

# RESEARCH REPORTS IN THE ECONOMICS OF GIANT CLAM MARICULTURE

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Economics of Giant Clam Production in the  
South Pacific – Fiji, Tonga and Western Samoa

by

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**Economics of Giant Clam Production in the South Pacific –  
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**Luca Tacconi<sup>2</sup> and Clem Tisdell<sup>3</sup>**

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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.

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# **Economics of Giant Clam Production in the South Pacific – Fiji, Tonga and Western Samoa**

## **ABSTRACT**

The paper considers the economics of giant clam mariculture in the South Pacific, with special attention to Fiji. Approximate economic and biological data are used in order to determine the internal rate of return from a small maricultural activity. Under certain conditions, it is found that clam mariculture could be profitable. Important factors affecting profitability are found to be 1) post-harvest drip loss, 2) seed clam price, 3) output price and 4) mortality rates of clams. It is also stressed that it appears unlikely that villagers will undertake clam farming as a subsistence activity. Villagers' interest lies in finding new commercial activities to supplement subsistence production.

**Keywords:** Economic viability of Giant clam farming, Fiji, Tonga, Western Samoa, Fisheries Division.

**JEL Classification:** Q57, Q21, Q22

# **Economics of Giant Clam Production in the South Pacific – Fiji, Tonga and Western Samoa**

## **1. Introduction**

The economic viability of giant clam farming has been considered for Australia by Tisdell et al. (1991a, 1991b). Economic analysis of this for Pacific countries has not been undertaken, except by Hambrey (1991). This paper tries to fill this gap.

Because of the experimental stage of giant clam farming, only limited data is available to analyse its profitability. The analysis of returns from *Tridacna derasa* farming reported in this paper is based on data provided by the Fiji Fisheries Division. At the present stage the Fiji Fisheries Division is planning to supply *T. derasa* seeds to interested farmers as these seeds are already available. When *T. gigas* seeds will become available they will also be introduced. It should be noted that because of differences in biological characteristics (e.g. growth rate), *T. Gigas* might yield higher returns than *T. derasa*. However, the choice of the species to be grown will not only depend on economic returns but also on local environmental conditions.

Before considering the economic returns from clam farming, the paper briefly considers possible villagers' livelihood strategies and their relevance for giant clam farming.

Fieldwork for this report was conducted during the period 26 August – 3 October 1991 and we acknowledge the extremely helpful assistance of the people listed in the Appendix and that of their organizations.

## **2. Villagers' Livelihood And Giant Clam Farming**

In the current research on giant clam mariculture, it is often assumed that coastal people may be willing to grow giant clams for subsistence purposes, or putting it in a different way, that giant clams could supply Pacific Islanders with 'needed' proteins (e.g Baker, 1988; Watson and Heslinga, 1988). It has been shown in Tacconi and Tisdell (1992) that, at the aggregate level, in Fiji and Western Samoa the contribution of giant clam meat to the local diet is very

marginal. From qualitative information obtained during fieldwork it appears that traditionally clam meat has been a: 1) 'ritual' food consumed on special occasions such as village festivities; and 2) a delicacy consumed at most once or twice a week in limited quantities. The marginal relevance of clams in the local diet has also been observed in Wallis Island by Pollock (1991).

Vuki et al. (1991a; 1991b) reported that in the Lau group, Fiji, villagers appeared to be particularly interested in giant clam farming as a source of income. Growing giant clam for food would present a relatively high opportunity cost in terms of cash and labour foregone.

In Fiji, each clam seed is expected to cost between 50 cents<sup>1</sup> and F\$1.00. If a villager buys 600 clam seeds (*T. derasa*) for F\$300-600 to produce food, this capital outlay would represent a major investment item by a household if we consider the average capitalization of a Fijian household as measured by Veitayaki (1990) in the village of Qoma (Qoma Island): House F\$945, houseware F\$421, boat F\$448, outboard engine F\$660, fishing gear F\$130, farm tools F\$44.

Obviously, this measure of household capitalization is only indicative and it cannot be extended to the rest of Fiji, but it points to the fact that investing even in a small giant clam project might be a major expenditure and the implications should be carefully considered.

The importance of risk in household decision-making is often underestimated but it plays an important role (e.g. Eder, 1991; Byerlee, 1991). It is arguable if a household, with low capitalization, would be willing to make a substantial capital investment in a still risky enterprise such as clam farming, and this not to earn cash but to 'grow' food. Note, that even if the investment in giant clam farming might not be a major capital outlay for a family, the risk involved in giant clam farming (e.g. diseases, predators, theft) should be always accounted for and compared with that of alternative sources of food. At the present state of knowledge, it would be quite hazardous to advance any conclusion, but it can be said that a new enterprise usually presents a degree of risk and uncertainty higher than those of already established activities such as, in this case, traditional fishing activities.

It should be noted that risk will also influence the adoption of clam farming as a commercial activity. Even if villagers may appear to be interested in clam farming in order to increase

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<sup>1</sup> Exchange rate at the time of fieldwork: F\$/A\$ = 0.9

their income (Vuki et al. 1991a, 1991b), the uncertainty about future market prospects will influence the (rate of) adoption of clam farming.

The cost of giant clam meat for own consumption can be approximately determined as follows. Without considering labour costs and other operating costs<sup>2</sup> the cost of clam meat could be expected to be about F\$2.44/kg (F\$4.88/kg if the price for seeds is F\$1). The cost is derived under the following assumption. The biological parameters are those adopted in Table 1 - Case 1 (i.e. meat weight after 5 years is 198.2kg) and they represent the 'optimistic case'. An interest rate of 10% is used as a measure of the opportunity cost of the capital invested. Thus, we can derive the cost per kilogram for an initial outlay of F\$300 as:

$$\text{F\$ per kg} = 300(1 + 0.1)^5 / 198.2 = 2.44$$

Data on prices of fish and shellfish at the village level are not available and a direct comparison with the prices just derived is not possible. However, it is indicative that the price of fish in municipal markets in Fiji varied in 1990 between a maximum of F\$4.09/kg in Nausori and a minimum of F\$2.52/kg in Labasa (Fiji Fisheries Division, 1990). These prices of course, include transport costs and margins retained by traders. For shellfish, it was calculated by Tacconi and Tisdell (1992) that the flesh price of kai (*Batissa violacea*) at the municipal market in Suva was F\$2.50/kg. Therefore, it may be reasonably expected that the prices for fish and shellfish at the village level would be lower than those at the municipal markets. Thus the price of giant clam meat just derived can be assumed to be higher than other available alternative fish food.

It would be erroneous to consider villages as homogeneous communities. Inequality in income distribution is the norm (Hill, 1986). Income affects expenditures on food. With regard to the Pacific, Shaw (1983) subdivided rural people into two groups: those with 'low cash incomes' and those with 'moderate cash incomes'. Those in the low income groups depend on subsistence food whereas those in the moderate income group purchase part of their food. On this basis, if giant clam farming is adopted at all as a 'subsistence' activity, it would be probably adopted by those villagers who can afford to pay for their food (i.e. those who can afford the initial capital funds) and are already in a better condition as far as food security is concerned.

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<sup>2</sup> See Section 3 for a more detailed discussion of these costs.



A further look at households' strategies is instructive. Veitayaki (1990) reports that fisherfolk consume unsold fish or fish of lower commercial value in order to maximize returns from fishing activities. Similar strategies, with specific reference to giant clams, were observed in the course of fieldwork in Tonga and Western Samoa. Women and men interviewed stated that they prefer to sell their clam catch rather than using it at home 'because it is a good source of cash'. They do sometimes keep some clams for home consumption, but they are only a limited proportion of the total catch. This tendency to maximize economic returns from clam collection was also evident from the fact that in Tonga fisherfolk tend to use only the smaller clams for home consumption as the big ones can be sold on the market for a higher price.

If the above economic considerations and the livelihood strategies are taken into account, it is apparent that clam farming should be looked at as a commercial activity and not as a subsistence one.

### **3. Economic Returns From Clam Farming**

The Fisheries Division in Fiji is planning to provide one year old *T. derasa* seeds to interested farmers (Ledua pers. comm.). In respect of subtidal farming of *Tridacna derasa*, Vuki et al. (1991b) found that, in the villages surveyed in the Ono-I-Lau group, sixteen out of forty-eight villagers interviewed thought that subtidal farming would be a hindrance to village activities. The species chosen and therefore the method of cultivation, i.e. subtidal or intertidal, is also likely to affect the gender division of labour. Because of their traditional activities, men are more likely to be involved in subtidal farming and women in intertidal farming (Vuki et al. 1991a). A caveat applies. It has been observed in different parts of the world that when a new cash crop is introduced, it is the men that take over that activity irrespective of the traditional division of labour within the family.

The economic returns from giant clam farming have been calculated as follows. The one-year old clams will be kept by the farmer for one year in a protective cage in the ocean and then put in a grow-out location until harvest. The cost of one roll of fence, that makes six cages, is F\$69. Each cage contains 200 clams and is expected to last for two years. If the farmer buys 600 clam seeds, the cost of the cages for one year is \$16.75. The non-subsidized price for these seeds is expected to be between 50 cents and F\$1. Thus, the cost for the seeds would range between F\$300 and F\$600. The Fisheries Division is suggesting that the farmer will

harvest the clams after stocking them for five years (six-year old clams).

The average volume of commercially valuable meat (muscle and mantle) that could be expected from a six-year old *T. derasa* cultured in Fiji is yet not certain, due to the limited number of observations available on cultured clams. Fiji Fisheries Division (1986a) reports of a ratio of adductor muscle to total flesh weight in the range of 15 percent to 20 percent. Hambrey (1991) considers that ratio to be in the order of 14 percent. Watson and Heslinga (1988) report a ratio of muscle to 'all other soft parts' of 15.3 percent for a six-year old *T. derasa*. For the following analysis we shall employ the data from Watson and Heslinga (1988) as it is the only study available that documents exactly the data for six-year old *Tridacna derasa*. The adoption of this data probably implies an overestimate of growth rates in Fiji, due to the fact that Palau, where Watson and Heslinga conducted their research, seems to have more favourable environmental conditions for *Tridacna derasa* farming than Fiji.

It is assumed that a six-year old *T. derasa* will yield 81g of muscle and 485g of 'other soft tissues'. The latter weight is derived as: 535g as from Watson and Heslinga (1988) less 50g of kidney as from Fisheries Division (1986b). Alternative post-harvest drip-weight losses from soft tissues of 5 percent and 40 percent are considered. Hambrey (1991) suggests a post-harvest drip loss of up to 50% and this appears to be confirmed by practical experience at 'Reefarm', a commercial maricultural activity on Fitzroy Island, North Queensland, Australia (Barker, pers. comm.). The mortality rate is taken to be 25 percent during the first year and alternatively 5 percent and 10 percent in the following years (Ledua, pers. comm.).

In the following calculation labour costs or eventual other operating costs are not considered. This is not because it is assumed that there is a freely available surplus labour, but because the amount of labour requirements and other costs are considered (by the Fisheries Division) to be extremely limited. If this assumption is proved to be incorrect, a revised analysis accounting for the exact costs should be carried out. Notice, however, that allowance for such costs can only lower returns.

The farm-gate prices adopted for the analysis are based on the prices observed on the Fijian giant clam market. For adductor muscle, the prices adopted are F\$10/kg, F\$7/kg and F\$5/kg. This price range should accommodate not only for variation in the purchase price paid for by exporters and retailers, but also for transport costs. The same apply to the price range for 'other soft tissues' that is set at F\$2/kg and F\$3/kg.

The variables considered and that have a considerable impact on the profitability of clam farming are: 1) the price of clam seeds, 2) the price of the output, 3) the post-harvest weight drip loss, and 4) mortality rate of clams. Tables 1 and 2 give the alternative rates of return for a range of combinations of the above variables. The results are summarised in Table 3.

At a price of F\$1 per clam seed, a 5% drip-weight loss and for the highest farm-gate price considered in Table 1, the maximum internal rate of return from clam farming is only 5.4 percent. In one case the IRR is 0.9% and it is negative in all other cases considered in Table 1 and 2.

**Table 1: Returns from *T. Derasa* mariculture activity in Fiji (drip loss 5%)**

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**Capital Costs**

Seeds (at F\$1)	600.00	(at F\$0.5)	\$300.00
Cages	<u>16.75</u>		<u>16.75</u>
Total	\$616.75		\$316.75

**Gross Income and Returns after 5 years**

**Case 1**

Mortality rate 25% year 1; 5% subsequent years. Surviving clams (end of 5 years) No 366 (61%)

GROSS INCOME

	Weight (kg)	Muscle F\$10 Other Tissues F\$3	Muscle F\$7 Other tissues F\$2	Muscle F\$5 O/tissues F\$2
Muscle	29.6	296.0	207.2	148.0
Other Tissues	<u>168.6</u>	<u>505.8</u>	<u>337.2</u>	<u>337.2</u>
Total	198.2	801.8	544.4	485.2

IRR

seed @ F\$1	5.4%	negative	negative
seed @ F\$0.5	20.4%	11.5%	8.9%

**Case 2**

Mortality rate 25% year 1; 10% subsequent years. Surviving clams (end of 5 years) No 294 (49%)

GROSS INCOME

	Weight (kg)	Muscle F\$10 Other Tissues F\$3	Muscle F\$7 Other tissues F\$2	Muscle F\$5 O/tissues F\$2
Muscle	23.8	238.0	166.6	119.0
Other Tissues	<u>135.5</u>	<u>406.5</u>	<u>251.0</u>	<u>271.0</u>
Total	159.3	644.5	437.6	390.0

IRR

seed @ F\$1	0.9%	negative	negative
seed @ F\$0.5	15.3%	6.7%	4.2%

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**Table 2: Returns from *T. Derasa* mariculture activity in Fiji (drip loss 40%)**

<b>Capital Costs</b>		
Seeds (at F\$1)	600.00 (at F\$0.5)	\$300.00
Cages	<u>16.75</u>	<u>16.75</u>
Total	\$616.75	\$316.75

**Gross Income and Returns after 5 years**

**Case 1**

Mortality rate 25% year 1; 5% subsequent years. Surviving clams (end of 5 years) No 366 (61%)

**GROSS INCOME**

	Weight (kg)	Muscle F\$10 Other Tissues F\$3	Muscle F\$7 Other tissues F\$2	Muscle F\$5 O/tissues F\$2
Muscle	29.6	296.0	207.2	148.0
Other Tissues	<u>106.5</u>	<u>319.5</u>	<u>213.0</u>	<u>213.0</u>
Total	136.1	615.3	420.2	361.0

**IRR**

seed @ F\$1	negative	negative	negative
seed @ F\$0.5	14.2%	5.8%	2.6%

**Case 2**

Mortality rate 25% year 1; 10% subsequent years. Surviving clams (end of 5 years) No 294 (49%)

**GROSS INCOME**

	Weight (kg)	Muscle F\$10 Other Tissues F\$3	Muscle F\$7 Other tissues F\$2	Muscle F\$5 O/tissues F\$2
Muscle	23.8	238.0	166.6	119.0
Other Tissues	85.6	256.8	171.2	171.2
Total	109.4	494.8	337.8	290.2

**IRR**

seed @ F\$1	0.9%	negative	negative
seed @ F\$0.5	15.3%	6.7%	4.2%

**Table 3: Internal rates of return: summary of Tables 1 and 2**

	Output Price		
	High	Medium	Low
<u>Drip Loss 5%</u>			
Low Mortality			
Seed F\$1 each	5.4	Negative	Negative
Seed F\$0.5 each	20.4	11.5	8.9
High Mortality			
Seed F\$1 each	0.9	Negative	Negative
Seed \$0.5 each	15.3	6.7	4.2
<u>Drip Loss 40%</u>			
Low Mortality			
Seed F\$1 each	Negative	Negative	Negative
Seed F0.5 each	14.2	5.85	2.6
High Mortality			
Seed F\$1 each	0.9	Negative	Negative
Seed \$0.5 each	15.3	6.7	4.2

The picture is more promising if the Fisheries Division can keep the cost of seeds to F\$0.50 each.

With a drip-weight loss of 5% in three cases out of six, the IRR would exceed 10 percent and in one case it would be close to 9 percent. In the most optimistic case, the IRR could exceed 20 percent, about four times the IRR when the seed price is F\$1. A decrease in the price of clam meat from F\$10/kg for the muscle and F\$3/kg for the 'other tissues' to F\$7/kg and F\$2/kg respectively, determines a decrease in the IRR from 20.4 percent to 11.5 percent. A further drop in the price of the muscle (to F\$5/kg) causes a decrease in IRR of over 2 percentage points. Notice that when the adductor muscle is priced at F\$5 and 'other tissues' at F\$2, the IRR is consistently below 10 percent. Shang et al. (1990) observed that the wholesale price for adductor muscle smaller than 100g could be expected to be about US\$7.7/kg (approximately F\$12). If that is correct and handling, packaging and transport costs are accounted for, it could imply a farm-gate price close to F\$5.

In the case of a drip loss of 5 percent, reduction in the mortality rate from 10 percent to 5 percent results in a 5 point percentage increase in IRR.

In the case where a post-harvest drip loss of 40 percent occurs, the IRR exceeds 10 percent only when mortality rates are at the low level and for the most optimistic output price (muscle F\$10 and other tissues F\$3) considered. It is obvious that if a post-harvest drip loss of 40 percent occurs, this would drastically reduce the profitability of clam farming. Reduction in this drip-loss can add significantly to the economic success of clam farming.

From this analysis, it appears that it is a priority to keep the cost of clam seeds to growers low (F\$0.50 each and possibly lower). The extent to which the cost of seeds and on-farm mortality rates are correlated, will determine whether both variables can be substantially improved at the same time.

The price of the adductor muscle can be expected to be largely determined on international markets unless a country can achieve a certain degree of monopoly in the adductor muscle supply. If export taxes exist in exporting countries and they substantially reduce farm-gate prices, a relief from these taxes could be considered in order to promote the industry. To improve the marketing power of producers, co-operatives could be formed or the produce could be sold through already existing marketing co-operatives.

#### **4. Conclusion**

The assumption, adopted by some researchers working on the development of giant clam farming, that villagers in the Pacific might be eager to farm giant clams for their own consumption, does not appear to be supported by present evidence.

There seems not to be much rationale for villagers to invest limited resources in a risky activity such as giant clam farming in order to produce food, because fish is available at less cost and with less financial risk. Empirical evidence on nutrition in the South Pacific suggests that a certain degree of malnutrition (especially of children) is found in Melanesia. Nutritional disorders are mainly related to changes in the diet and not to lack of proteins (Thaman, 1983; Manderson, 1987). This is also confirmed by Bloom (1986), who reports that changes in the diet arising from 'modernisation' are the most important factors at the roots of low nutritional status in Fiji, Solomon Islands, Tonga, Vanuatu and Western Samoa.

Unfortunately most of the empirical evidence refers to urban areas. More village level studies, and for the present purpose coastal village studies, would be useful. However, even if we assume that malnutrition exists in coastal villages, it cannot be asserted that giant clam farming would lessen the problem. First, if malnutrition is due to an insufficient food production, the cost per protein provided by clams should be compared with the cost of other alternative protein sources. It is usually the poorer who face deficient protein intake and the cost of producing proteins is therefore relevant. The second point to be made in respect of malnutrition is that often it is not a 'production problem' but an 'entitlement problem' (Sen, 1981). In other words, food is available but the poor cannot afford it. The solution is to increase their income. In the present case, the economic benefits from giant clam farming should be compared with other alternative income-generating activities appropriate to those in need.

In this respect, it has been noted that villagers themselves appear to be more interested in engaging in income-generating activities than in increasing supplies of food. It is important for project sustainability that both needs and objectives of the beneficiaries are taken into account (Tacconi and Tisdell, forthcoming).

The implications of eventually providing subsidised clam seeds to villagers should be considered. If Fisheries Divisions make clam seeds available free of charge, all interested farmers, regardless of their investment potential, can undertake giant clam farming. One issue is whether this approach is sustainable, that is, whether Fisheries Divisions have enough funds to carry on over time this subsidization. Of course, the funds could be met by foreign aid. However, it should be considered if these funds could be used to generate more profitable activities for the villagers. In other words, the opportunity costs of those funds should be considered.

Fisheries Division could also provide clam seeds at a subsidized price (e.g. 50% of the actual cost). One implication of this approach, apart from the issues raised above, is that it could accentuate inequalities at the village level, if only better off villagers can afford to pay the subsidised price.

The present analysis has been made without considering production risk factors such as cyclones or extremely high mortality rates of clams due to predators. It is difficult to assess these factors at the present stage but, as already emphasised about risk, they will influence



villagers' adoption of giant clam farming.

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## **APPENDIX**

### Persons met during fieldwork

#### **FIJI**

Tim Adams	Acting Director, Fisheries Division
Esaroma Ledua	Fisheries Officer, Fisheries Division
Subodh Sharma	Fisheries Officer, Fisheries Division
Hamidan Bibi	Senior Fisheries Assistant, Fisheries Division
Jone Sogovale	Senior Fisheries Assistant, Fisheries Division
Apisai Sesewa	Senior Fisheries Assistant, Fisheries Division
Johnson Seeto	Director, Marine Institute, University of the South Pacific
Robert Gillet	Project Manager, UNDP

#### **TONGA**

Sione Mangisi	Director, Ministry of Fisheries
Taniela Koloa	Principal Fisheries Officer, Ministry of Fisheries
Ulunga Fa'anunu	Head of Aquaculture, Ministry of Fisheries
Naita Manu	Giant Clam Project Leader, Ministry of Fisheries
Tupou Tupou	Fisheries Assistant, Ministry of Fisheries

#### **WESTERN SAMOA**

Ueta Fa'asili	Chief Fisheries Officer, Fisheries Division
Leon Zann	Fisheries Resources Advisor, FAO/UNDP
Dan Su'a	Senior Marine Biologist, Fisheries Division
Ameto Kalolo	Fisheries Assistant, Fisheries Division

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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.
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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.
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10. "Assessing Species for Mariculture in Developing Countries: A Review of Economic Considerations." Carunia Firdausy and Clem Tisdell, April, 1990.
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