

RESEARCH REPORTS IN THE ECONOMICS OF GIANT CLAM MARICULTURE

Working Paper No.40

Final Report on ACIAR Project No. 8823
(ROU 259) 'Economics of Giant Clam
(Tridacnid) Mariculture'

by

Clem Tisdell

March 1993



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MARICULTURE**

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Final Report on ACIAR Project No. 8823 (ROU 259)

'Economics of Giant Clam (Tridacnid) Mariculture'¹

by

Clem Tisdell²

March 1993³

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³ Actual report submitted to ACIAR in December 1992. This is the final report in this series.

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Research for the project *Economics of Giant Clam Mariculture* (Project 8823) is sponsored by the Australian Centre for International Agricultural Research (ACIAR), G.P.O. Box 1571, Canberra, A.C.T. 2601, Australia. The following is a brief outline of the Project:

The technical feasibility of culturing giant clams for food and for restocking tropical reefs was established in an earlier ACIAR project. This project is studying the economics of giant clam mariculture, to determine the potential for an industry. Researchers will evaluate international trade statistics on giant clams, establish whether there is a substantial market for them and where the major overseas markets would be. They will determine the industry prospects for Australia, New Zealand and South Pacific countries, and which countries have property right factors that are most favourable for commercial-scale giant clam mariculture. Estimates will be made of production/cost functions intrinsic in both the nursery and growth phases of clam mariculture, with special attention to such factors as economies of scale and sensitivity of production levels to market prices.

Commissioned Organization: University of Queensland.

Collaborators: James Cook University, Townsville, Queensland; South Pacific Trade Commission, Australia; Ministry of Primary Industries, Fiji; Ministry of Natural Resources and Development, Kiribati; Silliman University, Philippines; Ministry of Agriculture, Fisheries and Forests, Tonga; Forum Fisheries Agency, South Pacific; ICLARM, Manila, Philippines.

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EXECUTIVE SUMMARY

Final Report on ACIAR Project No. 8823

R.O.U. No. 259

- Project:** Economics of Giant Clam (Tridacnid) Mariculture
- Commissioned Organization:** University of Queensland
- Project Leaders:** (i) Australia - Professor Clem Tisdell
(ii) Partner Country - Various, complementary to ACIAR Project No. 8733
- Date of Commencement:** 1st March, 1989
- Date of Completion:** Scheduled for 28th February, 1992 but extended to June 30, 1992, with carryover of financial commitments allowed to end of 1992.
- Aims of Project:** To provide information about
- (i) market prospects for giant clams;
 - (ii) the production economics and supply factors involved in giant clam mariculture;
 - (iii) marine property rights as these affect the economies of giant clam mariculture, and
 - (iv) the possible value of giant clam mariculture in development in less developed countries in the Indo-Pacific region, especially South Pacific countries.

Description of Work:

Initial research work focused on the markets for giant clam products and research on this subject continued throughout the life of the project, with the initial geographical focus widening with the passage of time to include selected islands in the South Pacific, Indonesia as well as other Asian-Pacific countries. In mid-1989 marine property rights in the South

Pacific was phased in and the bulk of this work was completed by April 1991. Investigation of production economics commenced in August 1989 and continued throughout the remaining life of the project. Hatchery/nursery economics was considered first followed by the economics of ocean growout. This sequence allowed time for production data to accumulate sufficiently to provide a basis for economic analysis. The research phase involving studies of the economic development possibilities in the South Pacific based on giant clam culture got under way in 1991 and continued throughout most of the remaining life of this project. Because of the broad development and sustainability issues involved, this part of the study was phased in the second part of the schedule for the project.

Diagram 1 shows the broad phases of research activity. Publication occurred throughout the whole life of the project. A major monograph covering research contributions on primarily objectives (3) and (4) is to be published by ACIAR in December 1992, and a second monograph covering principally results for objectives (1) and (2) is to be published by ACIAR in the last half of 1993.

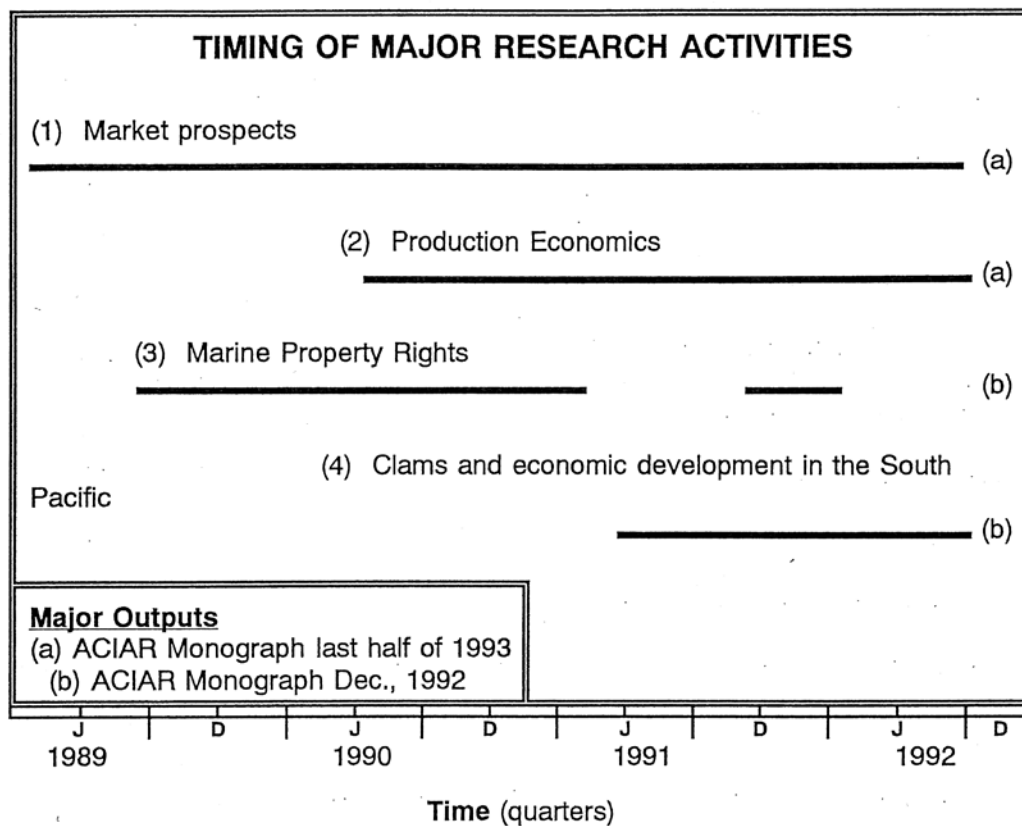


Diagram 1: Flow diagram showing timing of major research activities. Output in terms of research reports and papers occurred throughout the whole period of

the project. Two major ACIAR monographs are being published based on this research- one is to appear at the end of 1992 and the other in last half of 1993.

Results, Conclusions and Assessments

It is convenient to present the results and conclusions in a parallel way with objectives. It should be noted that because of space limitations only broad results can be presented here.

1. Markets

Potentially the largest market for farmed giant clams is for food. While some markets for giant clam meat continue to exist, e.g. in the Pacific Islands, Taiwan and the Ryukyus of Japan, these markets are now much reduced in size compared to former times because of the limited availability of giant clam meat. Original markets were based on a 'capture' fishery and present markets are best described as remnant markets. There is a need to develop or redevelop markets specifically for the meat of cultured giant clams. These clams may be harvested on average at a younger age than wild tridacnids were and be more expensive.

Apart from the food market, there are other market outlets for giant clams e.g. as aquarium specimens, for shells and for seed. The latter, of course, is ultimately a derived demand. Commercial giant clam growers have been able to 'piggyback' economically on the existing market for giant clams as aquarium specimens. This market will accept giant clams of a relatively young age, e.g. at 2-years old, and has been of economic benefit to Reefarm Pty. Ltd., Cairns and to the semi-commercial Micronesia Mariculture Demonstration Center (MMDC), Palau. Sales of shells from farmed clams seem so far to have been negligible and would in any case be only possible at the farmgate if clams are 'shucked', or if the shells of dead clams are used or if clams are grown only for shells and the meat discarded. However, some sales of shells are occurring at MMDC. Tourism centred around giant clams has been a significant revenue earner for MMDC and is becoming so for Reefarm.

The giant clam has multiple uses and values and almost every portion of it is useable. Few, if any, marine animals have a greater range of uses. However, the suitability of different species of tridacnid clams for different end-uses and markets varies. For example, although *T. gigas* produces the greatest meat biomass per unit of time, this species is not usually the best choice

for the aquarium market. Furthermore, some consumers of giant clam meat, e.g. in southern Japan, prefer the flavour and texture of the meat of other species of tridacnid clams. Biomass in itself is a poor guide to economic value. However, there seems to be markets for all species of tridacnids, including *T. gigas* to fill different market niches.

2. Production Economics

This research identified economies of scale in production of giant clams in the hatchery/nursery stage as being very important. Consequently larger hatchery/nursery establishments would tend to be more economical than smaller ones given current techniques for mariculture of giant clams. This is not to say that some small establishments would not survive. They may do so because of site advantages and they may be able to take advantage of economies of scope by using their facilities to produce a variety of products e.g. giant clam mariculture and production of seed of the South Sea pearl oyster have been combined at Reefarm. But even when economies of scope occur, overall economies of size can be significant as well.

The study indicated that ocean growout of *T. gigas* could be profitable under Australian conditions even after allowing for drip weight loss in the meat. The estimates were based on potential prices which were obtained from a survey of possible consumers, mostly Pacific Islanders resident in Australia. Nevertheless, it seems that under present Australian conditions only a moderate return from ocean growout of giant clams could be expected, given a suitable site and location for growout. Estimates of returns for Fiji for ocean growout indicate that these are likely to be small. However, it might be argued that this is an infant industry and that foreign aid to subsidise it initially would be justified e.g. via subsidies for seed production and subsidies for market development.

In some areas, particularly more developed countries in tropical or subtropical regions, it is possible that land-based giant clam production will be profitable, at least to satisfy particular markets e.g. the aquarium trade or the sashimi market.

3. Marine Property Rights

There is considerable variation in marine property rights in the Pacific. In Australia and New Zealand, the British system operates - marine resources below the high tide mark are the

property of the Crown, but in the Pacific Islands customary tenure is strong. In many cases, communal village ownership of reef, lagoon and other inshore areas is the dominant form of ownership in the Pacific Islands. Such communal ownership is an essential part of the social fabric of Pacific Island communities in which sharing is important and helps to provide social security. In most cases, replacement of communal property rights by private property rights to marine areas is not an option which is easily available. Consequently, development of the mariculture of giant clams in the Pacific Islands must be compatible with existing systems of property rights or socially possible transformations of these. Communal or social factors are likely to play a major role in the economic success or future of any enterprise to culture giant clams in the South Pacific.

4. Economic Development Aspects.

Giant clams are ecologically well adapted to tropical and subtropical marine environments, especially those of small island economies, e.g. coral atolls. Such economies have limited resources/projects for economic development and most are heavily dependent on foreign aid to supplement the per capita income levels of their inhabitants. This is especially so of South Pacific Island economies. In this context giant clam culture provides a new economic opportunity to be highly import-intensive.

But it seems that most Pacific Islands are not especially short of food of protein. While some Pacific Islanders might be induced to farm giant clams to supplement their means of subsistence, most appear to have a high preference for obtaining cash income rather than adding to their means of subsistence. Furthermore, even in subsistence and semi-subsistence communities, cultivation of giant clams involves an opportunity cost in terms of alternatives forgone e.g. fishing and cultivation of vegetable gardens. The extent to which this substitution is warranted is likely to vary according to locality. While there may be places where subsistence cultivation of giant clams is worthwhile, this cannot be assumed to be commonly the case. Pacific Islanders, however, are very interested in the possibility of obtaining cash income as a result of tridacnid culture. By cultivating giant clams, Fiji and Tonga may be able to re-establish the export markets for giant clam meat which they had in the past. In particular, Fiji had a substantial export market based on the exploitation of wild stocks.

Particular attention needs to be given to the selection of the appropriate species of giant clams

to cultivate. The appropriate species depends not only on market or subsistence requirements and local ecological conditions, but also on sociological factors. Species of clams favouring intertidal habitats will be more suitable than those favouring subtidal ones, for communities in which diving is not common and/or women rather than men are principally engaged in regular economic marine activities, e.g. gathering of food on the reef flats or inshore.

Publications

See Appendix to the main body of the final report for a list of publications arising from this Project.

Follow-up

This will involve the production of an edited monograph covering the main results from this research project as far as markets and economics of production of cultured giant clams are concerned and will also incorporate research material funded by USDA grant no. 90-38500-5045 through the Center for Tropical and Subtropical Aquaculture in Hawaii. In view of the latter connection, it is proposed that Professor Y.C. Shang and Professor P.S. Leung of the Department of Agriculture and Natural Resource Economics, University of Hawaii be joint editors with Professor Tisdell. It will be necessary to produce the complete manuscript and to do sufficient additional research to round out .and integrate the text in the next few months. However, the basic material is already available. Professor Tisdell is planning to continue his interest in coastal zone use and the economics of aquaculture. A paper on actual business strategies used by commercial companies culturing giant clams is also to be produced.

MAIN BODY OF
Final Report on ACIAR Project No. 8823 (ROU 259),
'Economics of Giant Clam (Tridacnid) Mariculture

Final Report on ACIAR Project No. 8823 (ROU 259), ‘Economics of Giant Clam (*Tridacnid*) Mariculture’: Main Body of Report

1. Background

Research on ACIAR Project 8823 began in March 1989. The University of Queensland was the commissioned organization with Professor Clem Tisdell, Department of Economics, University of Queensland being the Project Leader. Collaborating institutions included James Cook University of Northern Queensland; The Ministry of Primary Industries, Fiji; The Ministry of Agriculture, Fisheries and Forests, Tonga; The Fisheries Division, Ministry of Commerce and Natural Resources, Tuvalu; The University of the Philippines and Silliman University, the Philippines.

This project arose out of the need to complement ACIAR Project No. 8733 ‘The Culture of the Giant Clam (*Tridacnidae*) for Food and Restocking of Artificial Reefs - Second Phase’ with socio-economic research and assessment, and it involved close co-operation and collaboration with researchers involved in this project of which Dr. John Lucas was the team leader.

Until Project 8823 was launched, very little economic research had been undertaken into the economics of giant clam mariculture. This was perhaps not surprising because it has only been in the last decade or so that there has been substantial progress in determining the natural scientific technical possibilities for such culture. Although it would have been valuable to have had economic assessment earlier, economic assessment could not proceed without adequate data on the scientific and technical possibilities for such culture. In the past, a ‘chicken and egg’ problem existed. The progress of economic research was hampered by lack of empirical data and experience with giant clam mariculture. Since experience is very often the best teacher, the absence of this was a serious impediment to this economic research. However, despite such constraints considerable progress was made with economic research on giant clam culture as a result of ACIAR Project 8823.

In 1986, at the request of ACIAR, Tisdell (1986) completed a ‘rapid’ evaluation of the socio-economic prospects for giant clam mariculture. In essence, it was a summary of knowledge on this subject as at the mid-1980s. The continuing importance placed on the socio-economic

aspect of giant clam mariculture by ACIAR was further emphasized by the appointment of an economist (C.A. Tisdell) to the ACIAR committee to review ACIAR Project 8332, 'The Culture of the Giant Clam (*Tridacna* spp.) for Food and Restocking of Tropical Reefs' in 1987. The Chairman of this Committee was Dr. J. Baker, Chairman of the Australian Institute of Marine Science. The third member was G. Heslinga, Director, Micronesian Mariculture Demonstration Centre, Palau. Dr. John Copland of ACIAR, acted as secretary to the committee. Mr. Barney Smith joined the Committee during its enquiries in the South Pacific. Information, experience and contacts established as a result of serving on this Committee proved to be of considerable assistance to Professor Tisdell in his capacity as coordinator of ACIAR Project 8823.

The framing of the aims of this Project was greatly facilitated by the input of Dr. Kenneth A. Menz, ACIAR Co-coordinator for Economics and Farming Systems Research who together with John Copland and then Barney Smith provided useful guidance for this Project.

During the course of the Project, the coordinator of the Project was fortunate to be able to become jointly involved in a complementary research project funded by the United States Department of Agriculture through the Center for Tropical and Subtropical Aquaculture (CTSA) in Hawaii. This Project (USDA grant no 90-38500-5045) was led by Professor Y.C. Shang of the Department of Agricultural and Natural Resource Economics at the University of Hawaii. It involved joint research with Professor Shang and Professor Ping Sun Leung of the same department at the University of Hawaii. This co-operative research enabled economic assessment of the prospects for giant clam culture to be seen from a wider perspective than would have been possible without such co-operation.

In addition, useful contacts were established with researchers in Southern Japan. In particular, Professor Masua Yamaguchi, Department of Marine Science, University of Ryukyus was most helpful in providing new insights into this research, even though no formal joint research program on the subject was established with Japanese researchers. However, a Fellowship of the Japan Society for the Promotion of Science made available to Professor Tisdell in 1991 did facilitate contacts with Japanese researchers.

2. Aims of ACIAR Project No. 8823

The scope of this project has been summarised as follows:

This project is studying the economics of giant clam mariculture, to determine the potential for an industry. Researchers will evaluate international trade statistics on giant clams; establish whether there is a substantial market for them and where the major overseas markets would be. They will determine the industry prospects for Australia, New Zealand and South Pacific countries, and which countries have property right factors that are most favourable for commercial-scale giant clam mariculture. Estimates will be made of production/cost functions intrinsic in both the nursery and growth phases of clam mariculture, with special attention to such factors as economies of scale and sensitivity of production levels to market prices.

The main objectives of ACIAR Project No. 8823 as specified in the Research Agreement, were to provide information about (i) market prospects for giant clams, (ii) the production economics and supply factors involved in giant clam mariculture, (iii) marine property rights as these affect the economics of giant clam mariculture and (iv) the possible value of giant clam mariculture in development in less developed countries of the Indo-Pacific region especially South Pacific countries.

Information has been published on all the above matters. The objectives of this Project have been as fully satisfied as seems reasonably possible.

3. Research and Related Activities

Initial progress with this research was specified in *Progress Report No. 1 to ACIAR Project No. 8823* of August 1990. Following that Report, the research activities listed below were completed.

- (i) Dr. T'eo I. Fairbairn completed his research on marine property rights for this project. This included reports on Fiji and Western Samoa along with a report on customary marine tenure in the South Pacific Region as a whole and its implications for giant clam mariculture.
- (ii) Joint research by the clam economics group at University of Queensland with the James Cook University giant clam group was completed on the economics of ocean culture of giant clams, *Tridacna gigas*.

- (iii) Research was completed on economic aspects of giant clams in Indonesia and their status concentrating on four villages in Bali and Java. This fieldwork was undertaken by Carunia Firdausy, a Ph. D student in the Department of Economics at the University of Queensland. His research was supervised by Professor Tisdell and sponsored by AIDAB.
- (iv) The potential market for giant clam meat in New Zealand was investigated. Demand, domestic markets and export markets for giant clam meat in relation to Fiji, Tonga and Western Samoa were studied.
- (v) Socio-economic factors likely to influence the development of giant clam culture in the South Pacific were studied in some detail. Selected countries or areas studied in relation to developmental aspects included Tuvalu, the Lau Group in Fiji, Tonga, Wallis and Western Samoa.
- (vi) Factors likely to influence demand, or doing so, in Australia, continued to be studied. These studies included surveys of the market for the meat of giant clams for use by Asian restaurateurs. Also the aquarium market for giant clams continued to be investigated. Methods used included test marketing. These studies added to earlier marketing studies completed as a part of this project.
- (vii) An analysis of the economics of giant clam production in the South Pacific was completed, paying particular attention to Fiji.
- (viii) Research was completed on aspects of the market for giant clams in Taiwan for food, including recipes for their use. This research gives some new insights into demand for giant clam meat in Taiwan.
- (ix) Research was also undertaken on appropriate economic financial strategies for firms embarking on the mariculture of giant clams. An Australian case study provided useful pointers in this regard.

During the period of this project, the following persons were employed:

In the initial stages of the project, William R. Thomas was employed as a full-time graduate research assistant, and then Luca Tacconi was employed in that capacity and subsequently as

a Research Officer.

Research consultants engaged at various times during the period of this project to produce specific reports included Dr. Teo Jan Fairbairn, Dr. Nancy Pollock, Dr. John Stanton and Ms. Veikila Vuki. Casual research assistants included Carunia Firdausy, Rene Wittenberg, Thea Vinnicombe and others. In addition, valuable support was provided by a number of secretarial and administrative staff at the University of Queensland e.g. on the administration side, Mrs. Rowena Lawson. Without the support of the above personnel and the co-operation received from participants in ACIAR Project No. 8733, it would have been impossible to achieve the considerable output and valuable information obtained from this research project.

Travel and Meetings

A considerable amount of travel and number of meetings were required to complete this project. Fieldwork and consultations were an essential ingredient of it. Consultants visited Fiji, Tonga, Western Samoa, Vanuatu, Futuna and Wallis for data collection. Researchers engaged directly in the project visited the following areas outside Australia for data collection and gathering of information: Fiji, Tuvalu, Tonga, Western Samoa, Solomon Islands, Vanuatu, the Philippines, southern China, Hawaii and Guam. Although not funded by this Project a research visit was made by the Project Leader to the Nansei Island (Ryukyus) of Japan. Within Australia, several journeys were made to Townsville and to Cairns, mostly for consultation with researchers and commercial enterprises involved in giant clam culture and to Canberra for consultations at ACIAR.

Presentations were made at all the giant clam research workshops organised through ACIAR Project no. 8733. These workshops were held in Suva, in Bolinao (the Philippines), in Townsville and in Guam. In addition, in the early part of the Project a presentation was made at the conference on 'Economics of Fisheries Management in the Pacific Islands' held in Hobart.

Publications

A large number of publications have resulted from this project or are in the process of being completed.

Research Reports or Papers in Economics of Giant Clam Mariculture served as a useful

discussion paper or working paper series. This series was published as a result of ACIAR support and provided a useful way to obtain feedback about results from this research, to disseminate results and to provide a record.

Several papers in this series, after revision, have been published in more permanent form. Journal articles resulting from this research have appeared in or are to appear in journals such as *Aquaculture*, *International Journal of Environmental Studies*, *Journal of the World Aquaculture Society*, *Journal of Development Administration* and *World Development*. The research has also enabled contributions to be made to several books, monographs, manuals and proceedings of conferences.

A full list of publications is attached in Appendix A.

4. Financial Aspects

A budget summary for 1992 is included as Appendix B. The funds provided for the research were adequate for the task. It was however, found that all required research tasks could not be completed by 30 June, 1992 and a carryover of committed funds was permitted to complete projected research needed to round off the results in a suitable manner. There usually is an inevitable lag between scientific and technical results and follow-up of applied economic research and in this case the completion of ACIAR Project 8753 preceded the completion of this Project by a few months. All research papers connected with this Project will be completed by early December 1992 and all committed funds will have been expended.

5. Benefits Obtained from this Project

Within Australia, this project has enabled expertise to be developed on the economics of mariculture and has increased knowledge about natural resource economics.. This has been particularly so as far as the leader of the Project is concerned and it has also added to knowledge about socio-economic aspects of economic development in Western Pacific countries. It assisted in building up the experience of participants within Australia. Luca Tacconi originally a graduate research assistant was able to gain initial experience with natural resource issues in the South Pacific as a result of this Project which assisted him to become involved as a Research Fellow in another ACIAR sponsored project dealing with forestry in Vanuatu for which the Australian Defence Forces Academy is the commissioned

body. Dr Teo Fairbairn, a consultant for the Project, was successful in obtaining a subsequent grant from AIDAB for research on natural resource issues, especially marine resource issues, in the South Pacific.

The Project was also instrumental in enabling Professor Tisdell to make contact with some of the leading economists in the United States involved in the economics of mariculture and presumably in helping to secure his involvement in a complementary research project financed by the United States Department of Agriculture for the purpose of investigating markets for the products of Pacific giant clams. The contacts with Professors Y.C. Shang and P.S. Leung in the Department of Agriculture and Resource Economics at the University of Hawaii for co-operative research proved to be especially useful and stimulating. Professor Shang is recognized as a world leader in the economics of aquaculture and Professor Leung is an expert in operations research and economic analysis of farming systems. Exchange and contact is expected to continue, e.g. a joint monograph on the economics of giant clam mariculture is envisaged and Professor Tisdell has been invited to contribute to an international conference (of which Professor Shang is the Chairperson) to be held in Taiwan next year on the economics of aquaculture. Partially through this ACIAR Project, valuable continuing contact has also been established by Professor Tisdell with the Department of Marine Science at the University of the Ryukyus, mainly through Professor Masua Yamaguchi. Experience gained through this ACIAR Project, has contributed to the appointment this year of Professor Tisdell as Deputy Director of the newly formed School of Marine Science at The University of Queensland.

A noteworthy feature of this Project has been the extent of co-operation between economists involved in it with natural scientists particularly those contributing to ACIAR Project No. 8733. For example, joint research papers were written with Dr. John Lucas and with Jeremy Barker. This co-operation was of indirect assistance to Australian industry. When Jeremy Barker was at the James Cook University he was involved in economic assessment for the joint venture to culture giant clams commercially through a partnership of James Cook University and an outside venturer. Subsequently, he has become Manager of Reefarm, a commercial company involved in mariculture which includes giant clams in its product range and research co-operation with him has continued. However, there has also been significant research co-operation and assistance from other scientists also involved in ACIAR Project No. 8733. These include Dr Rick Braley, Dr. Hilconda Calumpong, Professor Ed Gomez and

E. Ledua. Evidence of this assistance and co-operation can be supported by many concrete examples, for instance, contributions to Manuals edited by Braley and by Calumpong, research visits to the Philippines Marine Research Laboratory in Bolinao, assistance with production information in Fiji.

A special effort was made to ensure the relevance of the research to developing countries, particularly those in the South Pacific. In assessing prospects for the mariculture of giant clams in these countries, attention was given to markets for giant clam products, to marine property rights, to the economics of production of giant clams and to cultural factors likely to influence the success of tridacnid culture. Whenever practical, personnel from developing countries were involved directly in research for the project, e.g., in Fiji and in Indonesia, and indirectly in many other cases. Close contact was maintained with natural scientists overseas involved in ACIAR Project No. 8733. The results of the economic research were not only disseminated to this group but more widely, e.g. to enterprises in the Pacific interested in giant clam mariculture on a commercial basis, international organisations, e.g. FAO, interested in economic development, and in response to individual requests. The research undertaken for this Project has resulted in more realistic assessments of the economic prospects for giant clam farming in both less developed and more developed countries than would be possible in its absence, even though giant clam mariculture still remains an infant industry. In practice, a small commercial industry is now established but for economic reasons it is unlikely to expand rapidly, although it is likely to grow gradually.

While giant clam culture can yield a modest profit, it does not promise a 'bonanza' in terms of returns. One of the main hurdles at the moment is to develop the food market for farmed tridacnid meat in more developed countries. Market development is a costly and risky exercise. Furthermore, developers of markets tend to generate a number of favourable externalities for market followers, e.g. product acceptance, establishment of outlets, distribution channels. In addition, lumpiness is involved in the development of markets because significant overhead and 'start-up' costs are incurred in developing a market. For this reason, the availability of sufficient volume of product and continuity of its supply may be required before it becomes economic to establish a new market e.g. for tridacnid meat for restaurants or supermarket supply. A well-established market exists for giant clams as aquarium specimens but this in itself is not capable of maintaining a very large industry for the culture of giant clams. If an industry of a significant size is to develop, the market for

clams as food needs to be developed. In reality, markets or appropriate markets do not always emerge spontaneously. This is clear from this case study.

APPENDIX A

List of Publications Resulting from or Associated with this Grant

- C. Tisdell, (1989) 'Giant Clams in the Pacific- The Socio-Economic Potential of a Developing Technology for Their Mariculture', pp. 74-88 in A.D. Couper, (ed.) *Development and Social Change in the Pacific Islands*, Routledge, London and New York.
- C. Tisdell, (1989) 'Pacific Giant Clams and Their Products: An Overview of Demand and Supply', pp. 100-104 in H. Campbell, K. Menz and G. Waugh (eds.). *Economics of Fishery Management in the Pacific Islands Region*, Australian Centre for International Agricultural Research, Canberra.
- (D. McKee and C. Tisdell) (1999), *Developmental Issues in Small Island Economies*, Praeger, New York, August, Ch 12, esp. pp. 136-137*.
- (Carunia Firdausy and C. Tisdell) (1991), 'Economic Returns from Seaweed (*Eucheuma cottonii*) Farming in Bali, Indonesia'. *Asian Fisheries Science*, **4**, 61-73.
- C. Tisdell (1991), 'Project Appraisal, the Environment and Sustainability for Small Islands', *Department of Economics Discuss Paper No. 66*. The University of Queensland, 17 pp., June.
- C. Tisdell (1991), 'Culture of Giant Clams for Food and for Restocking Tropical Reefs'. *Economic Assessment Series No.11*, ACIAR, Canberra.
- (with Yung C. Shang, C. Tisdell and Ping Sun Leung) (1991), *Report on a Market Survey of Giant Clam Products in Selected Countries*. Center for Tropical and Subtropical Aquaculture, Publication #107.*
- C. Tisdell (1991), *Economics of Environmental Conservation*, Elsevier Science Publishers Amsterdam, Ch.6.

- C. Tisdell, (1991) 'Development of Aquaculture and the Environment: Coastal Conflicts, and Giant Clam Farming as a Case', *International Journal of Environmental Studies*, **39**, 35-44.
- C. Tisdell, (1992) 'Production Economics and Sensitivity of Returns from Giant Clam Mariculture' *Abstracts*, p. 102, 7th International Coral Reef Symposium, 22-26 June, Guam.
- (Carunia Firdausy and C. Tisdell) (1992), 'Rural Poverty and its Measurement: A Comparative Study of Villages in Nusa Penida, Bali, in *Bulletin of Indonesian Economic Studies*, **28**(2), 75-93 (August), Australian National University, Canberra.*
- (Luca Tacconi and C. Tisdell) (1992) 'Rural Development Projects in LDCs: Appraisal, Participation and Sustainability', in *Public Administration and Development*, **12**, 267-278.
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Tisdell, C. (1993), 'Economics and the market', in H.P. Calumpong (ed.), *The Giant Clam: An Ocean Culture Manual*, pp. 57-61, Canberra: Australian Centre for International Agricultural Research.

Shang, Y.C., Tisdell, C. and Leung P.S. (1994), 'Markets for giant clam products in selected countries: an initial overview concentrating on East Asia, Australia and the United States', in C. Tisdell, Y.C. Shang and P.S. Leung (eds.), *Economics of Commercial Giant Clam Mariculture*, Canberra: Australian Centre for Agricultural Research, Chapter 4, 48-66.

* Associated publications

Associated Ph.D.Thesis

Carunia Mulya Firdausy, '*An Economic Analysis of Indonesian Mariculture Development in Relation to Coastal Rural Income Levels, Poverty and Income Inequality. A Case Study of Seaweed Mariculture in Bali*'. Submitted to University of Queensland, December, 1991. Accepted subject to minor revision.

APPENDIX B

Final Financial Statement for ACIAR Project No. 8832 for 1992

THE UNIVERSITY OF QUEENSLAND

ACQUITTAL

ACIAR 17

ACIAR PROJECT NO. 8823 R.O.U. NO. : 259

TITLE : Economics of Giant Clam (Tridacnid) Mariculture

PERIOD : Six month period ended 30 June 1992

Set out below is a statement of receipts and expenditures.

RECEIPTS :	Variation b/f from previous period	12,498.17
	Total advances received this period	24,907.66
	TOTAL (a)	37,405.83

EXPENDITURES :

	Australia \$	Overseas \$	Total \$
Personnel	14,538.87	0.00	14,538.87
Supplies and Services	4,143.91	0.00	4,143.91
Travel	1,313.10	0.00	1,313.10
Other	1,809.00	0.00	1,809.00
TOTALS	21,804.88	0.00	21,804.88 (b)

Progress Variation Carried Over (a-b) 15,600.95

COMMENTS Please refer to the attached listing of outstanding acquittals from collaborating organisations, and committed expenditure as at 30 June 1992.

I certify that the expenditure shown above has taken place and is correct.

A. J. Pett
A.J. Pett
Assistant Bursar
(Research and Commercial)

27 July 1992

THE UNIVERSITY OF QUEENSLAND

PROJECT NO. 8823

ROU NO. 259

Economics of Giant Clam (Tridacnid) Mariculture

Statement of Committed Funds as at 30 June 1992

Cash Balance as at 30 June 1992 15,600.95

Commitments as at 30 June 1992

i) Outstanding Purchase Orders

Order No.	Date	Description	Amount	
Travel				
213897	11/6/92	Ansett	1,445.00	
213905	26/6/92	Ansett-Domestic	478.00	
213906	26/6/92	Ansett-Domestic	478.00	
213908	26/6/92	Ansett-Domestic	598.95	
213909	1/7/92	Ansett-Internat.	1,813.00	4,812.95
		Balance		10,788.00

Note: All of the above travel was delayed past 30 June 1992.

ii) Provisions

Salaries: S Tooth to 30.9.92	3,143.00	
Casual Research Assistant	7,645.00	10,788.00
		10,788.00

Adjusted Cash Balance as at 30 June 1992

0.00

Research Reports and Papers in: Economics of Giant Clam Mariculture

Previous Working Papers

1. "Market for Giant Clam Shells: Report on a Survey of Retailers and Wholesalers in Southeast Queensland, Australia." Clem Tisdell with the assistance of Rene Wittenberg, November, 1989.
2. "Seafarming as a Part of Indonesia's Economic Development Strategy - Seaweed and Giant Clam Mariculture as Cases." Carunia Firdausy and Clem Tisdell, November, 1989.
3. "Market for Giant Clams as Aquarium Specimens: Report on a Survey of Retailers of Supplies for Saltwater Aquariums, Southeast Queensland, Australia." Clem Tisdell with the assistance of Rene Wittenberg, November, 1989.
4. "Aquaculture as a Use of the Coastal Zone: Environmental and Economic Aspects, Giant Clam Farming as a Development." Clem Tisdell, December, 1989.
5. "Pacific Giant Clams and their Products: An Overview of Demand and Supply Factors." Clem Tisdell, December, 1989.
6. "Marine Property Rights in Relation to Giant Clam Mariculture in the Kingdom of Tonga." Dr T'eo I.J. Fairbairn, February, 1990.
7. "Exploring the Demand for Farmed Giant Clams and Their Components: Approaches and Problems." Clem Tisdell, February, 1990.
8. "Report on possible Demand for Giant Clam Meat by Tongan Descendants in Australia: Inferences from interviews conducted in the Brisbane Area". Clem Tisdell and Rene Wittenberg, February, 1990.
9. "Evaluation of International Trade Statistics on Giant Clams and Related Products and the Market for Giant Clam Meat." Dr John Stanton, March, 1990.
10. "Assessing Species for Mariculture in Developing Countries: A Review of Economic Considerations." Carunia Firdausy and Clem Tisdell, April, 1990.
11. "An Analysis of the Cost of Producing Giant Clam (*Tridacna gigas*) Seed in Australia." Tisdell, C.A., Lucas, J.S. and Thomas, W.R., May, 1990.
12. "Marine Property Rights Fiji: Implications for the Development of Giant Clam Mariculture." Dr T'eo I.J. Fairbairn, August, 1990.
13. "Reef and Lagoon Tenure in the Republic of Vanuatu and Prospects for Mariculture Development". Dr T'eo I.J. Fairbairn, August, 1990.
14. Progress Report No. 1 to ACIAR, Project No. 8823. Professor Clem Tisdell, August, 1990.
15. "The Potential Market for Giant Clam Meat in New Zealand: Results of Interviews with Pacific Island Immigrants." Clem Tisdell and Rene Wittenberg, October, 1990.
16. "The Potential Demand for Giant Clams in Indonesia and Their Status: A Report on a Survey of Four Coastal Villages in Bali and Java." Carunia Firdausy and Clem Tisdell, November, 1990.
17. "Traditional Reef and Lagoon Tenure in Western Samoa and Its Implications for Giant Clam Mariculture." Dr T'eo I.J. Fairbairn, February, 1991.
18. "Ocean Culture of Giant Clams (*Tridacna gigas*): An Economic Analysis." C.A. Tisdell, J.R. Barker, J.S. Lucas, L. Tacconi and W.R. Thomas, February, 1991.
19. "Aid for Village-Based Rural Projects in LDCs: Experiences, Project Appraisal and Selection, ACIAR and Giant Clam Culture as a Case". Luca Tacconi and Clem Tisdell, March, 1991.
20. "Customary Marine Tenure in the South Pacific Region and Implications for Giant Clam Mariculture". Dr T'eo I.J. Fairbairn, April, 1991.
21. "ACIAR-Supported Research on the Culture of Giant Clams (*Tridacnidae*): A Multi-Faceted Economic Assessment of Research Benefits (Draft Appraisal)". Professor Clem Tisdell, April, 1991.
22. "Economics of Ocean Culture of Giant Clams: Internal Rate of Return Analysis for *Tridacna gigas*". Tisdell, C.A., Tacconi, L., Barker, J.R. and Lucas, J.S., April, 1991.
23. "Socio-Economic Aspects of Giant Clams in The Lau Group, Fiji, and Farming Prospects: Results of Field Research". Veikila Vuki, Clem Tisdell and Luca Tacconi, June, 1991.
24. "Subsistence Economic Activities and Prospects for Clam Farming in Ono-i-Lau, Fiji: Socio-Economic Factors". Veikila Vuki, Clem Tisdell and Luca Tacconi, June, 1991.

25. "Giant Clams in Tuvalu: Prospects for Development". Luca Tacconi and Clem Tisdell, July, 1991.
26. "A Report on the Test Marketing of Giant Clams as Aquarium Specimens in Brisbane, Australia". Clem Tisdell, November, 1991.
27. "Economic Returns from Farming Different Types of Seaweed (Eucheuma) and for Farms of sizes in Nusa Penida, Bali, Indonesia." Carunia Mulya Firdausy and Clem Tisdell, December 1991.
28. "The Market for Giant Clams as Aquarium Specimens in Sydney and Melbourne: Results of a Telephone Survey of Retail Outlets." Clem Tisdell and Thea Vinnicombe, January 1992.
29. "Domestic Markets and Demand for Giant Clam Meat in the South Pacific islands - Fiji, Tonga and Western Samoa". Luca Tacconi and Clem Tisdell, January 1992.
30. Economics of Giant Clam Production in the South Pacific - Fiji, Tonga and Western Samoa". Luca Tacconi and Clem Tisdell, February 1992.
31. "Exports and Export Markets for Giant Clam Products in the South Pacific: Fiji, Tonga and Western Samoa". Luca Tacconi and Clem Tisdell, March 1992.
32. "Institutional Factors and Giant Clam Culture and Conservation in the South Pacific: Observations from Fiji, Tonga and Western Samoa". Luca Tacconi and Clem Tisdell, March 1992.
33. "Giant Clams in Wallis: Prospects for Development". Nancy J. Pollock, May 1992.
34. "Current and Potential Markets for Giant Clam Meat in Fiji - A Case Study of the Market in Suva". Vina Ram, August, 1992.
35. "Interest of Asian Restaurants in Queensland in Using Giant Clam Meat in their Cuisine and Their Knowledge of It." Clem Tisdell, September, 1992.
36. "Notes on the Use of Giant Clam Meat for Food in Taiwan". Clem Tisdell and Cheng Ho Chen, October 1992.
37. "Interest of Japanese Restaurants in Brisbane in Using Giant Clam Meat in their Cuisine and their Knowledge of It". Clem Tisdell and Yoshihiro Kuronuma. November, 1992.
38. "Business Strategies for Commercial Giant Clam Growing". Clem Tisdell and Jeremy Barker, December, 1992.
39. "Giant Clams in Japanese Cuisine - Brisbane Trials and Use in the Ryukyus". Clem Tisdell and Yoshihiro Kuronuma, December, 1992.
40. "Final Report and ACIAR Project No. 8823 (ROU 259) 'Economics of Giant Clam (Tridacnid) Mariculture". Clem Tisdell, March, 1993.