A. SUMMARY

1. Title

ICLARM, ACIAR, National Scientists and Communities: Partners for Progress in Mariculture in the Pacific Islands

2. Duration

Continuous since 1987.

3. Objectives

Pacific island nations do not always have the financial and human resources needed to develop methods for mariculture and other forms of inshore fisheries management (Adams, 1998). The ICLARM-ACIAR partnership was established to work with National Fisheries agencies, coastal villagers and Australian Advanced Research Institutions (ARIs) to develop the required methods for restocking, aquaculture and inshore fisheries management on behalf of the Pacific region (Lawrence, 1999).

To harness the potential of their inshore fisheries, island nations must restore stocks to the carrying capacity of the habitat and then harvest them in the optimal, sustainable way. The fastest way to rebuild coastal fisheries is through restocking programs (Bell, 1999). The other way to increase productivity of inshore marine resources in the Pacific is by breeding additional juveniles and raising them on farms, commonly known as aquaculture (Bell and Gervis, 1999).

The objectives of the ICLARM-ACIAR partnership are to provide the people of the tropical Pacific with the tools and knowledge they need to increase the productivity of their inshore marine resources on a sustainable basis. This need arises because many Pacific island nations have few opportunities to earn income, apart from fisheries for tuna within their 200 nautical mile Exclusive Economic Zones, and the harvest of valuable inshore species. Unfortunately, the coastal resources are already over-exploited in many countries. In some cases, the coral reefs which support the inshore fisheries have also been degraded through poor land use and destructive harvesting methods.

4. Activities

ICLARM, ARIs, Solomon Islands fisheries staff and participating villagers have cooperated in several major research projects based at the ICLARM Coastal Aquaculture Centre (CAC) in Solomon Islands, since 1987, supported by ACIAR and to a lesser extent by AusAID. A brief overview of each project is set out below.

Giant clams
The first major research project at the CAC was part of the ACIAR-assisted international giant clam mariculture project. With research partners in various Asia-Pacific nations, reliable technology for rearing giant clams in hatcheries and land-based nurseries was developed. ICLARM now supplies “seed” clams to small-scale village-based farmers in Solomon Islands who grow them for sale to the aquarium market. Research to optimise grow-out techniques, to enhance the appearance of clams destined for the international aquarium market, and to reduce the cost of restocking projects, is continuing.

Pearl oysters
Technology for black pearl farming has been transferred from French Polynesia and Cook Islands to the open reef systems of the western Pacific. A demonstration pearl farm has been established in Solomon Islands and fisheries staff from Fiji and Tonga have been trained to collect wild spat. Initial
trials in hatchery rearing of blacklip pearl oysters have been successful, and future research will focus on increasing the quality of pearls produced by oysters derived from the hatchery, and from wild spat.

**Sea cucumbers**
ICLARM and ACIAR are developing technology for mass-rearing of tropical sea cucumbers for the purposes of restocking depleted fisheries. This research includes broodstock management, spawning protocols, and development of reliable methods for producing juveniles at low cost. The partnership is now embarking on research to develop the best methods for releasing cultured juvenile sea cucumbers into the wild.

**Reef fish**
This activity is assessing the scope for catching and growing postlarval coral reef fish to supply the live fish trade. The postlarvae are caught as they settle from the plankton to coral reefs at night and are then grown to the minimum size required by exporters. Two methods for catching fish, light traps and crest nets, are being assessed. Temporal and spatial variation in the supply of postlarvae are being compared. These methods are being developed as appropriate technologies for application in small-scale village based trapping operations and grow out farms.

**Fisheries management**
The use of marine reserves to prevent or limit fishing is promoted widely as a tool for the management of inshore marine resources. Advantages attributed to such reserves are: recovery of exploited populations within the reserve; increased size of adults within the reserve leading to greater egg production; and dispersal of eggs and larvae to replenish areas that remain open to fishing outside the reserve. ICLARM and ACIAR have been collaborating to test the validity of these assumptions for populations of commercially-important invertebrates at the Arnavon Islands Marine Conservation Area (MCA) in Solomon Islands. To provide an unequivocal analysis of the effects of the MCA, pre- and post-declaration surveys of abundance at sites within and outside of the MCA are being compared.

5. **Area:** Commodity chain

6. **Region:** Asia-Pacific

**B. STAKEHOLDERS**

1. **Beneficiaries**
   - Individual village-based small-scale entrepreneurs utilising technology developed by ICLARM, and their families.
   - Village-based communities.
   - Private sector hatcheries and exporters of live marine products.
   - Fisheries departments in Pacific island nations.
   - National governments (through increased opportunities for coastal dwellers, taxes on exports of marine products and employment of personnel by the partners).

2. **Research partners**

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<th>International agricultural research centre:</th>
<th>International Center for Living Aquatic Resources Management (ICLARM)</th>
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<tr>
<td>Donors:</td>
<td>Australian Centre for International Agricultural Research (ACIAR)</td>
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<td>Australian Agency for International Development (AusAID)</td>
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<td>Australian Advanced Research Institutions:</td>
<td>James Cook University (JCU)</td>
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<td>Australian Institute of Marine Science (AIMS)</td>
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• Great Barrier Reef Marine Park Authority (GBRMPA)

National government partners:
• Fisheries Division, Department of Agriculture and Fisheries, Solomon Islands
• Environment Division, Department of Forestry, Environment and Conservation, Solomon Islands
• Ministry of Agriculture, Fisheries and Forests, Fiji
• Ministry of Environment and Natural Resources Development, Kiribati
• Ministry of Fisheries, Tonga

Regional organisations:
• South Pacific Regional Environment Program (SPREP)
• FAO South Pacific Aquaculture Development Program (SPADP)
• Economic & Social Commission for Asia & Pacific (ESCAP)
• Secretariat of the Pacific Community (SPC)
• University of the South Pacific (USP)

Non-governmental organisations (NGOs):
• The Nature Conservancy
• Overseas Service Bureau, Australia (OSB)
• US Peace Corps
• Canadian University Students Overseas (CUSO)
• New Zealand Volunteer Services Abroad (VSA)

Village farmers and community involvement:
• 50 small-scale giant clam farms run by villagers and their families in six main areas of Solomon Islands.
• 30 farms growing coral croppings for the aquarium trade, run mainly by village women.
• Community management of the Arnavon Islands Marine Conservation Area involving groups from three different islands, including local Conservation Officers who participate in marine resource surveys.
• Communities who provide wild sea cucumber and giant clam broodstock for ICLARM’s hatchery operations, and access to sites for experimental release of cultured animals.
• Participation of the Pearl Growers Association in surveys to assess the potential for black pearl farming in Tonga.

Private enterprise:
• Paruru Aquaculture (giant clam hatchery under development)
• Aquarium Arts (exporter of aquarium products in Solomon Islands)
• The Ecology Laboratory Pty Ltd

3. Donors and budget
• Since 1993, ACIAR has provided a total of AUD$2m towards the costs of operating five research projects and postgraduate education for three national scientific staff in Solomon Islands (recommended by ICLARM). A PhD scholarship for one of ICLARM’s national scientists has also been provided by AusAID. The ACIAR Fisheries Research Program Manager spends 10% of his time per annum on the partnership projects. ACIAR and AusAID also provided AUD$45,000 for a major external review of the partnership in February 1998.
• ICLARM spends AUD$750,000 p.a. on the direct costs of operating the Coastal Aquaculture Centre’s in Solomon Islands.
C. PROJECT RESULTS AND IMPACT

1. Main results

Giant clams
- Development of reliable technology for mass production of giant clam “seed” in hatcheries and nurseries.
- Development of viable methods for small-scale village-based giant clam farming, and coordination of exports of cultured giant clams for four years.
- A model for private enterprise to operate a giant clam hatchery, coordinate the supply of seed to village farms, and organise the export and marketing of clams.
- Technical assistance to the private sector to establish giant clam farming on a commercial basis.
- A model for restocking giant clams which reduces the cost and improves survival through the participation of village farmers.
- Identification of markets for giant clams in the aquarium and live seafood trades.
- Diversification into small-scale farms growing-out hard coral for the aquarium trade.

Pearl oysters
- Development of methods for collection of wild spat of the blacklip pearl oyster in the open reef systems typical of the western Pacific.
- Establishment of a demonstration pearl farm using wild spat, including development of grow-out techniques to suit local conditions, and the seeding and harvest of an initial batch of pearls.
- Spawning blacklip pearl oysters in the hatchery, and comparison of grow-out of wild and hatchery-reared spat on the demonstration pearl farm.
- Promotion of the results of the project to the point where the national government of Solomon Islands is negotiating with the Asian Development Bank to assist with the uptake of technology by industry.
- Transfer of technology for collecting blacklip pearl oyster spat to Fiji and Tonga.

Sea cucumbers
- Documentation of the spawning cycle of wild tropical sea cucumbers as the basis for hatchery breeding.
- Development of rearing methods for the commercially-important species, Holothuria scabra.
- Identification of aspects of the behaviour and ecology of H. scabra likely to affect survival of cultured juveniles released in the wild.
- Design of research project to develop optimal ways for releasing cultured juveniles of H. scabra into the wild.

Reef fish
- Assessment of temporal and spatial variations in diversity and abundance of postlarval reef fish in the Western Province of Solomon Islands and the effectiveness of light traps and crest nets in capturing the postlarvae for grow-out.
- Successful rearing of >20 species of postlarval reef fish for sale to the aquarium trade.

Fisheries management
- Surveys of commercially-important invertebrates within and outside the Arnavon Islands Marine Conservation Area (MCA), before and after declaration of the MCA.
- Three years after the declaration of the MCA, some species, e.g., trochus, had increased greatly within the MCA relative to areas outside. Other species, e.g., several sea cucumbers, had not increased inside the MCA indicating that recovery may take decades.
- Coastal villagers near the MCA now have a much greater awareness of the need to limit harvests and set aside areas where stocks can increase and then replenish surrounding (fished) areas.
2. Dissemination of the results

- Training workshops for village-based farmers, regular site visits, farmer’s newsletter (giant clam grow-out).
- Training of fisheries officers from the Asia-Pacific region in hatchery and farming techniques for giant clams and pearl oysters.
- Transfer of technology to fisheries staff through joint projects in Fiji and Tonga (pearl oyster spat collection and farming).
- Participation in the Management Committee for the Arnavon Islands MCA.
- Supervision of postgraduate students in the Marine Studies Programme at the University of the South Pacific (giant clam aquaculture).
- Research published in primary scientific journals, regional newsletters and bulletins (all projects).
- Presentation of results at international and regional scientific meetings, and to national governments (all projects).

3. Impact of the project

- 30 of the original small-scale giant clam farms still operating in Solomon Islands.
- Private sector giant clam hatchery under development (Paruru) in Solomon Islands.
- Farming of hard coral by village women has been a direct “spin-off” from the success of village-based giant clam farming.
- Demonstration pearl farm in Solomon Islands has led to establishment of one small enterprise and initiatives by the national government to attract investors.
- ICLARM and ACIAR have been requested to assist fisheries departments in Fiji and Tonga to set up trials for collection of blacklip pearl oyster spat.
- Four national staff from ICLARM and the Solomon Islands Fisheries Division have been supported for postgraduate education in marine aquaculture (three funded by ACIAR and one by AusAID).
- Government of Solomon Islands has introduced legislation banning export of wild pearl oysters, giant clams and the sea cucumber, *H. scabra*, to promote restoration of stocks for use in aquaculture.
- Government of Solomon Islands has allocated funding from its EU Stabex Program for a major, 5-year project to develop village-based aquaculture, including pearl farming and the restocking of giant clams.
- Numerous other donors and NGOs have provided supporting funding for projects within the ACIAR-ICLARM partnership (e.g., FAO, ESCAP, CIDA, CUSO and the EU Stabex Fund).

4. External Review

The program was reviewed externally during 1998 as a joint activity of ACIAR, ICLARM and AusAID. This review was highly participatory with stakeholders; its main findings were that:

- The biological and ecological science undertaken was found to be of the highest order and was positively significant from a biodiversity conservation viewpoint as well as meeting the needs for economic development.
- The research has advanced aquaculture and stock enhancement to the stage where the development aspects of R&D can be pursued in their own right.
- All the projects have been designed to enhance the livelihood of coastal communities. Market aspects and constraints have received attention during implementation of the program and it is now timely to undertake more thorough financial economic and socio-economic assessment. Amongst their many recommendations the review team proposed that it was time for:
• A greater developmental focus, with preparation of business plans for farmers at the village level, regional marketing studies for products, and assessment of potential socio-economic impact at country and village level.
• A regional approach by national fisheries experts for identifying aquaculture initiatives and research, mediated by SPC and for continuation of regional activities such as those initiated by FAO SPADP.
• ICLARM, SPC and USP to strengthen cooperation on tertiary training in aquaculture/mariculture.
• SPC take the lead in developing aquaculture in the Pacific.

Following the external review, ACIAR convened a workshop with ICLARM, SPC, AusAID and National Fisheries Agencies to explore ways whereby these recommendations might be taken forward. A significant outcome has been the Strategy to Continue the Development of Aquaculture in the Pacific (see below).

5. Development of Pacific Regional Aquaculture Strategy

• The 22 member nations and territories of the Secretariat of the Pacific Community (SPC) have requested that more emphasis be given to aquaculture in the development and management of their inshore fisheries resources and that SPC, ICLARM and USP work together to advise the members about the best way to achieve this outcome.
• In 1999, the members of SPC approved the “Strategy for the Continued Development of Aquaculture in The Pacific” prepared by SPC, ICLARM and USP. The strategy has the following components: 1. A regional advisory service and focal point to keep SPC members, the private sector and individuals in touch with information and opinions on all aspects of aquaculture; 2. Applied research for development and testing of workable aquaculture systems for the Pacific; 3. Aquacultural education – undergraduate and postgraduate degree courses and pure research; 4. Dissemination of information and vocational training; 5. Export market information and opportunity alerts; 6. Assistance with national legislative/economic infrastructure for aquaculture; 7. Assessment of potential environmental effects of aquaculture; 8. Development of aquatic quarantine systems and impact assessment of exotic species introductions; 9. Compilation of statistics and detailed information on aquaculture activities; 10. Regular meetings with stakeholders to review the status of regional aquaculture, and amend the strategy as appropriate.
• The strategy will be implemented in two phases, each of 5 years duration. The first phase will involve components 1-4, and 10, whereas all components will be included in the second phase.
• SPC will be the focal point for the strategy providing member governments with assistance in developing aquaculture policy, disseminating information, and providing key vocational training for the public and private sectors; ICLARM will undertake the applied research needed to underpin appropriate environmentally-sound aquaculture development; and USP will provide formal undergraduate and postgraduate education in aquaculture.

D. PARTNERSHIPS

1. Respective roles of the different stakeholders and coordination mechanisms for:

Project design
• Ideas for projects are generated by ICLARM staff on the basis of discussions with National Fisheries Agencies and regional needs presented at fora such as the SPC Heads of Fisheries Meeting.
• Potential projects are then discussed with the ACIAR Fisheries Research Program Manager prior to preparation of funding proposals to ensure they fit within ACIAR’s mandate, and to identify the most appropriate collaborators. Projects usually involve ICLARM, a National Agricultural Research System (NARS) and an Australian Advanced Research Institution (ARI).
• For International Agricultural Research Centres (IARCs) like ICLARM, ACIAR provides feedback on the design of the project in three phases. Phase 1 is a concept proposal, Phase 2 is a full proposal and detailed budget subject to international peer review, and Phase 3 is a final endorsement by a special committee for proposals from IARCs.
• Draft Phase 1, 2 and 3 proposals are also subject to review by ICLARM’s own Research Management Committee prior to submission to ACIAR and submitted only after final approval by the Deputy Director General (Programs).

Project implementation
• ICLARM implements the project in consultation with the collaborating NARS and ARI, and with participation from villagers. The large network of village sites and participating village farms in Solomon Islands has been a major strength of the ICLARM-ACIAR partnership – it has enabled access to a wide variety of collection and grow-out sites and yielded results that are robust across diverse locations.
• Most projects have been implemented in Solomon Islands, however, there is now a strong trend to operate projects in several Pacific countries. Once the methods have been proven to be viable, the technology is transferred throughout the region.

Project management
• ICLARM appoints a leader for each project, who in turn is supervised by the leader of the Coastal Aquaculture and Stock Enhancement Program.
• Annual reports and financial statements are prepared by the project leader in conjunction with the collaborators and submitted to the ACIAR Fisheries Research Program Manager after clearance by ICLARM’s Deputy Director General (Programs).
• Major projects are subject to mid-term review by ACIAR.
• ICLARM’s project and program leaders attend regional ACIAR meetings designed to encourage interaction among related ACIAR projects.
• Where projects represent a new field of endeavour, such as the research on sea cucumbers, ACIAR funds a multidisciplinary Advisory Panel to assist ICLARM with various aspects of the project.

Result dissemination
• ICLARM disseminates the results of projects through training workshops for villagers, regular site visits and local newsletters. ICLARM also publishes the results in peer-reviewed scientific journals and regional newsletters and bulletins.
• ACIAR produces manuals and monographs on aquaculture methods and developments and, together with ICLARM, organises specialist workshops and individual training for national fisheries officers. ACIAR also summarises the progress and impact of projects in their journal “Partners”.
• Staff from ICLARM and ACIAR also present the results of projects at regional and international conferences on aquaculture and management of inshore marine fisheries.
• The Strategy for the Continued Development of Aquaculture in the Pacific now provides an effective mechanism for dissemination of the results of the partnership throughout the region.

2. Added value of the partnership
• By operating the Coastal Aquaculture Centre in the Solomon Islands under official Agreements with the national and provincial governments, ICLARM has been able to establish strong links with all levels of the nation’s fisheries management, and with a large number of coastal dwellers. Through the partnership with ICLARM, ACIAR have been able to use these links to gain first-hand knowledge of the needs of coastal communities and contribute the results of Australian science and technology to meeting these needs.
ICLARM has benefited from the rigorous approach used by ACIAR to evaluate and approve research proposals (which is analogous to scientific peer review). ACIAR’s links to ARIs in Australia have provided a rich pool of expertise to complement the skills of ICLARM’s staff in implementing projects. Australian ARIs have also had opportunities to expand their horizons and experience by undertaking R&D in the region to the benefit of their domestic programs.

The ultimate beneficiaries of the ICLARM-ACIAR partnership, governments and coastal dwellers in the Pacific, have been able to interact with project teams that have an excellent understanding of their customs and needs, are well organised, and committed to delivery of methods that will improve their livelihoods in a sustainable manner.

The partnership has been able to build linkages with Heads of National Fisheries Agencies, and with SPC as the lead agency for coordination of technical development in natural resources in the region. Via SPC, the partnership has also contributed to the development of policy through such organisations as the South Pacific Forum.

E. CONCLUSION

The partnership between ICLARM and ACIAR is paving the way for increased, sustainable harvests of inshore marine resources through restocking wild populations and growing-out “seed” produced in hatcheries on farms. Methods have already been developed for farming and restocking giant clams, and for farming blacklip pearl oysters in the western Pacific. Research on the potential for restocking sea cucumbers and growing-out wild postlarval reef fish for the live fish market is well under way. In addition, research by ICLARM and ACIAR has shown that marine reserves facilitate the recovery of trochus within a few years but that fishing closures of longer duration will be needed to rebuild populations of other commercially-important invertebrates.

The success of the ICLARM-ACIAR partnership is due to the participation of village farmers and NARS familiar with ICLARM’s operations in the Pacific; arrangements specified by ACIAR for projects (which include an IARC, NARS, and an Australian ARI; and the rigour of ACIAR’s process for approving grants (which involves international peer review). The impact of the partnership is evident through the request by the 22 nations and territories of SPC that ICLARM join forces with the SPC and USP to design and implement a strategy for the continued development of aquaculture in the Pacific.

The challenges for ICLARM and ACIAR are to: 1) complete the development of methods for restocking and aquaculture for species currently under investigation; 2) develop methods for “new” species (see Bell and Gervis, 1999); and 3) encourage development assistance agencies to apply the methods stemming from the partnership so that benefits are delivered to larger numbers of coastal dwellers throughout the Pacific. Support for private sector hatcheries and grow-out farms, and integration of restocking, aquaculture and marine reserves with other forms of management, will be key elements in the application of technology by development agencies. Support for private sector hatcheries is particularly important because restocking and many forms of aquaculture depend on the production of “seed” animals for grow-out.

References


