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RESEARCH REPORTS IN THE ECONOMICS OF GIANT CLAM MARICULTURE

Working Paper No. 14

Progress Report No 1 to ACIAR Project No. 8823

by

Clem Tisdell

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RESEARCH REPORT OR PAPERS IN ECONOMICS OF GIANT CLAM MARICULTURE

Working Paper No. 14

Progress Report No. 1 to ACIAR Project No. 8823[1]

by

Clem Tisdell[2]

[1] This Series, *Research Reports and Papers in the Economics of Giant Clam Mariculture*, is supported by the Australian Centre for International Agricultural Research (ACIAR) Project 8823 and published by the Department of Economics, University of Queensland, Queensland 4072, Australia

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RESEARCH REPORTS AND PAPERS IN ECONOMICS OF GIANT CLAM MARICULTURE are published by the Department of Economics, University of Queensland, St Lucia, Queensland 4067, Australia, as part of Australian Centre for International Agricultural Research Project 8823 of which Professor Clem Tisdell is the Project Leader. It is planned to publish contributions to the series over the next 3 - 4 years.

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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UNIVERSITY OF
QUEENSLAND

AUSTRALIAN CENTRE FOR
INTERNATIONAL AGRICULTURAL
RESEARCH

(i) **FIRST REPORT**: 1 March 1989 - 30 June, 1990.

(ii) **PROJECT NO. 8823**

ECONOMICS OF GIANT CLAM MARICULTURE

(iii) **PROJECT COORDINATOR**: Professor Clem Tisdell, University of Queensland.

(iv) **COMMENCEMENT DATE**: 1 March 1989

TERMINATION DATE: 30 June 1992

(v) **TOTAL BUDGET**:

	$
Approved Budget 1988/89	25,209
Less cash balance	9,874
	15,335
Approved Budget 1989/90	64,253
Total to June 30, 1990	79,588

(vi) **ABSTRACT**: The main objectives of ACIAR Project No. 8823 are 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.

(vii) Approved budget less expenditure for the period

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Approved budget 1988/89	25,209
Less expenditure 1988/89	15,335
Balance	9,874
Approved budget 1989/90	64,253
Less expenditure & commitments 1989/90	64,256
Balance	(3)

2. EXECUTIVE SUMMARY

(a) Purpose and Context of Project

This Project (ACIAR Project No. 8823) on the "Economics of Giant Clam Mariculture" is intended to complement ACIAR Project No. 8733 on "The Culture of the Giant Clam (*Tridacnidae*) for Food and Restocking of Tropical Reefs". The latter Project, after having demonstrated the scientific/technical possibility of mariculture of giant clams, is now in its second phase. In this phase, economic factors are critical to the practical use of mariculture techniques developed and being developed.

The main objectives of ACIAR Project No. 8823 are 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.

(b) Names of Collaborating Researchers and Institutions

The University of Queensland (U of Q) is the Commissioned Organisation and Professor Clem Tisdell is the Project Leader. Co-operative economic research is being undertaken with groups involved in ACIAR Project No. 8733. This has included to date, James Cook University (Dr John Lucas and colleagues); Ministry of Primary Industries, Fiji (Dr Tim Adams and colleagues) and the Ministry of Commerce and Natural Resources, Tuvalu (Mr. Tim Gentle and colleagues). In addition, staff from the Institute of Marine Resources, University of the South Pacific are involved (e.g. Ms. Veikila Yuki, a Fellow of the Institute). Dr T'eo Ian Fairbairn, Newcastle, and Dr John Stanton, senior lecturer in economics, University of Newcastle, NSW completed research papers for the project. It is hoped to extend and strengthen co-operative research with groups and individuals in less developed South Pacific countries in the period ahead.

(c) Results or Expected Results and Their Value

Marketing and Trade: From surveys done in Queensland and from analysis, our results indicate that the size of sub- markets for giant clam products in terms of quantities likely to be sold at prices able to cover costs are in decreasing order of size are those for (1) meat, (2) shells, and (3) aquarium specimens. The meat market is the largest potential market for giant

clam end-products. The potential size of the meat market in Australia and New Zealand is unknown since most residents have not had an opportunity to sample giant clam meat prepared in any of the many alternative ways possible so a pioneering effort would be needed to develop this part of the potential market. However, amongst immigrants from the South Pacific familiar with clam meat, our evidence suggests that a substantial and currently unsatisfied demand for giant clam meat exists. While it is commonly believed that Asian immigrants have a similar latent demand for giant clam meat, preliminary investigations suggest that many Asians are unfamiliar with giant clam meat. Potential markets in Australia and New Zealand are worthwhile investigating because they may provide outlets for production of giant clams in the South Pacific and constitute an alternative potential market to that in North Asia e.g. Japan, Taiwan and Hong Kong.

International trade statistics are inadequate as a guide to the market for giant clam meat and the demand for possible substitutes such as scallop are of limited value. Past international trade statistics are inadequate because of the coarse classificatory system used for commodities and doubt in the case of giant clam meat about whether it has always been accurately classified. Furthermore, for many years the international market for giant clam meat has been a disappearing market due to depletion of supply and more recently it has been restricted by the Convention on International Trade in Endangered Species (CITES).

Production Economics: Australian data indicates substantial economies of scale in the production of giant clam seed of 10-12 months of age using production techniques similar to those at Orpheus Island Marine Research Station (JCU). At 10 per cent interest, the full cost of production of giant clam seed may drop from $1 .43 per clam at an annual volume of production of 100,000 seed, to 41 cents per clam for an annual output of 500,000 seed and down to 26 cents per clam at an annual throughput of million seed (see *Economics of Giant Clam Mariculture* Paper No. 11, p.18). This suggests that a few large hatcheries are likely to be more economic than many small hatcheries (in a commercial environment). However, a crucial factor which is likely to influence the optimal, size, location and distribution of hatcheries is transport costs. Once this is included in the analysis the economic picture is liable to be altered and a premium may be placed on hatcheries close to suitable growout sites even if they are smaller than those not so well located.

Marine Property Rights: Marine property rights are likely to affect giant clam mariculture very considerably throughout the South Pacific. Marine property rights in Tonga and Fiji

have been studied. While there are differences in marine property rights between Tonga and Fiji, in both cases traditional rights are important and will have to be taken into account in clam mariculture. Any outside commercial investors in giant clam mariculture in these countries will need to obtain agreements at local/village level in order to use marine areas for clam farming and ensure the success of the enterprise. Investigations of marine property rights are being completed for Vanuatu and Western Samoa. After this, an overview report is to be prepared on marine property rights in the South Pacific as a whole and their implications for giant clam mariculture.

Development of Less Developed Countries - Role of Giant Clam Mariculture: A literature review of economic and related considerations believed to be important in assessing the suitability of a species for mariculture in developing countries has been completed. This provides a guide to whether giant clams are a suitable species and to their value in relation to other possible species for mariculture in LDCs. Investigation of economic returns to seaweed growing in Indonesia suggests that giant clam farming is likely to give much lower returns than seaweed farming but this aspect including the possibility of growing clams in conjunction with seaweed needs further investigation. Co-operative research has commenced with a view to assessing the potential socio- economic value and most suitable form of giant clam farming in Tuvalu and in Fiji. The results should provide guidance on the appropriate economic development of giant clam mariculture in these countries.

(d) Likely Direction of Future Research Activities

Marketing and Trade: Market prospects for giant clam sales in New Zealand will be investigated in the near future since New Zealand may provide an important export possibility for a number of the island countries in the South Pacific. However, export markets in North Asia and the best means of gaining access to these will not be ignored. To access these markets effectively may require joint venture arrangements and growout or grow-on facilities close to such markets e.g. in South China. New technological developments in transport and rearing of clams may alter the pattern and location of production e.g. warmed or heated holding tanks. It is also important to undertake some direct trials of giant clam meat in restaurant cuisines in Australia and it is hoped that arrangements can be made for this.

Production Economics: In conjunction with James Cook University, a paper on the economics of growout of clams will be completed. In co-operation with Fiji, the costs of producing seed clams based on experience at Makogai Island will be estimated and other

relevant cost factors affecting the economics of giant clam mariculture in Fiji will be studied. The possible economic role for giant clam mariculture in the semi-subsistence communities and villages of the Lau Group of Fiji will be investigated and a co- operative economic assessment of the potential of giant clam mariculture in Tuvalu will be completed.

Marine Property Rights: The study for Vanuatu will be written up in final form and also that for Western Samoa. There will be a report on the overall marine property rights situation in the South Pacific and its implications for giant clam mariculture.

Development Economics Aspects: As mentioned above, appropriate research will be completed for Fiji and Tuvalu. In addition, research results will become available for Indonesia as a result of fieldwork being undertaken currently by C. Firdausy in coastal areas of Bali. If funds are sufficient, other personnel from less developed countries will be involved in economic research relevant to giant clam mariculture in their own countries.

3. PROGRESS REPORT

3.1 Objectives of Project

The main objectives of the Project, as outlined in the Project Document, are:

> "to complete a study which will provide guidance on market prospects for giant clams and trading arrangements, production economics and supply, marine property rights as these affect the economics of giant clam mariculture, and the value of giant clam mariculture in deve1opment as a component of productive possibilities in less developed countries in the Indo-Pacific region, especially South Pacific countries."

There has been no change in the aims of the Project. A more detailed description of the aims of the Project as published by ACIAR is 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 growout phases of clam mariculture, with special attention to such factors as economies of scale and sensitivity of production levels to market prices."

3.2 Research Activities

(a) Timetable and Personnel

At the University of Queensland, Mr W. Thomas was employed as a Senior Research Assistant for the Project as from August 1989. Other persons involved directly in the project were Professor Clem Tisdell (Project Leader) and Rene Wittenberg (part-time Research Assistant). In addition Carunia Firdausy provided some casual research assistance as well as engaging in complementary research for his Ph.D involving a study of the ability of mariculture to relieve coastal poverty in Indonesia. His current survey in Bali, to the extent

that it re1ates to clams, is a1so being funded. His Ph.D studies are independently financed by AIDAB. Contributions to the Project were also made by Dr T'eo Ian Fairbairn, consultant, Charlestown, New South Wales, and by Dr John Stanton, Senior Lecturer, Department of Economics, The University of New South Wales, 2308, Australia. Joint research was also undertaken with Dr John Lucas on the economics of production of giant clams. Ms. Veiki la Vuki, Fellow, Institute of Marine Resources, University of the South Pacific, Suva, Fiji, commenced a funded survey of socio-economic aspects of giant clams in the Lau Group, Fiji, and is completing interviews on five islands (for- a total of nine villages in the Lau Group). Arrangements have been made to undertake co-operative research with personnel in Fiji and Tuvalu involved in ACIAR Project No. 8733.

The research is basically on timetable but some delays were experienced in the initial stages in appointing support personnel because the project did not begin until towards the end of the 1988/89 financial year and coincided with Professor Tisdell's transfer from Newcastle to Brisbane and his visit to China as a China/Australia Exchange Fellow. This meant some lags in adjusting to a new institution and in becoming familiar with the local supply of support staff.

The marine property rights component of the study (being undertaken by Dr T'eo Ian Fairbairn, consultant) is running slightly behind the original schedule and all reports are not expected to be completed until into the 1990/91 year. The report on Tonga is finished, that for Fiji is also finished and is now being prepared for printing. A visit has been made by Dr T'eo Ian Fairbairn to Vanuatu to collect material for a report on marine property rights there (the draft of this report is now ready) and a visit to Western Samoa is underway for a similar purpose. The delay is partially due to the fact that preparation of the reports on marine property rights is relatively time consuming and Dr Fairbairn has to schedule this work in with other research obligations and commitments. The delays are not such as to affect the progress of the 'Project substantially.

(b) Analysis and Research Methods.

The research results of this Project have been presented in a series of research reports and papers, *Economics of Giant Clam Mariculture* series. Eleven papers have appeared so far and others are in preparation. Methods used included surveys, direct interviews, literature surveys, application of standard economic analysis e.g. to production economics data provided by James Cook University and the use of spreadsheet computer analysis of

production cost methods.

***Markets, marketing and trade*:** In relation to the Australian market, surveys were undertaken to determine the market for giant clam shells, for giant clams as aquarium specimens and to explore one segment of the possible market for clam meat. This research was undertaken in conjunction with the Center for Tropical and Subtropical Aquaculture project "A Market Study of Pacific Giant Clam Products".[1]

The results suggest that of these three markets the meat market is potentially the largest, the market for shells is next in size with the aquarium market being smallest.

Annually about 100,000 - 120,000 clam shells appear to have been sold in the Australian market in recent years with *Hippopus hippopus* (mostly imported from the Philippines) accounting for about 80 per cent of the trade. While there may be room to increase these sa1es somewhat, the size of the market is likely not to exceed 200,000 shells per year. At the time of the survey, only the shells of *T. gigas* and *H. porcellanus* were reported to be in short supply by retailers and wholesalers surveyed. Nevertheless one suspects that the size of the market for *T. gigas*, which .is mostly used for exterior and particular interior designs, is limited.

Possibly the annual demand for clam shells in developed countries is around 20 times that for Australia. Thus world demand could be supplied by ten farms if each turned out 100,000 clams per year which were used for this purpose.

The market for giant clams for aquarium specimens appears to be smaller. At present the Australian market could absorb about 5,000 clams per year for sale as aquarium specimens. While this market might increase in the long-term, the market is relatively small. An upper limit to it is set by the number of saltwater aquariums in existence. Possibly worldwide annual demand for giant clams for aquarium specimens is around 100,000 - 200,000 per year at present prices. This is a worthwhile market but could be supplied by just one clam farm.

It appeared from our surveys that the species most likely to be in demand as aquarium specimens are *T. crocea* and *T. maxima*. It was also noted that the species which appeared to be in greatest demand for their shells were *H. hippopus* and *T. squamosa*. Thus the species

[1] This project is funded by a grant from the Research Corporation of the University of Hawaii on behalf of the Center for Tropical and Subtropical Aquaculture #88-38500-3884 and is co-ordinated by Professor Yung C. Shang, Department of Agriculture and Resource Economics, University of Hawaii.

which ACIAR Project No. 8733 and MMDC have concentrated on for meat, namely *T. gigas* in the former case and *T. derasa* in the latter case do not appear to be ideal for these other end-uses. However, in the case of *T. gigas* a demand does exist for **large** shells.

The potential market for the meat of the giant clam appears to be the largest of all the possible markets for clam end-products. Whereas previous studies have concentrated on the Taiwan, Hong Kong and Japanese markets, the Australian and New Zealand potential market has been insufficiently explored. The following considerations make it worthwhile to explore this market:

1. The presence of Pacific Islanders and their recent descendants, especially in New Zealand, who are familiar with giant clam meat and have reasonably high incomes.
2. The relatively large increase in Asian immigration to Australia and the popularity in Australia of Chinese take-away food and restaurants.
3. The large increase in tourists to Australia from Asia, especially Japan.
4. The willingness of Australians to try new dishes.

Apart from providing a market for some Australian production of giant clam meat, the Australian and New Zealand market may be a realistic export market for the South Pacific Islands to target on the basis of proximity, knowledge, transport links and freight cost considerations.

Interviews for example with Tongans and their descendants in the Brisbane area conducted earlier this year suggested that the Tongan community in Australia would consume approximately 100,000-200,000, 5-year old clams annually if they happened to be available and the meat was to sell for around $8.50/kg. All the meat, bar the kidneys, would be consumed.

Work was undertaken by Dr J. Stanton, Senior Lecturer, University of Newcastle, to assess the value of international trade statistics as a guide to possible demand for giant clam meat and particular attention was paid to the demand for potential clam substitutes as an indicator of the demand for giant clam meat. The prospects for applying the characteristics or attributes approach to assessing the demand for giant clam meat was also explored. In practice, these methods are of limited value for determining the likely demand for giant clam meat from farms.

The possibility was also noted that different groups may have preferences for the meat of different species of giant clams. For example, Okinawans appear to prefer *T. crocea* to *H. hippopus*. The aborigines of Palm Island on the other hand will not eat *T. crocea* and prefer *H. hippopus*. The acceptability of *T. gigas* and *T. derasa* for Japanese requirements has not yet been fully determined. Many factors influence acceptability e.g. flavour, texture, colour. Mere meat biomass is not always an accurate indicator of market value.

***Property rights and related issues*:** Dr T'eo Ian Fairbairn, consultant, prepared background papers on marine property rights in Tonga and in Fiji based in part on interviews with fisheries departments in these countries. Visits have also been made by Dr Fairbairn to Vanuatu and are in progress for Western Samoa for a similar purpose. In Vanuatu, Dr Fairbairn met with chiefs to discuss property rights as well as with government officials. Property rights to marine areas can be quite complicated in the Pacific and even when statutory law vests all areas below high tide mark in the Crown, as in the case of Tonga, traditional village rights in coastal areas cannot be ignored. In any joint enterprise operation, , it is essential to take account of such rights.

***Giant clam mariculture and economic development*:** So far limited work has been done on this subject. Carunia Firdausy is undertaking research for his Ph.D thesis on the potential in Indonesia of mariculture to relieve coastal poverty. While he is concentrating on seaweed cultivation, he is also taking account of clam mariculture as a possibility. He is currently involved in fieldwork in Bali.

As economic deve1opment proceeds, demands to use the coastal zones for economic purposes increase. The demand to use it for mariculture (aquaculture) can be expected to increase and may give rise to increasing social conflict. Some consideration has been given to clam farming as a form of coastal zone use. It appears to be environmentally less damaging than many other forms of mariculture. The degree of environmental impact appears to vary with the form of growout used. Subtidal growout may have fewer adverse environmental impacts than intertidal growout even though it may be more costly (see *Economics of Giant Clam Mariculture*, Paper No.4).

A review has been undertaken of literature dealing with the economic assessment of species for mariculture in developing countries. Further work on this subject is envisaged in the future. A survey of economic aspects of giant clams in the Lau Group is underway with the

assistance of Ms. Veikila Yuki, Fellow, Institute of Marine Resources, University of the South Pacific.

***Production economics*:** A start has been made on estimating costs of production based upon data obtained from James Cook University Research Station at Orpheus Island and from Reefarm (Cairns). While the results are speculative, they do suggest that significant economies of sea1e exist in the production of c1am seed. Preliminary estimates indicate that under Australian conditions using (conventional' techniques the per unit operating cost of producing 100,000 seed per year is about $1 – $1.20, for 500,000 seed 29 – 35 cents, and for 1 million seed 18 – 23 cents. Capital costs however add to production costs. When capital costs are taken into account (and a 10% rate of interest is assumed) the corresponding total cost per seed clam may be $1.43 – 2.01, 41 – 54 cents, and 26 – 35 cents. This would indicate that if each seed clam were to sell at $1.00 at the farm gate, a clam farm producing a half-million clam seed per year would be quite profitable but one producing 100,000 seed per year would be unprofitable. The results of this research (being undertaken jointly with Dr John Lucas of James Cook University) are currently being finalised and a start has been made on the estimation of growout costs. 'First Choice' is being used to facilitate a Spreadsheet (matrix) analysis of possible growout alternatives.

(c) Implications/Results

Future research plans: On the marketing side, the prime focus will be on the market for giant clam meat in Australia and New Zealand. Prospects in the Australian restaurant trade will be exp1ored concentrating on Vietnamese, Chinese and Japanese restaurants. Some taste testing is envisaged in Brisbane in co-operation with restaurants. Some taste-testing and supply of clam meat to restaurateurs is essential because many Asian and other restaurateurs in Australia are not familiar with giant clam meat and its potential. Direct experimentation is necessary in this case. This part of the study will be undertaken in co-operation with James Cook University. Further research on the likely demand for clam meat by Pacific Islanders in Australia and especially New Zealand is envisaged.

A desktop review of studies of likely world demand for clam meat is also envisaged. In addition, in conjunction with the Center for Tropical and Subtropical Aquaculture (CTSA) Project co-ordinated by Professor Y.C. Shang, test marketing of giant clams as aquarium specimens is planned for later this year, if CTSA funding is forthcoming for this.

In relation to marine property rights and related issues, a study for Western Samoa is underway and has been completed for Vanuatu. Reports on these studies have been written up and will be available in the coming year. Then will follow an overall report on marine property rights in the South Pacific.

Prospects for exports from the South Pacific to Australia and New Zealand will be considered, taking into account likely production costs and in particular storage and transport costs. Fiji and/or Tonga and a small atoll country such as Tuvalu may be singled out for particular attention.

In addition, the economic value of cultivating giant clams for subsistence use in the Pacific and for local trade will be assessed along with the value of providing foreign aid for giant clam farming and reseeding, particularly for subsistence needs.

This coming year Carunia Firdausy will complete a survey of villagers in two coastal villages in Bali to obtain information about mariculture particularly of the seaweed *Eucheuma cottonii*. But he will also ask questions about giant clams and the possible interest of villagers in the farming of these. Ms. Yeikila Yuki, Institute of Marine Resources, University of the South Pacific, will complete a socio-economic survey of giant clams (at village level) in the Lau Group, Fiji, the results of which will be analysed in 1990/91. Ms. Yuki comes originally from the Lau Group and knows the local people and their language. During the year Bill Thomas will define his Ph.D topic which is expected to include an assessment of the socio-economic value of giant clam farming and reseeding of reefs in parts of the Pacific.

Furthermore, it is envisaged that a joint report will be completed with Mr Tim Gentle and colleagues, Ministry of Commerce and Natural Resources, Tuvalu on the economic prospects for giant clam mariculture in Tuvalu and the role which it may play in the economy of Tuvalu. In Fiji, it is hoped to involve Ms. Yina Ram-Bidesi, fisheries economist, Institute of Marine Resources, University of the South Pacific, in the Project, possibly in co-operation with the group led by Dr T. Adams, Ministry of Primary Industries, Suva. The possibility of considering giant clam farming in relation to seaweed cultivation is one aspect which is being examined as a possibility for study but there are other subjects also worth considering joint research.

Further research on the costs and economics of production is anticipated. Tentative estimates made of costs for the ocean-nursery and growout phases using Australian data will be

strengthened. These estimates will then be modified for techniques used elsewhere and for different situations in other countries. To this end, contacts have been made with Dr Tim Adams and colleagues, Ministry of Primary Industries, Suva, Fiji, with a view to doing this for Fiji and co- operative research resulting in working papers in *Economics of Giant Clam* series is envisaged.

It may be useful to catalogue the economic and social benefits which have stemmed from the ACIAR scientific project No. 8823. This is useful in itself because, given the sunset clause for ACIAR, ACIAR will need to justify its continued existence. The desirability of this is likely to be judged in part by the benefits obtained from the research which ACIAR has funded.

Future project budget: With the standard ACIAR adjustments, the budget for 1990/91 should be sufficient overall to meet basic needs but the supplies and services component is likely to be less than is required or is desirable and this is also likely to be so in 1991/92. This is because of the cost of producing papers in the series Economics of Giant Clam Mariculture (central printing, covers, etc.) and because of the desirability of having some funds available for contract expenditure to involve personnel from less developed countries (especially the South Pacific) in joint research sub-components of the Project.

Conduct of other (related research projects) and related research grants received or applied for: A small grant was received from the Research Corporation of the University of Hawaii, on behalf of the Center for Tropical and Subtropical Aquaculture, Hawaii (U.S. Department of Agriculture, CSRS Grant #88-38500-3884)as a part of the project "A Market Study of Pacific Giant Clam Products" co-ordinated by Professor Yung C. Shang, Department of Agriculture and Resource Economics, University of Hawaii. This provided some support for studies of the market in Australia for giant clam shells, for giant clams as aquarium specimens, and for demand for clam meat by Tongans in Australia.

Development of linkages with developing country organizations: Linkages have been established with the Ministry of Commerce and Natural Resources, Tuvalu, with the Ministry of Primary Industry, Suva, Fiji, and with personnel of the Institute of Marine Resources, University of the South Pacific.A joint report “On the Economic Prospects for Giant Clam Mariculture in Tuvalu” is being prepared in co-operation with M.T. Gentle and S. Maluofenua of the Ministry of Commerce and Natural Resources, Tuvalu. Cost and

production economics studies are planned in Fiji in co-operation with Dr T. Adams and A. Ledau of the Ministry of Primary Industry. Possibly, at a later time, Ms. Yina Ram-Bidesi, fisheries economist, Institute of Marine Resources, University of the South Pacific, will become involved in the research or related research. Ms. Yeikila Yuki, Fellow, Institute of Marine Resources, is conducting a socio-economic survey in the Lau Group as part of this project. Contacts have been made with other organizations in the Pacific and there is potential for joint research with their personnel if adequate funding is available. In addition, Dr T'eo Ian Fairbairn has been in direct contact with developing country organizations in Fiji, Tonga, Vanuatu and Western Samoa discussing marine property rights issues.

Optimal methods/channels of extension/outreach of results to end users: The series *Economics of Giant Clam Mariculture* reports and papers produced as a part of this Project provides a useful means of disseminating the results. These are being distributed to all project leaders involved in ACIAR Project No. 8733, "The Culture of the Giant Clam (*Tridacnidae*) for Food and Restocking of Trapi ca1 Reefs" and on request, to those individuals involved in related projects.

(d) Problems

There was some delay initially in recruiting support staff for the Project due to the transfer of Professor Tisdell from Newcastle to Brisbane and the need for him to adjust to opportunities in a new locality. This resulted in the budget for 1988/89 being underspent. In addition there were competing claims on the time of Dr Fairbairn which resulted in some delays with execution of the research for the marine property rights component. The first problem has been overcome and Dr Fairbairn is now well advanced with the second stage of the marine property rights component and should complete his contribution during the coming financial year.

(e) Reports and Publications

Conference Papers

Tisdell, C.A. (1989) Pacific giant clams and their products: An overview of demand and supply factors. Paper presented at an International Conference of The Economics of Fishery Management in the Pacific Islands, Hobart, Tasmania, March 1989.

Tisdell, C.A. (1989) Aquaculture as a use of the coastal zone: Environmental and economic

aspects. Giant clam farming as a development. Paper presented at the Conference on Coastal Zone Management: Integrating Development and Conservation, Griffith University, Queensland, 25-27 September, 1989.

Tisdell, C.A. (1990) Exploring the demand for farmed giant clams and their components: approaches and problems. Paper presented at 34th Annual Conference of Australian Agricultural Economics Society, University of Queensland, 12-15 February, 1990.

Tisdell, C.A.(1990) Report on economics of giant clam mariculture for 1989/90. Paper presented at First Project Leaders Meeting ACIAR/JCU Giant clam Project, Suva, Fiji, 26- 30 March, 1990.

Research Reports and Papers in the series

ECONOMICS OF GIANT CLAM MARICULTURE

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.

Proceedings

C. Tisdell and K. Menz, "Socioeconomic Considerations in Giant Clam Mariculture."Pp. 246-249 in J.W. Copland and J.S. Lucas (Eds.) *Giant Clams in Asia and the Pacific*, Australia Centre for Internationa1 Agricultura1 Research, Canberra, 1988. [Predates grant]

C. Tisdell, "Pacific Giant Clams and Their Products An Overview of Supply and Demand." Pp. 100-104 in H. Campbell, K. Menz and G. Waugh, Economics of Fishery Management in the Pacific Islands Region, Australian Centre for International Agricultura1 Research, Canberra, 1989.

Other Publications

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 Change in the Pacific Islands*, Routledge, London, 1989. [Predates grant]

C. Tisdell (1990) "Review of Oceans of Wealth? by the Review Committee on Marine Industries, Science and Technology (AGPS Canberra, 1989) Pp. x + 188" *Prometheus* **7**(2), 349-351.

Firdausy, C. and C. Tisdell (1991), "Economic Returns from Seaweed (*Eucheuma cottonii*) Farming in Bali, Indonesia." *Asian Fisheries Science*, **4**(61-73), 1-20.

Firdausy, C. and Tisdell, C.A. (1992), ‘Seafarming as part of Indonesia's economic

development strategy: seaweed and giant clam culture as cases', in C. Tisdell (ed.), *Giant Clams in the Sustainable Development of the South Pacific*, Canberra Australian Centre for International Agricultural Research, Ch. 6, 80-100.

Tisdell, C. (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 and J.M. Broadus (1989), "Policy Issues Related to the Establishment and Management of Marine Resources", *Coastal Management*, **17** (37-53). [Related but not part of project]

Other papers are in preparation including one on the economics of growout of giant clams.

(f) Benefits of Research

Benefits include: Improved assessment of economic prospects for giant clam farming in Tuvalu, Fiji and Australia. Development of economic assessment techniques which can be modified and applied in a range of countries. Identification of marine property rights issues of importance in the South Pacific. Training of Ph.D students (Carunia Firdausy, from Indonesia; W.R. Thomas, Brisbane). Involvement of academic staff from Institute of Marine Resources, University of South Pacific. Interaction with natural scientists in ACIAR Project 8733 so as to provide economic back-up where required.

3.3 Travel and Meetings

Mr Bill Thomas completed two trips to James Cook University including the Marine Research Station at Orpheus Island for data collection and co-operative research on production economics. On one of these journeys, he also visited commercial farms in the Cairns area for a similar purpose. Rene Wittenberg also made a visit to Townsville and Cairns (only partially funded by ACIAR) to visit the Great Barrier Reef Marine Park Authority (e.g. Dr Leo Zann), the Palm Island Community, commercial farms in the Cairns area, and retail outlets for clam shells.

In March, 1990, Bill Thomas attended the First Project Leaders' Meeting in Fiji for the purpose of becoming better informed about developments in giant clam farming and to make contacts with other researchers, especially in the South Pacific Islands. In May 1990, Bill Thomas visited Tuvalu and Fiji for fieldwork and to follow up co-operative research possibilities with Dr T. Adams, Ministry of Primary Industries, Fiji; Mr. T. Gentle, Ministry of Commerce and Natural Resources, Tuvalu and members of the Institute of Marine Resources, University of the South Pacific.

Clem Tisdell attended the Project Leaders' Meeting in Fiji in March and presented a paper on socio-economic aspects of the research. Useful contacts were made. In April/May Clem Tisdell took a side-trip from Hong Kong to Guangdong, China, from an international journey (financed from other sources) to discuss, explore and consider mariculture possibilities for giant clams in this province of China.

Dr T'eo I. Fairbairn, consultant, undertook journeys to Fiji, Tonga, Vanuatu and Western Samoa to collect data for reports in connection with the project.

3.4 Budget Discussion

This has been covered under item 3.4. There was under expenditure in the 1988/89 financial year due to the late stage at which the grant was made in that financial year and the shift of Professor Tisdell from the University of Newcastle, N.S.W. to the University of Queensland which necessitated adjustment to a new organization and required time for learning about local labour availability etc. The time of the start was also later than had been anticipated by Dr T'eo Fairbairn, consultant, and by the time an agreement was drawn up there was little time left in that financial year for completion of stage one of the marine property rights study.

These problems were overcome in 1989/90. However, budgeted funding for the category, supplies and services, is expected to be inadequate in 90/91 and 91/92 to (a) provide financial support for joint research by personnel from less developed countries whom it is desirable to have involved in the project and (b) to meet the cost of publication of the series of research reports and papers in the *Economics of Giant Clam Mariculture* series e.g. printing costs and (c) meet norma1 research maintenance costs. An additional $2,000 should be budgeted for 1990/91 and for 91/92 to cover the printing costs for the above-mentioned series. It would also be desirable to have contract expenditure of around $6,000 for each of the years 90/91 and 91/92 to support personnel in less developed countries involved in joint research for this Project. For example, joint research with Fiji as mentioned above involving researchers from the University of the South Pacific. No financial provision has been made in the budget for a possible conference in the final year of the project and/or publication of an edited monograph or book bringing together the overall results of the study. An end-product of this type seems desirable. The above adjustments are desirable in view of the progress of the Project and in the light of learning-by-experience.

3.5 Conclusions

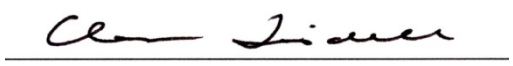
Progress of the Project, after some initial delays, is now basically in accordance with plan. The marine property rights subcomponent is slightly behind schedule but is expected to be completed in the near future. While data has been collected on the implications of CITES and about industry developments in giant clam farming in Australia this part of the research has not yet been written up. Research papers and reports have been published on all the main objectives of the research: (1) Market prospects for giant clams (2) production economics of their mariculture (3) marine property rights as they affect giant clam mariculture and (4) giant clam mariculture as a possible contributor to the development of less developed countries in the Indo-Pacific Region.

In the immediate future it is planned to investigate the potential New Zealand market for giant clam meat amongst migrant groups from these- Pacific Islands where clams are present and sought after for eating. A similar approach will be adopted to that used in Brisbane for surveying Tongan groups. A report on economic prospects for giant clam mariculture in Tuvalu will be completed together with research and papers dealing with production economics of giant clam mariculture in Fiji. This work will be completed in co-operation with local researchers. Preliminary work has been done on growout economics and it is

planned to complete this in co-operation with Associate Professor John Lucas and others at James Cook University. At least one paper dealing with production economics for Australia will be prepared for submission to a journal.

Papers are also expected to be written on Australian industry developments, CITES, prospects for joint ventures for giant clam aquaculture in China. Resu1ts of the economic survey of clams and potential mariculture in the Lau group, Fiji, will be analysed and written. The survey results for Bali, Indonesia, will also be reported. A desktop market review will be completed and written up at least in draft form. Direct testing of giant clam meat in the restaurant trade in Brisbane will if possible be undertaken in co-operation with James Cook University. Some direct testing seems essential to market deve1opment. Test marketing of aquarian specimens will be undertaken if funds become available from CTSA as part of the project co-ordinated by Professor Yung C. Shang. Within the limits set by available ACIAR funding, possibilities for further joint economic research with other groups in less developed countries in the Pacific will be explored e.g. with Kirabati and/or Vanuatu.

PROJECT LEADER'S SIGNATURE



University of Queensland

4. APPENDICES•

4.1 Research Results of Note

These include the following:

1. Significant economies of scale exist for the production of clam seed if 'high tech' production methods are used as in Australia.
2. Taking (i) meat, (ii)shells and (iii)aquarium specimens as the main potential end-products for farmed clams, the potential market for clam meat is much larger than that for shells which in turn is much larger than that for aquarium specimens.
3. A substantial market for giant clam meat exists in Australia amongst individuals and their families who have migrated from the South Pacific Islands.
4. Existing international trade statistics cannot be used as a guide to the potential demand for giant clam meat and currently there are great difficulties in using the demand for 'substitutes' for clam meat, such as scallops, as indicators of the demand for clam meat.
5. In those countries studied so far in the South Pacific, traditional village property rights to reef areas are prevalent. Any enterprise intending to farm giant clams in these countries will have to come to terms with these traditional property rights.
6. Preliminary evidence indicates that the economic returns from seaweed farming are likely to be much higher than from the farming of giant clams, at last in Indonesia. However, the comparative economic value of giant clam farming in less developed countries needs further investigation, and the economics of using giant clams in polyculture or in mixed farming should be investigated.

4.2 Research Reports, Papers, Publications and Theses

(i) In Progress

"Economics of the Giant Clam Ocean Growout", Lucas, Tisdell, Thomas. [basic matrices only]

Fairbairn, T'eo I.J., "Marine Property Rights in Fiji: Implications for the Development of Giant Clam Mariculture" [final draft being prepared for the printer for inclusion in the series, *Economics of Giant Clam Mariculture*"]

Fairbairn, T'eo I.J., "Marine Property Rights in Vanuatu" [in preparation]

Fairbairn, T'eo I.J., "Marine Property Rights in Western Samoa [in preparation]

Tisdell, C.A., Lucas, J. S. and Thomas, W.R. "Cost of Producing Giant Clam (*Tridacna gigas*) seed in Australia [being revised for journal submission]

(ii) Completed

Firdausy, C. and Tisdell, C.A., "Economic Returns from Seaweed (*Eucheuma cottonii*) Farming in Bali, Indonesia", submitted to *Asian Fisheries Science* and provisionally accepted for publication.

Firdausy, C. and Tisdell, C.A., "Seafarming as a Part of Indonesia's Economic Development Strategy- Seaweed and Giant Clam Mariculture as Cases". Submitted to *South East Asian Economic Review*.

Tisdell, C.A. (1990), "Economics of Giant Clam Mariculture: Main Results of Investigations for 1989/90". Paper presented at the First Giant Clam Leaders' Meeting held in Suva, Fiji 26-28 March, 1990.

Tisdell, C.A., "Aquacu1ture as a Use of the Coasta1 Zone: Environmental and Economic Aspects". Submitted to *Coastal Management*.

(iii) Published

Fairbairn, T'eo I.J. (1990), "Marine Property Rights in Relation to Giant Clam Mariculture in the Kingdom of Tonga", *Economics of Giant Clam Mariculture*, Paper No. 6, Department of Economics, University of Queensland, Brisbane, Qld 4072, Australia.

Firdausy, C. and Tisdell, C.A. (1989), "Seafarming as Part of Indonesia's Economic Development Strategy Seaweed and Giant Clam Mariculture as Cases", *Economics of Giant Clam Mariculture*, Paper No. 2, Department of Economics, University of Queensland, Brisbane, Qld 4072, Australia.

Firdausy, C. and Tisdell, C.A. (1990), "Assessing Species for Mariculture in Developing Countries: A Review of Economic Considerations", *Economics of Giant Clam Mariculture*, Paper No. 10, Department of Economics, University of Queensland,

Brisbane, Qld 4072, Australia.

Stanton, J. (1990), "Evaluation of Australian Trade Statistics on Giant Clams and Related Products and the Market for Giant Clam Meat", *Economics of Giant Clam Mariculture*, Paper No. 9, Department of Economics, University of Queensland, Brisbane, Qld 4072, Australia.

Tisdell, C.A. (1989), "Pacific Giant Clams and Their Products: An Overview of Supply and Demand". Pp. 100-104 in H. Campbell, K. Menz and G. Waugh, *Economics of Fishery Management in the Pacific Islands Region*, Australian Centre for International Agricultural Research, Canberra, 1989.

Tisdell, C.A. (1989), "Giant Clams in the Pacific- The socio-economic potential of a developing technology for their mariculture". Pp. 74-88 in E.D. Couper (Ed.) *Development and Change in the Pacific Islands*, Routledge, London, 1989.

Tisdell, C.A. (1989), "Market for Giant Clam Shells: Report on a Survey of Retailers and Wholesalers in Southeast Queensland, Australia". *Economics of Giant Clam Mariculture*, Paper No. 1, Department of Economics, University of Queensland, Brisbane, Qld 4072, Australia.

Tisdell, C.A. (1989), "Market for Giant Clams as Aquarium Specimens: Report on a Survey of Retailers of Supplies for Saltwater Aquariums, Southeast Queensland, Australia", *Economics of Giant Clam Mariculture*, Paper No. 3, Department of Economics, University of Queensland, Brisbane, Qld 4072, Australia.

Tisdell, C.A. (1990), "Exploring the Demand for Farmed Giant Clams and their Components: Approaches and Problems", *Economics of Giant Clam Mariculture*, Paper No. 7, Department of Economics, University of Queensland, Brisbane, Qld 4072, Australia.

Tisdell, C.A. (1990), "Review of Oceans of Wealth?" by the Review Committee on Marine Industries, Science and Technology (AGPS, Canberra, 1989)Pp. x + 188", *Prometheus* Vo1.7, pp. 349-351.

Tisdell, C.A. and Broadus, J. (1989), "Policy Issues Related to the Establishment and Management of Marine Resources". *Coastal Management*, **17**, 37-53 [not supported by project grant but of related interest].

Tisdell, C.A., Lucas, J.S. and Thomas, W.R. (1990), "An Analysis of the Cost of Producing Giant Clam (*Tridacna gigas*) Seed in Australia", *Economics of Giant Clam Mariculture*, Paper No. 11, Department of Economics, University of Queensland, Brisbane, Qld 4072, Australia.

Tisdell, C.A. and Wittenberg, R. (1990), "Report on Possible Demand for Giant Clam Meat by Tongan Descendants in Australia: Responses from interviews conducted in the Brisbane area", *Economics of Giant Clam Mariculture*, Paper No 8, Department of Economics, University of Queensland, Brisbane, Qld 4072, Australia.

(iv) Theses

Carunia Firdausy, "Coastal Poverty in Indonesia and the Ability of Mariculture to Relieve It" (PhD thesis in progress)

W. Thomas, "Economic and Ecological Bases for Restocking Reefs with Giant Clams" (PhD thesis tentative title)

4.3 Trip Reports

The following trip reports are included here:

Professor C.A. Tisdell - Trip to Fiji in period 23-30 March 1990.

Professor C.A. Tisdell- Hong Kong to Guandong, China, journey in period 30 April to 6 May 1990.

Mr W.R. Thomas - Trip to Fiji in the period 23-30 March 1990. Mr. W.R. Thomas- Trip to Tuvalu and Fiji in the period 22 May to 2 June 1990.

In addition, Dr T'eo I. Fairbairn made visits to Tonga, Fiji, Vanuatu and Western Samoa in connection with his contribution to the project.

Trip Report - Visit to Suva. Fiji for Clam Project Leaders' Meeting

Personnel: Professor Clem Tisdell (Project Leader, Economics of Giant Clam Mariculture) and Mr W. Thomas (Senior Research Assistant)

Period: 23 - 30 March, 1990

Purpose: To attend Clam Project Leaders' Meeting, deliver a report on the first year of the economics research project, and to make direct contacts with researchers interested in collaborating in the economics research.

Friday, 23 March: Depart Brisbane by plane for Nadi, Fiji.

Saturday, 24 March: Arrive Nadi. Collect rental car with a view to driving to Suva via northern route. Drove to Rakiraki but unable to proceed further because northern route (King's Highway) closed due to effects of cyclone. Stayed overnight in Rakiraki.

Sunday, 25 March: Return to Nadi and travelled by the southern route (Queen's Highway) to Suva arriving mid-afternoon. Informal meeting with conference participants.

Monday, 26 March: Attending and participating in Project Leaders' Conference at Suva Travelodge.

Tuesday, 27 March: Attending and participating in Project Leaders' Conference at Suva Travelodge. Professor Tisdell presented a paper on "Economics of Giant Clam Mariculture: Main Results of Investigations for 1989/90 for ACIAR Project No. 8823".

Wednesday, 28 March: Visit to University of South Pacific to purchase source materials and obtain lists of relevant reference material from the Institute of Pacific Studies. Visit to the Institute of Marine Resources. Discussions with Ms. Vina Ram-Bidesi, fisheries economist. In the afternoon, return to Project Leaders' meeting.

Thursday, 29 March: Travel by car to Natovi and then by boat to Marine Research Station at Makogai Island. Inspection of faci1ities, of clam seed in tanks and of clams offshore. Professor Tisdell had a videoed interview with USP Extension Staff.

Friday, 30 March: Return by boat to Natovi and thence by car to Nadi to join return flight to Brisbane.

Trip Report - Visit to Guandong. P.R. of China

Project participant Professor Clem Tisdell, Project leader.

Period 30 April 1990 to 6 May 1990

Purpose: To take advantage of travelling through Hong Kong on a return journey from Budapest, Hungary (where I was attending and presenting a paper at an international conference on the Environmental Future) to make a side-trip to Guangzhou to determine Chinese interest in and knowledge of giant clam farming.

Sunday, 30 April: Travelled by plane from Hong Kong to Guangzhou arriving late Sunday.

Monday, 1 May: Public holiday in China- May Day

Tuesday, 2 May: Enquired with assistance of a lecturer/translator from Zhongshan University with the South China Sea institute of Oceanology, Guangzhou whether or not any member of the Institute could assist with my enquiries about giant clams. However, it proved impossible to make effective contact on this subject. But prior contacts had been established in Shenzhen both at the Shenzhen University and with local aquaculture/mariculture organizations. It transpired that these groups were interested in exploring the possibilities of a joint mariculture venture with Australian interests in this area, and a delegation was sent to escort me from Guangzhou "to Shenzhen. Discussed giant clams with this group and travelled by road to Shenzhen University arriving late at night.

Wednesday, 3 May: Tour of Shenzhen University arranged by Professor Hu and visit to Shecou Harbour (Snake Head harbour) for inspection of market selling agricultural and marine produce, including aquacultured produce. Also had a discussion with local fishermen at the harbour. They were shown photos of giant clams and claim that they have seen them but they are very rare. When they find one they take it home and eat it after frying it in oil.

This was followed by a visit to the offices of Au Fat Ming (Head Manager, Shenzhen County Agricultural Products Bureau) which is also responsible for aquaculture in the county, that is, for the enterprises operated by the local government authority.

County authorities had not heard of the possibilities of farming giant clams before. In

particular, they had no knowledge of any experimentation with this farming possibility in China, for example on nearby Hainan island; They expressed interest in this type of farming and want to explore the possibilities of getting seeds of giant clams and of having a joint international venture for the growing of giant clams in the County. They were unsure, however, whether loca1 conditions would be suitable for giant clam farming. It was suggested that I should visit existing aquaculture (including mariculture) operations of the County to give them a better idea of whether the matter was worth considering further.

The first visit was to Nantou Prawn Farm which covers several hectares. Seed is imported from Taiwan and prawns are grown mostly for export to Hong Kong and Taiwan but some are sold locally. Two crops are produced per year. Prawns are fed on small shellfish collected from a nearby bay so no imports of expensive food are needed. The water is brackish with temperature and salt content varying greatly throughout the year. The variety or species of prawn used is an improved Chinese type well adapted to such conditions. Good economic returns are usually obtained from this farm. However, during the last year a typhoon struck the area and one crop of prawns was lost because they swam away or were swept away by the high seas. Typhoons are a particular problem in this area. Conditions at this site were unsuitable, of course, for giant clam farming because of the brackish water.

This was followed by a visit to the freshwater aquaculture operations of the County. The freshwater aquaculture area produces for market white eels, black eels, turtles, frogs and fish. We only had time to inspect the white eel farm. This is a grow-on operation. The young eels are obtained from abroad or from elsewhere in Guandong. The eels are held in large concrete tanks and fed on fish meal which is imported from the USA and the grown eels are sold as a high value export to the USA and Japan. However, last year due to the high price of imported fish meal, the farm ran at a loss. This year the price-ratio is reported to be more favourable. It was reported that no suitable local substitute food for the eels is available. Since the operations for this product seem more capital-intensive than labour-intensive and the grow-on is to some extent footloose, this area may not have a comparative advantage in this particular line of production.

Turtles are also produced for a high value market and particularly for export to Japan. The turtles are fed on frozen small fish obtained by local fishermen. Import of food is not required.

The Shenzhen County Agricultural Bureau also produces other products such as pigeons, ducks and fruit and operates its own restaurant.

Thursday, 4 May: Visited mariculture facilities of the Shenzhen County Agricultural Bureau at Shatoujiao Yantian (Sword Field Bay). The facility had a number of rectangular concrete tanks (raceways), equipment and an office building and has been engaged in breeding saltwater prawns. At the time of the visit, breeding was not in progress although the staff were still present. While this was not clear it, may have previously been operated as a joint venture with a Japanese company. It was mentioned that a Japanese company involved in a prawn joint venture in the County had withdrawn and that this gave an opening for another joint venture to replace it.

Casual inspection indicated that the area be1ow the marine hatchery could be suitable for giant clam grow out and that current tanks (raceways) could be converted to hold seed or young clams. But the foreshore below the nursery is sandy and the approach to it fairly steep. The area is said to be well protected from the effects of typhoons. Other potential sites in the area could be more suitable. The Bureau had, it was suggested, other possible sites. Also the Army holds a considerable amount of land in the area and it is interested to use some of this commercially. It could also probably offer suitable sites for a joint venture, it was said. I was asked to make both the interest of the Bureau and the suggested interest of the Army known to any potential joint venturers in relation to giant clam farming. It was envisaged that any such farm would principally grow-on giant clams and export them to nearby Hong Kong, Taiwan and possibly Japan.

From the point of view of location the County is well placed and it is in an area which was in the original natural distribution of several species of giant clam.

After this visit and discussions, I returned to Guangzhou by train.

Friday, 6 May: Discussions were held at Zhongshan University about how more information could be obtained about the use of giant clams in Cantonese cuisine. In Hong Kong, a senior lecturer (Chinese) in economics informed me that he knows the giant clam. People in Hong Kong like to eat the muscle in winter. They pour very hot water over the muscle and consume it in a clear soup. But little progress was made in determining whether it is known in Guangzhou. However, informal arrangements have been made for a lecturer at the University to make enquiries at specialized seafood restaurants and report back on this matter.

Saturday, 7 May: Flew to Hong Kong to join flight back to Australia.

Log of activities: Trip to Fiii to attend proiect leaders meeting for complementary study (Project No. 8733) "The culture of the giant clam (*Tridacnidae*) for food and restocking of tropical reefs."

23/3/90 - 30/3/90

W.R. Thomas

23/3/90: Departed Brisbane 23.15.

24/3/90: Arrived Nadi 05.00. Arranged rental car hire after considerable difficulty with local rental car group "Bula car rentals" 11.00 took delivery of rental car and proceeded to drive to Suva via Kings Highway. 14.00 arrived at Rakiraki and advised that road to Suva impassable. Decided to spend night at Rakiraki Hotel (quite pleasant).

25/3/90: Departed Rakiraki and drove to Suva. (Experienced some problems with rented car cutting out on hills.) 15.00 arrived Pender Court Apartments. Attended an informal get-together of majority of conference participants that evening.

26/3/90: 08.30 - 17.30 attended conference

27/3/90: 08.30 - 17.30 attended conference

28/3/90: 08.30 - 12.00 attended conference.

12.00 - 16.00 visited University of the South Pacific to make contact with Vina Ram who was interested in collaborating in study on the economics of giant clam mariculture and to visit Institute of Pacific Studies. 19.00 attended formal conference dinner.

29/3/90: 08.00 departed for Makogai Island to inspect hatchery facilities there with rest of conference delegates. Inspected what appears to be a new species of giant clam called the Tevoro clam.

30/3/90: 09.00 departed Makogai with conference delegates. Drove through to Suva and then to Nadi and then caught the plane back to Brisbane at 19.55. 22.35 arrived back at Brisbane.

Log of activities Trip to Fiji and Tuvalu 22/5/90 - 2/6/90

W.R. Thomas

22/5/90: Depart Brisbane 05.30. Arrive Nadi 11.05. Booked into Raffles Gateway Hotel. Arranged interviews with Dr Tim Adams and Professor Ravuvu for period after return from Tuvalu. Arranged hotel accommodation for arrival in Suva.

23/5/90: 07.00 Departed Nadi. 10.00 arrived Funafuti. Met by Sikela Ulwmutu and subsequently by Tim Gentle. Arranged to stay with Tim Gentle for duration of visit. 14.00 arranged bicycle hire for transport on Funafuti. Paid a visit to Tuvalu Fisheries Division. 19.00 had lengthy conversation with Tim regarding clam mariculture and fisheries in Tuvalu. Was shown a copy of Dr R. Braley's 1988 report on giant clams in Tuvalu.

24/5/90: Read report by R. Braley on status of giant clams in Tuvalu. 14.00 had long discussion with Sautia Maluofenua (Chief Fisheries Officer, Fisheries Divi.sion, Tuvalu) regarding prospects for clam mariculture in Tuvalu.

25/5/90: 09.00 to 12.00. Rode/walked to Fatato Islet to get an appreciation of the environmental factors present in the atoll. Observed good coral growth between main island and Fatato Islet. 14.00- 16.00 again read Rick Braley's report. Arranged with Tim Gentle to visit giant clam mariculture site at Amatuku.

26/5/90: 10.00 had a bad fall down slipway near Fisheries Division while loading boat with diving equipment for visit to Amatuku. Visited Marine training centre at Amatuku. Very impressed with the general condition of the training centre, seemed very well run. Skin-dived out to where the *T. derasa* clams were being kept. Found a recently dead clam and one in the process of dying. Returned to the boat with the two specimens and re-equipped with scuba gear to help Tim Gentle carry out maintenance on the *T. derasa* clams. Proceeded to a coral bombie where Tim Gentle said that there were still *T. squamosa* growing naturally at a depth below that where skin divers could collect them. Dived to 24 metres but only saw one *T. squamosa*. It was at a depth of 9 metres. Coral growth seemed very healthy.

25/5/90: 09.00 wrote up preliminary draft of report on economics of giant clam mariculture in Tuvalu. 14.00 helped Tim Gentle secure the mooring of a friend's runabout. The friend was the Chief Engineer on the M.V. Nivanga (the inter-atoll vessel, 54 metres) who provided some useful background information on Tuvalu and the use of the Nivanga.

28/5/90: Arranged with Tim Gentle to have a further discussion with Sautia Maluofenua. 14.00 had further talks with Sautia Maluofenua who read the preliminary report. He said he agreed largely with what was recommended and appeared happy to be a co-author of a report on the economics of giant clam mariculture in Tuvalu.

29/5/90: 12.40 departed Funafuti. 15.40 arrived Nadi. 20.40 departed Nadi. 21.10 arrived Nausori airport. 22.00 booked into Grand Pacific Hotel in Suva.

30/5/90: 09.00 met Dr Tim Adams, discussed arrangements for a joint paper on economic potential for giant clam mariculture in Fiji. Tim Adams stated that he would be most happy to participate. He said that he would be able to supply cost figures for hatchery at Makogai Island, and that E. Ledua was already undertaking surveys of suitable sites for outgrowing of giant clams in Fiji. Tim Adams invited me to participate in a survey of the Lau Group to be undertaken in September 1990. The survey will be to determine present populations of giant clams and to conduct interviews with the inhabitants of the Lau Group regarding clam culture. One of the islands to be visited had strict controls over giant clam use in order to conserve them, while another island was involved in selling the g1ant clams for profit. It will be interesting to see the differences between the two islands. I met Viliami Langi and arranged for him to supply Tim Gentle with formalin so that the two *T. derasa* clams from Amatuku could be forwarded to him and subsequently to Oonoonba Veterinary Laboratory for testing. 11.30 met Vina Ram and Veikila Vuki at the Institute of Marine Resources (USP). Discussed the project with them. Suggested collaboration with Tim Adams at the Fisheries Division to Vina Ram. 15.00 met with Hideyuki Tanaka and discussed project. He gave me a copy of Rick Braley's report on Tuvalu. 17.00 met briefly with Greg Brooks of AIDAB and arranged to meet with him the next day.

31/5/90: 10.00 spoke to Greg Brooks of AIDAB who is responsible for AIDAB and ACIAR projects on Tuvalu. He was of the opinion that it would be almost impossible to set up a hatchery in Tuvalu because of its remoteness. We discussed some of the problems inherent in Tuvalu because of its remoteness and small size. Greg Brooks recommended that a visit to

New Caledonia to see what the French were up to would be a good idea. 12.30 had lunch with Veiki la Yuki and discussed the survey she was to undertake of the Lau Group of Fiji. 15.00 visited Professor Asesela Ravuvu at the Institute of Pacific Studies (USP) and discussed development problems in Fiji and the prospects for giant clam mariculture in Fiji.

1/6/90: 08.00 travelled to Deuba to board a boat in order to inspect the naturally growing giant clams (*T. squamosa*) in Beqa Lagoon. Informed that almost all clams within depth of skin divers had been taken. Saw some *T. Squamosa* at about 10 metres (15 - 38 cm in size).

2/6/90: 08.30 paid a visit to the Fiji Museum. 11.15 departed Suva (Nausori Airport). Arrived Nadi 11.45. Departed Nadi 14.35. Arrived Brisbane 16.55.

4.4 Budget Expenditure Details

Project No. 8823

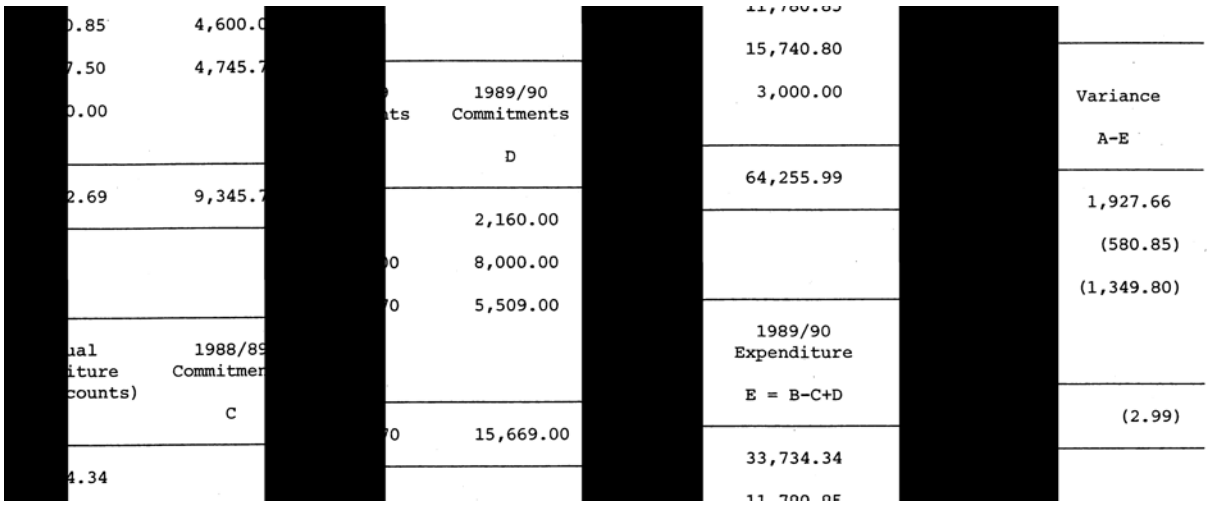
Expenditure for 6-month period to 30 June 1989

	$
Personnel	805
Supplies and Services*	9,786
Travel**	4,762
Other	_____
	15,335

* Includes $4,600 consultancy payment

**Includes $4,746 travel funds advance

Expenditure for the 12-month period to 30 June 1990 (see next page)



4.5 Project Publicity

The following is the known publicity for the Project:

(1) "UQ studies giant clam marketing potential", *University News*, p.14, March 14, 1990, University of Queensland.

(2) Small entry in an *Australian Financial Review* column.

(3) "Market for giant clams assessed", *Gold Coast Daily News*, 17 April 1990, p.18.

(4) Videoed interview with University of South Pacific, External Studies Unit, March 1990 for use in teaching and extension.

(5) June 1990. Recorded interview with John Ringwood, Media Section of Overseas Information Branch, Department of Foreign Affairs and Trade for the program "Australia- Pacific" distributed throughout the South Pacific region. Excerpts often used by Radio Australia.

(6) Entries in the *ACIAR/JCU Giant Clam Project Newsletter* and in *Clamlines*, ICLARM South Pacific, Honiara, Solomon Islands.

(7) "Giant Clam Study" *Fish Farming International*, No. 6, Vol. 17, June 1990, p. 18.

The University of Queensland

Equal Opportunity in Employment is University Policy

Senior Research Assistant Grade II

Economics Department

To conduct full time research into the Economics of Giant Clam (Tridacnid) Mariculture under the supervision of the Project Leader. The study will involve investigations into markets, marketing and trade; production economics; marine property rights and aspects of development economics. Some travel and field work will be required. This project is funded by the Australian Centre for International Agricultural Research (ACIAR) and Professor Clem Tisdell is the Project Leader.

Tenure: One year with extensions for another two years subject to satisfactory performance.

Commencement Date: As soon as possible.

Qualifications: At least an undergraduate degree or a postgraduate degreee with a major in agricultural economics or economics. Postgraduate qualifications are desirable but not essential. Previous work or study in the natural resources field, especially marine science, would be an advantage, as would be some econometric, statistical knowledge and computing skills.

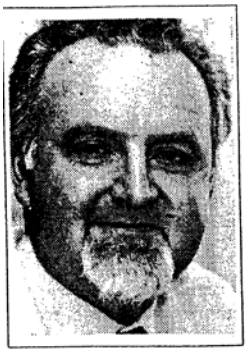
Salary: A$26,708–$28,234 p.a. An appointee is eligible to receive an economy class airfare to take up, and on expiry of, the appointment. Subject to a medical examination, an appointee will be eligible to participate in an employer-subsidised superannuation scheme.

Closing Date: August 3, 1989. **Ref. No:** 35389.

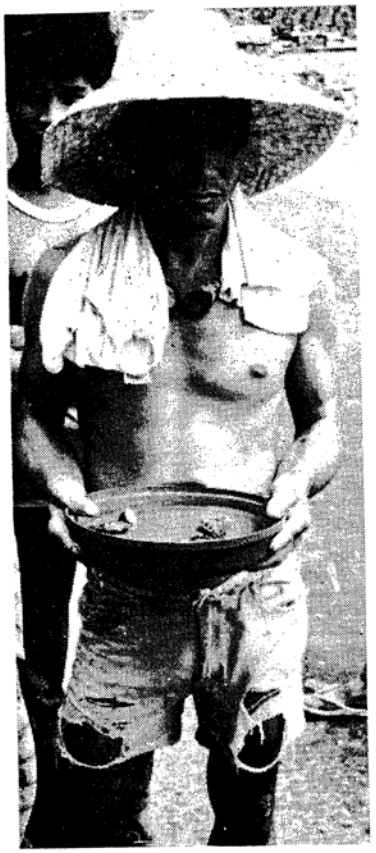
More details and application forms may be obtained from Professor C.A. Tisdell, Head, Department of Economics, The University of Queensland, St Lucia, Australia 4067. Fax No (070 371 2265.

S9022C

UQ studies giant clam marketing potential



Professor Tisdell



Giant clam broodstock.

Left: Fisherman at Los Negros, Philippines with baby clams supplied by Silliman University, Philippines with ACIAR help, as part of a project to improve their living standards.

UNIVERSITY OF Queensland researchers are assessing the potential market for giant clams to assist the economies of Australia and South-East Asian and South Pacific nations.

A team headed by Professor Clem Tisdell, head of The University of Queensland's Economics Department, is undertaking a four-year $204,000 study on the economics of giant clam mariculture funded by the Australian Centre for International Agricultural Research (ACIAR).

The study is intended to complement an ACIAR project on technical and scientific methods to culture giant clams, and restock tropical reefs, headed by Dr John Lucas, an associate professor in zoology at James Cook University of North Queensland.

"No one knows the exact potential of giant clams, and it's our job to find out," Professor Tisdell said.

"The work will particularly benefit developing South Pacific coral atoll countries with few natural resources, but the ability to grow clams well in tropical coral environments."

He said the study related to commercial trade possibilities as well as subsistence potential in developing countries.

The study of market possibilities in Japan, China, New Zealand, Australia and elsewhere had implications for all potential exporters of clam products in the region.

Professor Tisdell said the technical feasibility of farming giant clams was well established, and all recognised species had now been bred in captivity.

"Low-tech" and "high-tech" clam hatchery methods, using different clam varieties, had been developed at the Micronesian Mariculture Demonstration Center in Palau and at James Cook University.

The University of Queensland project was assessing the economics of the alternative methods and evaluating international trade statistics on giant clams to establish whether there was a substantial market for them and where major overseas markets would be.

Professor Tisdell said the project aimed to clarify the economic constraints and economic opportunities of giant clam mariculture.

"The economic viability of giant clam mariculture for commercial trade will depend upon the markets for the products and the economics of production," he said.

He said Mr Carunia Firdausy, from Indonesia, was completing a PhD thesis at the University examining the economic potential for mariculture in Indonesia and its ability to relieve coastal poverty.

Mr Firdausy is studying both seaweed farming and giant clam mariculture in Indonesia.

Professor Tisdell said it was planned to initiate studies in other countries such as Kirabati and Tuvalu.

The project would involve collaboration with partners including the South Pacific Trade Commission; Ministry of Primary Industries, Fiji; Ministry of Natural Resources and Development, Kirabati; Silliman University, Philippines; James Cook University and the Ministry of Agriculture, Fisheries and Forestry, Tonga.

Professor Tisdell is also involved in a market study of Pacific giant clam products commissioned by the University of Hawaii Research Corporation. This study is led by Professor Yung Shang of the University of Hawaii and includes Dr Paul Callaghan of the University of Guam.

It is being undertaken on behalf of the Center for Tropical and Subtropical Aquaculture, Hawaii, with a grant from the U.S. Department of Agriculture. Next year the study will expand to include live clams for aquarium specimens.

Professor Tisdell has been examining market prospects in Australia and his research group, including Mr Bill Thomas and Mr Rene Wittenberg has produced eight working papers on the project, available through the Economics Department.

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GOLD COAST DAILY NEWS
17 APR 1990
Page no 18

Market for giant clams assessed

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FISH FARMING INTERNATIONAL

June 1990, Volume 17, No. 6

Giant clam study

AN Australian project at the University of Queensland is assessing the economic benefits of giant clam farming for the countries of the South Pacific and South-east Asian Region.

Spokesman for the project, Professor Clem Tisdell, said the study aims to clarify the economic constraints and economic opportunities of giant clam aquaculture.

One of his co-researchers, Carunia Firdausy from Indonesia, is examining the economic potential of the species for aquaculture in his country to relieve coastal poverty. Similar reviews are planned for other countries in the region.

● Further information from: Professor Clem Tisdell, Economics Department, Queensland University, St. Lucia, Queensland, 4067, Australia.

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.