The world's seas now appear to have reached their production limits, with most of the major capture fisheries assessed as fully exploited or operating beyond sustainable limits. This applies to both developed and developing countries, with the situation particularly acute in Asia. World total capture fisheries production has stalled at or around 80–90 million metric tonnes (MMT) with the 2001 harvest approaching 85 MMT, of which more than one-third was used for annual feeds or applied to non-food purposes (Bartley *et al.* 2003). Fishery managers around the world now face the very significant challenge of stabilising catches at present levels or, more often, at lower, more sustainable levels, and drastically reducing effort in over-capitalised fisheries. The simplistic fisheries development mantra of the sixties and seventies — '*Give a man a fish and he eats for a day — teach him to fish and he eats for a lifetime*' has come back to haunt many of us.

In the short-to-medium term, any net gain to human food supplies from wild harvest fisheries must come predominantly from better utilisation of existing catches, and the diversion of more product to direct human use.

With future prospects for any sustained growth in landings from wild fisheries at best limited in the short-to-medium term, aquaculture is being targeted as the engine for growth in global fish supplies to meet the growing gap between supply and

demand. The recent performance of the aquaculture sector has been outstanding, and expectations for future performance remain very high. Aquaculture has been the fastest-growing food production sector in the world for the last two decades, with an overall growth rate of 11% per year (Delgado *et al.* 2003). The dominance by China of global mariculture (74%) and freshwater aquaculture (73%) production tends to mask the less spectacular growth elsewhere in the developing world, while production from the developed world has plateaued. The potential for aquaculture to meet future global food fish needs is real but significant constraints do remain, the solution to which will require ongoing and substantial private and public investment underpinned by innovative science.

The integration of aquaculture with existing agriculture provides significant opportunities to diversify farm income options for small-holders, to better use scarce water resources, to recycle farm by-products and waste, and to improve both the economic and the environmental sustainability of the farming system. Sea ranching, sea cage culture, and resource enhancement offer new opportunities to expand production, while mariculture will provide new tools to restore and supplement depleted wild stocks. Aquaculture in freshwater environments has a long history, particularly in Asia where pond and cage culture is the dominant source of production. Resource enhancement in closed and open water bodies is an area receiving increasing attention, and could deliver significant new opportunities to increase production. While enhancement of aquaculture and fisheries has the potential to increase their contributions to world fish supplies, many challenges face producers and resource managers alike. These include population pressures and the competition between users for land, water and coastal wetlands, as well as pollution and habitat degradation. However, the positive attributes for income generation and poverty alleviation make aquaculture an attractive option for both poor inland and coastal communities.

Sustainability is critical to both capture and culture fisheries, and research has a major role to play in helping individual countries, communities and farmers meet and maintain their production goals for both sectors.

Major research issues and challenges

Marine capture fisheries

Most fisheries production as well as many of the problems and challenges come from coastal and in-shore marine fisheries. The management environments for these largely open-access fisheries are demanding, but the multi-species multi-gear fisheries of Asia are particularly complex and subject to rapid change. Multiple stakeholders are involved, often in open conflict, and resolution of appropriate resource sharing arrangements are hampered by the often inadequate or inappropriate policy and institutional settings. This is further compounded by tangled legal rights and responsibilities. The situation is not assisted by substantial uncertainties as to the status of targeted fish stocks and their resilience to the combined impacts of exploitation, pollution and habitat loss. Commercial fishing interests seeking short-term financial gains often exploit such situations to their individual benefit but to the detriment of the community as a whole. Centralised national systems of fisheries management have all too often failed for in-shore fisheries, with the result that locally-evolved and community-supported management approaches are rapidly gaining credence. Such management solutions demand the commitment and active involvement of legitimate stakeholders at all levels and will be complex, hard won and, in the main, location /fishery specific.

Compliance with the growing suite of international fisheries agreements, many brokered by FAO, provide another area of significant challenge for developing countries in particular. Compliance with United Nations Law of the Sea requirements for the development of suitable management arrangements for cross-boundary stocks and the control of IUU fishing are two areas where progress is at an early stage.

Fisheries research has an important role to play in defining as accurately as practicable the physical dimensions to such local, regional and international management debates, but it is social- and policy-focussed investigations that will increasingly have primacy in terms of promoting the necessary policy and institutional changes required, and in facilitating the evolution of management arrangements that are socially equitable, affordable and enforceable. Given a lack of adequate data on trends in catch effort, a common character-

istic of most fisheries in Asia, there is a need for simple yet robust tools and methods for monitoring stock status, and assessing resource response to fishing pressure and other impacts in such data-poor situations.

Aquaculture

Aquaculture is considered to be many decades behind animal production industries in relation to the potential for productivity gains through the application of existing and developing technologies (see Fig. 1) (Gupta 2004). The impressive gains made by aquaculture, particularly in Asia over the last few decades, have been largely achieved through the intensification of existing systems as seed availability and related feed and disease control technologies improved. These developments have been propelled by the demand-pull of new and expanding markets and rising prices. Research and farmer innovation have driven this impressive progress to date, and will continue to play an important role. Recognising the importance of this production to the poor in particular, ACIAR has substantially increased its support to aquaculture in recent years.

Key areas of research challenge include:

- *Domestication and genetic improvement.* Inadequate seed stock supplies, too often based on dwindling wild sources in the case of marine species, are a generic constraint to sustainable and profitable aquaculture operations for many commonly-cultured species. Domestication is a prerequisite for breed improvement, yet relatively few culture species have been domesticated and genetic improvement programs are in their infancy. The potential for major productivity gains through genetic im-

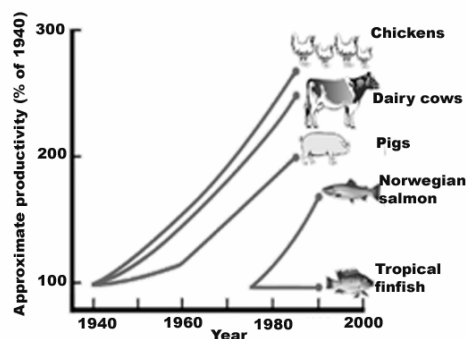


Figure 1. Productivity of key livestock has risen remarkably since 1940 (Gupta 2004)

provement of new and existing species is very substantial. The productivity and efficiency gains achieved with salmon underline this potential. GIFT tilapia, which under a WorldFish program recorded an 85% increase in growth over five generations (see Fig. 2), provides an exciting developing-world example (Gupta 2004).

- *Improved nutrition, the better use of on-farm feed sources, and the development of cost effective feed formulations.* Feed and fertiliser resources for aquaculture are often limiting, with many competing users, and comprise a major input cost to production. The development of cost-effective feeds with reduced reliance on fish-based proteins and oils is a compelling issue for the long-term sustainability of the aquaculture industry. With market demand driving the trend to higher-value and largely carnivorous species, there is an urgent need to address the growing diversion of so-called trash fish to aquaculture. Feeding trash fish also has consequences for the environment through the release of excess nutrients and wastage, and importantly, for current and future global food security. The diversion of fish to animal feeds can have significant detrimental impacts on the price and availability of food fish to poor urban and rural consumers alike. Feed development, with a focus on the reduced use of fish products and low-polluting formulations, can draw effectively from existing animal production expertise and experience to deliver broad productivity and environmental benefits.
- *Environmental issues.* With water and land increasingly limiting, aquaculture will need to be environmentally smarter if the sector is to meet its potential. There is a strong interdependence between aquaculture operations and

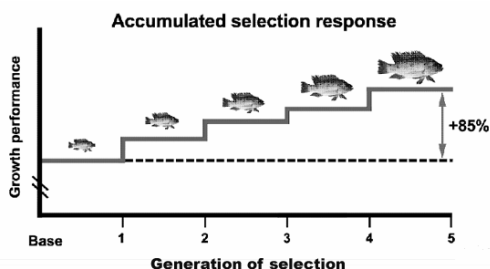


Figure 2. Tilapia has responded dramatically to just a few generations of selection, and the gain per generation promises to continue (Gupta 2004)

the quality of the grow-out environment, and if industry self-interest fails to address environmental sustainability issues, market forces will increasingly come into play. This will demand closer attention to the more efficient use of water and nutrients, and the containment and better management of effluents, preferably on farm. Aquaculture is also affected by other resource users and multi-sectoral, multi-disciplinary approaches will be needed to manage environmental impacts of and on aquatic farming systems. Mistakes have been made in the past and, without appropriate planning and regulatory environments, will continue to be made.

- *Disease control and management.* Severe, often catastrophic losses to disease have become commonplace, the causes of which in most cases remain poorly understood. Viral diseases in particular warrant special attention as they are consistently identified as major threats to the long-term viability of intensive aquaculture. The growth in aquaculture production has been paralleled by an exponential increase in trans-border movements of live aquatic animals, seed, broodstock, live food fish, etc., with a proportional increase in disease, parasite transfer and related biodiversity risks. Research must continue to provide the tools and knowledge required to improve disease and quarantine control systems, and importantly to assist farmers to better assess and manage disease risk at the farm level.
- *Food safety issues* and other consumer-driven requirements are affecting the aquaculture industry. The added costs of compliance will affect the viability of small producers and this issue will need special attention from researchers and policy-makers if they are to meet this challenge. The growing market for eco-friendly production and full traceability will also become increasingly important, again with special implications for small producers.

Role for Australia

Australia, through AusAID, ACIAR and other mechanisms, both formal and informal, has an abiding commitment to assisting developing-country neighbours to achieve their development aspirations in a sustainable manner. Fisheries remains a central area of common interest and involvement. Australia has one of the largest maritime zones in the world, with climate, habitat

and fish fauna similar to those of many of its Indo-Pacific neighbours, and in the case of PNG and Indonesia, we share international responsibilities to jointly manage cross-boundary fish stocks in the Torres Strait and Arafura Sea. Cooperative research on shared stocks can deliver strong mutual benefits in relation to the resources in question while providing the opportunity to enhance the capacity of partner countries to assess and better manage all exploited stocks, domestic and international. Australia, benefiting from past research investment in marine and environmental sciences, can assist with the further development of quantitative assessment methods, resource and habitat rehabilitation, and the further evolution of appropriate integrated system-wide management approaches.

Aquaculture has a long history in Australia, but recent rapid growth has seen it flagged as an emerging or sunrise industry. While small by world standards, production has more than doubled since 1984, and the industry now contributes 30% of the gross value of Australian fisheries production. This commonality of interest with the developing world provides significant opportunities for productive research collaboration. The existing aquaculture research skills base in Australia has been substantially augmented in recent years by the increasing involvement of specialists in environmental management and allied animal and plant production sciences. Sharing problems and potentials with Asia provides a valuable win-win situation where Asia benefits from Australia's strong technical skill base, while Australia gains valuable knowledge and experience from Asia's history and dominant position in aquaculture production.

ACIAR — research that works

ACIAR was established in 1982 to harness Australia's acknowledged expertise and experience in agricultural sciences to assist developing countries to solve problems constraining or threatening food production and food security. The chosen partnership model and win-win modality of mutual interest, mutual commitment, and mutual benefits to the partner countries and to Australia has been remarkably successful. It has been well received in the developing world, and importantly has stood the test of time. ACIAR is part of Australia's overseas aid program and has a clear focus on the application of good science to improve food security, livelihoods and quality of life for the poor and dis-

advantaged in partner countries. Fisheries is but one of eight focal program areas, as ACIAR activities cover crop sciences, forestry, animal sciences, agricultural policy and economics, land and water resources, post-harvest technology, and communications, training and extension.

ACIAR's Fisheries Program covers wild capture fisheries and issues related to their responsible management, and many aspects of aquaculture — sustainable aquatic farming systems, mariculture and fisheries enhancement. The program fosters a precautionary approach to wild fisheries resource management and retains a clear focus on small-scale fishers and farmers. The increasingly important role of aquaculture in food production and livelihood generation is reflected in the recent ACIAR decision to substantially increase its support to this area of research.

The program has a geographical focus on Asia, PNG and the Pacific islands, and in all projects the early involvement of local communities, resource managers and policy-makers in project design and execution is promoted. ACIAR has supported a total of 76 fisheries projects, completed or ongoing, which are broadly arrayed across the areas of research challenge and opportunity discussed earlier. The success of many of these projects has delivered and continues to deliver real benefits both in partner countries and in Australia. Several examples of projects that have delivered significant outcomes are briefly described below.

Highlight projects having impact

Capture fisheries

- *Illegal unregulated unreported (IUU) fisheries.* This has been identified by the international community as one of the more serious fisheries problems requiring urgent action by nations around the world. The FAO International Plan of Action to prevent and deter these practices was agreed by member nations in 2001. The resource implications of IUU fishing are: compromised fisheries statistics, poor quota setting, fisheries management failures, fisheries stock collapses and loss of social and economic opportunities. IUU fishing can also lead to an erosion of the relationship between bordering fishing nations, possible conflict over resource use and an escalation in the cost of fisheries management (Evans 2000). The situation is of stated concern to the

governments of Indonesia and the Philippines, and ACIAR is supporting policy-level research to assist both countries develop national IUU fishing action plans to address their international obligations and to work cooperatively to develop cross-border cooperation on IUU fishing in the Sulawesi Sea. The impact of this work in both countries, in terms of raising national awareness and stimulating action to address identified national IUU fishing issues, has been very significant.

- *Shared fish stocks in Arafura and Timor Seas (Indonesia and Australia).* Australia shares an extensive common maritime border with Indonesia in the Timor and Arafura Seas. Several workshops in 1991–92 established common interest in a cooperative research program to better understand the biology, stock status and impacts of fishing of a number of species of high economic value where the likelihood of cross-boundary stock interactions was considered high. This has led to a suite of cooperative research project covering red snappers, tunas and sharks and rays. A strong emphasis has been given in all projects to socio-economic studies to document the use of these resources by small-scale fishers and to ensure their interests are fully understood and accommodated in future management arrangements. The results flowing from this work have underpinned constructive dialogue between Australian and Indonesian officials on future management arrangements for such shared fisheries.

Aquaculture

- *High-value marine aquaculture industries.* Grouper and many other marine fish species are highly valued and sought after; the lucrative live fish markets in Asia are increasingly driving the trade. Excessive demand and irresponsible harvesting has led to significant overfishing and, in many cases, major depletion of vulnerable wild stocks. Research cooperation between Indonesia, the Philippines and Australia has resulted in more robust hatchery technology and production system for juveniles of several grouper species, with promising experimental seed production results achieved for a pipeline of other marine species. The rapid transfer of technology to interested local farmers has given rise to over 600 backyard hatcheries in Bali that are routinely producing seed grouper for grow-out elsewhere in Indonesia and increasingly for export to other Asian countries. Ongoing research is focused on grow-out in simple cage culture, with a strong emphasis on feed development to lower production costs and reduce pollution and other environmental problems. Related research projects will develop planning tools to assess carrying capacity for cage aquaculture in tropical inshore waters, and related land capability maps for land-based culture systems. A linked study, to better understand the demand and market chain factors driving the live reef food fish trade to Asia, is also in progress.
- *Sustainable shrimp culture.* Diseases, particularly viral diseases, cause serious financial losses to the small farmers that dominate the shrimp industry in Asia and Australia. ACIAR has supported research aimed at improving viral diagnostic tools while developing ‘best management practices’ through participating on-farm trials to minimise crop loss through disease outbreaks. Linked to this effort is an extension-focussed project which involves implementation and dissemination of existing, science-based methods to control these disease in farmed black tiger shrimp (*Penaeus monodon*), concentrating on ‘white spot disease’ in Asia and ‘midcrop mortality syndrome’ (MCMS) in Australia. The project is using carefully targeted training and extension programs to improve smallholder shrimp farmers’ knowledge and practical skills in health management and disease control. The recurrent failure of brackish-water aquaculture ponds may often be attributed to the acidification effect linked to the construction of ponds in acid sulphate soils (ASS), common to many shrimp-growing regions. Research has established the sources of acid effects on ponds and developed simple methods to ameliorate these effects and bring the ponds back into production.
- *Coral reef livelihood opportunities in the Pacific Islands (ACIAR/WorldFish partnership).* In what has been a long standing and particularly effective partnership, ACIAR and WorldFish have combined resources to exploit novel livelihood opportunities for small rural communities in the Pacific islands. While full success cannot be claimed, promising outcomes have been achieved with the following: giant clams for the aquarium trade, black lip pearl culture and capture/culture of pre-

settlement coral reef species for the aquarium trade.

Restocking/replenishment

- *Sea cucumbers (beche de mer)*. Related to the above, the potential to use hatchery-produced juveniles to restock depleted populations of reef species valued for food or sale is another area of concerted joint effort between ACIAR and WorldFish. A three-phase 15-year program, currently well advanced, is looking at the potential for restocking of sandfish, a valuable sea cucumber species. Hatchery production is now routine; the focus of current research is cost-effective grow-out and release strategies.
- *Trochus*. Other studies are looking at restocking as a tool to establish or rebuild populations of topshell (*Trochus niloticus*), valued for its pearly nacre by the fashion trade and an important cash crop in the Pacific islands. This research is linked to the implementation of community-supported management for the reseeded areas to underpin sustainable harvest regimes, once the populations have reached healthy levels.

Conclusion

Australia can be justly proud of the contributions made to date through the work of ACIAR. This success is due primarily to the inputs of many hundreds of talented and dedicated Australians working effectively with their counterparts in the developing world. I would also like to recognise the strong partnership that has evolved with WorldFish over a decade and more and which has

proven so productive, particularly in relation to the coral reef livelihood activities in the Pacific islands.

References

- Bartley, D., Kapetsky, J.McD., Aguilar-Manjarrez, J. and Riva, C. 2003. *Review of the State of World Fishery Resources: Inland Fisheries*. FAO Fisheries Circular No. 942, Rev. 1. Food and Agriculture Organization of the United Nations, Rome, 60 pp.
- Delgado, C.L., Wada, N., Rosegrant, M.W., Meijer, S. and Ahmed, M. 2003. *Outlook for Fish to 2020: Meeting Global Demand. A 2020 Vision for Food, Agriculture, and the Environment Initiative*. International Food Policy Research Institute, Washington, DC, USA. WorldFish Center, Penang, Malaysia. 29 pp.
- Evans, D. 2000. The consequences of Illegal, Unreported and Unregulated Fishing for fishery data and management. Paper prepared for the *Expert Consultation on Illegal, Unreported and Unregulated Fishing*, organised by the Government of Australia in cooperation with the Food and Agriculture Organization of the United Nations, 15–19 May 2000, Sydney.
- Gupta, M.B. 2004. Overview of tilapia. Presentation to Secretariat of the Pacific Community Workshop, May 2004, Suva.
- NACA/FAO 2004. Emerging trends and experiences in Asia-Pacific Aquaculture 2003. Prepared by the Network of Aquaculture Centres in Asia-Pacific and the Food and Agriculture Organization of the United Nations for the *15th NACA Governing Council Meeting*, 21–25 April 2004, Colombo, Sri Lanka. 144 pp.