Fishing for fortunes? A socio-economic assessment of Tonga's artisanal fisheries

Mecki Kronen*

*Community Fisheries Scientist, Reef Fisheries Observatory, Secretariat of the Pacific Community, B.P. D5,
98848 Noumea Cedex, New Caledonia*

Received 9 July 2003; received in revised form 9 April 2004; accepted 12 May 2004

Abstract

Societies in the South Pacific are undergoing transition from reciprocity exchange and direct sustenance systems into cash based economies. The Kingdom of Tonga was selected to represent this socio-economic change. In this context, the economic viability of Tonga's subsistence and small-scale artisanal fisheries and marketing of reef and lagoon fish is assessed.

Case studies were selected to represent three major geographical regions (Ha'apai, Vava'u, Tongatapu) and four major fisher groups (simple to very specialised and multi-gear fishing systems combined with cost of motorised boat transport, operational cost and fish market price). Marketing systems included operations of agents, middleman and shop owners. Economic assessment was performed by employing net present value (NPV) to explain the logic and to valorise fisheries and marketing systems against net revenues from employment and traditional agricultural production schemes.

This paper also illustrates the limitations of conventional economic analysis. While NPV proved to be a useful instrument to compare fisheries and alternative sources of income, it failed to assess social and traditional values that determine the rather non-economical and non-rational subsistence and small-scale fisheries systems in the Tongan and South Pacific context.

The conflict between applying mainly non-valorisation of societal and traditional values rather than underlying normal market behaviour rendered most fishing operations economically not viable or less attractive than agricultural production schemes and salaries from low skilled labour. Under these conditions, most Tongan fisheries do not reach the following suite of parameters required to make an operation economically attractive: minimum catch volume of 90–100 kg/week, a catch per unit effort of ≥ 5.8 kg/h, lowest possible operational cost and easy access to market selling prices of ≥ 5 TOP/kg fish. It was found that productivity increases from spear fishing to handline and multi-gear fishing.

Among small-scale fish marketing strategies, selling fish as a complementary activity to normal shop operations seems to be more lucrative than using agents and middlemen.

* Tel.: +687 26 09 58; fax: +687 26 38 18.

E-mail address: meckik@spc.int.

Discussions focus on explaining the rationale of Tongan fishers by extending arguments beyond the economic and rationale framework. Major economic parameters such as labour and time are not accounted for in the traditional social environment. It is further argued that social considerations are impediments to economic rationale as they do not aim at catch maximisation, risk minimisation and innovation principles but the need to satisfy subsistence, social obligations and networking for societal resilience and insurance.

© 2004 Elsevier B.V. All rights reserved.

Keywords: Economic viability; Small-scale artisanal fisheries; Subsistence fisheries; South Pacific; Tonga

1. Introduction

1.1. Background

Subsistence and artisanal coastal (reef and lagoon) fishing is regarded as one of the most important activities that determine the livelihood of people in the small island communities of the South Pacific (Ruddle et al., 1992; Veitayaki, 1993; Zann and Vuki, 2000). Traditionally, the extent to which these communities are dependent on marine resources is also determined by the availability of cultivable land. More recently, access and availability of alternative income sources in the secondary and tertiary sectors, which are due to a favourable institutional environment (Allison and Ellis, 2001) have become additional factors that determine the social and economic roles of coastal fishing.

Despite all past and recent changes, government policies and projects continue to focus on improving and upgrading coastal fisheries activities. Emphasis is given to interventions believed to foster commercial coastal fisheries, such as the provision of subsidised loans for boat and fishing equipment, and the installation of ice plants and market outlets. The development of appropriate and thus effective policies and projects requires knowledge of the resource, as well as fishing and marketing systems, both of which are in most cases not sufficiently known (Gillet and Lightfoot, 2001). Economic tools are usually employed to determine viability of fishing and marketing operations, and to identify constraining factors. Such analyses are based on principles of rationale economic behaviour, capital, labour and time as major input components. These principles, however, do not account for traditional non-rationale social values. Conventional economic analysis may therefore be limited to extend our understanding of the economic and socio-cultural structures and conditions associated with artisanal fisheries (Gustavson, 2002).

This paper is based on research undertaken in the Kingdom of Tonga¹ and addresses the question whether or not artisanal coastal fisheries and marketing represent lucrative sources of income. It also aims at determining factors and conditions that make artisanal coastal fisheries and its marketing economically viable. The results are considered as an essential foundation on which to argue for or against future economic investments in this sector.

1.2. Artisanal coastal fishing in Tonga

Historically, coastal fisheries determined the livelihood of Tongan people (Poulsen, 1977; Kirch and Dye, 1979). Similar to other countries in the South Pacific, the socio-economic role of fishing has substantially changed in the Polynesian society of the Kingdom of Tonga. Until the end of the 19th century fishers had a higher social status than farmers (Martin, 1817; Bataille-Benguigui, 1989). However, development of village structures, and missionary influences favoured agricultural production and as a result, determined the social decline of Tongan fishers (Bataille-Benguigui, 1988, 1992). Therefore, it is not surprising that the commencement of serious monetarisation in the early 1950s is linked to agricultural production, i.e. rise of copra prices.

The deterioration of fisher's general social status may further limit the future of small-scale artisanal fisheries in Tonga as preference is increasingly given to alternative and financially more attractive income sources such as maritime fisheries, agriculture and other sectors (Kronen, 2002).

¹ Research was undertaken in the framework of the 2-year De-mEcoFish project. The project is funded by MacArthur Foundation and implemented by the Secretariat of the Pacific Community's (SPC) Reef Fisheries Observatory in collaboration with Institut de Recherche pour le Développement (IRD).

In general, Tonga's reef and lagoon subsistence and small-scale artisanal fisheries are best characterised as hand-operated, multi-gear, and multi-species. Fishing is mostly restricted to nearby coastal areas and, as in other South Pacific island communities, involves little entrepreneurial skill, small informal groups, small fishing vessels, low capital investment, and correspondingly low productivity (Sabri, 1977; Veitayaki, 1993; Tu'avao et al., 1994; Passfield, 2001). However, within this overall picture, various fisher groups can be distinguished. Ownership or use of non-motorised or motorised boat transport is one important factor that determines access and choice of fishing grounds. Availability and use of different fishing gear is another major distinguishing parameter. Ice may be used during fishing trips, and bait may — or may not — be commercially acquired. Although social and gender roles have been redefined to permit a wider participation of women in village fishing activities, Tongan fisher women still focus on shallow waters close to shore and mainly fish without using canoes or motorised boats (Kronen, 2002). As a result, Tongan fin fishing continues to be dominated by men.

Similarly, the Tongan informal sector of marketing reef and lagoon fishes is predominantly determined by male players. According to its informal character, there are no official records by producers, agents and merchants on quantities, qualities, costs and prices of products and services, and general information on coastal fishery and market survey data is scarce. Based on experience from the study presented here, marketing systems seem to have evolved as a result of regional needs, capabilities and degree of urbanisation. Prices for reef and lagoon fish differ markedly between the outer islands and rural Tongatapu on one hand, and markets in Tonga's capital Nuku'alofa, on the other hand.

2. Methods

2.1. Data collection

Tongan reef fisheries are defined as subsistence or small-scale commercially oriented artisanal activities that target only species found in reef and lagoon locations. The sampling strategy aimed at capturing Tonga's subsistence and small-scale artisanal fishery systems by representing the most important coastal reef

and lagoon fishing grounds, the varying degree of urbanisation, geographical isolation and market access.

Accordingly, field surveys were conducted in three major regions, namely the Vava'u and Ha'apai island groups and the main island of Tongatapu. Two coastal communities, one representing the more traditional, the other the more urbanised societies in each region, were selected (Fig. 1). The degree of geographical isolation and distance from the next urban centre were employed as proxies for community selection. In a snapshot approach closed questionnaires were used to collect quantitative and complementary qualitative data on fishing and marketing activities. In each village between 49 and 104 fishers (50–90% of the adult population ≥ 15 years) including all "serious" fishers were interviewed. The term "serious" fisher was coined for persons who are considered by the community to fish more frequently and more successfully and are more commercially oriented than the average village fisher person.

The marketing system in each region was explored by interviewing agents, middlemen, and shop owners.

2.2. Fishing system groups

There is no clear distinction between commercial and subsistence coastal fisheries. Fishers are distinguished by their strategy rather than by their status. The sample of this study exposed four different fisher groups. Economic assessments for each of these four fisher groups are based on a number of selected case studies. Major characteristics of each group, and variables for case studies selected are summarised in Table 1.

Viability of marketing systems is tested using case studies that include agents and middlemen operating on Ha'apai (Koulo, Holopeka and Lofanga), and shop owners of Mataika village in Vava'u. Shop owners in the main settlement of Neiafu on Vava'u and middlemen operating at Tongatapu's two major fish markets (Faua and Vuna markets in Nuku'alofa) were not considered as their operations depended to a great extent on fishers not included in this survey (Tulua and Udagawa, 1994).

2.3. Net present value (NPV)

Net present value calculation was selected as it allows a comparison of the wide range of different

Fig. 1. Location of Tongan communities and regions surveyed.

Table 1

Major characteristics of four Tonga fishery systems groups

	Group I (simple coastal fishery system)	Group II (single-to multi-gear)	Group III (exclusive spear fishers)	Group IV (single- to multi-gear fishery systems with market choice)
Type of fishing	Simple	Variable	Specialised	Choice of markets
Boat transport	No, rarely or non-motorised	Owner and/or regular user of motorised	Always using rented motorised	Owner and/or regular user of motorised
Purchase of ice	No	Yes/no	Yes	Yes/no
Purchase of bait	No	Yes/no	No	Yes/no
Fishing gear	Restricted, mainly handline	Exclusive handline or multi-gear	Exclusive night time spear diving	Single- to multi-gear
Productivity CPUE kg	Low ≤ 3	Variable from ≥ 3.3 to mostly ≥ 6	Low 2.8	Variable from ≥ 3.3 to mostly ≥ 6
Average catch/trip kg	10–12	20–60	25	35–50
Total catch/week kg	40–50	60–180	75	105–160
Total hours fished/week	16–20	8–24	27	18–48
Major variables	Low investment, low productivity	Catch variation, compensation for motorised boat transport	High input cost prior to catches sold	Significant price variations according to markets served

Table 2
Fishing cost (TOP^a) for net present value calculations

Item	Description	TOP ^a	Lifespan (months)
Boats			
Canoe	Wooden	250	48
Motorised	30 ft, wooden, cabin, inboard engine included	40000	120+
Motorised	14 ft, wooden, open hull	2500	60+
Motorised	14 ft, wooden, 1/2 cabin	3000	60+
Motorised	16 ft, wooden, 1/2 cabin	3500	60+
Outboard engines			
15 HP Yamaha	Tongatapu/Vava'u	3962	60+
25 HP Yamaha	Tongatapu/Vava'u	4742	60+
30 HP Yamaha	Tongatapu/Vava'u	6511	60+
40 HP Yamaha	Tongatapu/Vava'u	8280	60+
60 HP Yamaha	Tongatapu/Vava'u	10498	60+
Maintenance			
Motorised boats	As indicated by owners	300–400	12
Outboard engines	As indicated by owners	50–200	12
Fishing gear			
Gillnet	Complete, 2–3 in.	378	60
	Maintenance	100	12
Castnet		126	12
Handline	Each (average weight strength)	0.36	0.25
Hooks	Assorted sizes	2.58	0.25
Spear gun	Complete elastic type including spares for 1 year	171	24
	Maintenance	86	12
Dive gear (night spear diving)	Mask, snorkel, torch, flipper	269	12
Ice box	Medium seize (238 qt)	415	60
Operational			
Fuel (oil included) (l ⁻¹)		1.2852	n.a.
Boat transport (trip ⁻¹ /person)	Flat rate occasionally paid by users to boat owners	20	n.a.
Ice (trip ⁻¹)	As indicated by user	5–10	n.a.
Batteries (trip ⁻¹)	Torch night diving	8	n.a.
Bait (kg ⁻¹)	“Japanese bait” Alatini	6	n.a.
Labour (h ⁻¹)	Average fishing trip duration in hours + transport time to/from regional market where applicable	4	n.a.

^a TOP: Tonga Pa'anga; exchange rate 1 TOP = US\$ 0.4916, 15 March 2002.

income and marketing strategy systems in Tonga. This economic procedure calculates the present net value of an investment, using a discount rate (interest rate), and a series of future payments (cost) and incomes (revenue) over a given time period.

All calculations are based on the following formulae:

$$NPV = \sum_{i=1}^n \frac{\text{values}^i}{(1 + \text{rate})^i}$$

where n is the number of cash flows in the list of values and rate the rate of discount over the length of one period.

For the economic analysis of fishing systems, catch is valued according to local market price. All costs are expressed in Tongan Pa'anga (1 TOP = US\$ 0.4916) and an interest rate of 14% (Tongan Development Bank, rate 2002) applies.

Assessment of economic viability of fishery and marketing systems is based on a comparison with alternative income sources. Simple, risk free paid employment and net income from mixed crop production were the alternatives selected. NPV for the four fisheries were calculated taking into account major investment, maintenance and operational cost listed in Table 2. Revenues were assumed by setting the

Table 3

Average fish selling prices (TOP^a)

Region	Village	Location/agent	Range (TOP/kg)	Price applied (TOP/kg)
Ha'apai	Lofanga	Middleman	1.80–2.30	2.05
Ha'apai	Pangai	Roadside	3.00	3.00
Ha'apai	Pangai, Holopeka	Agent(s)	2.00–2.50	2.25
Ha'apai	Pangai	Mixed	2.25–3.00	2.65
Ha'apai	Pangai	Lobster	n.a.	8.00
Vava'u	Mataika	Shops	2.50–3.00	2.75
Tongatapu	Manuka	Community	1.25–2.50	1.90
Tongatapu	Ha'atafu	Community	1.25–2.50	1.90
Tongatapu	Nuku'alofa	Markets	4.00–6.00	5.00

^a TOP: Tonga Pa'anga; exchange rate 1 TOP = US\$ 0.4916, 15 March 2002.

value of total catch equivalent to the average local or regional market price (Table 3). NPV calculations of marketing systems are based on the assumptions of cost and revenues set out in Table 4.

Paid employment NPV is based on a 30 h working week, i.e. 5 days × 6 working hours. The minimum wage paid in Tonga in 2002 of TOP 4.00 per hour has been compared to above average wages of TOP 6.00 and 8.00 per hour which reflect the fact that fishing requires certain levels of skill and knowledge.

For purposes of comparison net revenues of traditional mixed crop production schemes are based on establishment, operational, harvesting and processing

cost, as well as revenues listed in Table 5. Schemes involve a 4-year cycle of intercropped kava, taro and yams, followed in the fifth and last year by cassava cultivation only. Production of unprocessed and processed kava as the main cash crop are compared. Ascribing cost of land is unnecessary as each Tongan male is entitled to receive ~8 acres of arable land reaching his 16th birthday (Kataoka and Ishimura, 1989). Although land shortages may render this system not always applicable for youngest generations, most rural Tongan households still have access to ≥4 acres of arable land because land once allocated may remain within the direct family line.

Table 4

Cost and revenues (TOP^a) for fish marketing agents, middleman and shop owners

Item	Comments	Unit	Factor applied for shop owners
Investment costs			
Freezer		1200 TOP	×0.25
Boat and engine	Applies only to Lofanga based middleman	Refer to Table 3	
Operational costs			
Electricity	As paid for by individual	12 TOP/week	×0.25 (3.2–4.7 TOP/week)
Transport	As paid for by individual	10 TOP/week	n.a.
Boat and engine maintenance	Applies only to Lofanga based middleman	Refer to Table 3	
Ice	As paid for by individual	27–100 TOP/week	n.a.
Wage	Only paid for Lofanga middleman	40 TOP/week	n.a.
Fuel and ice	Only paid for boat transfer of Lofanga middleman	65 TOP/week	n.a.
Working hours	Scenario a	30 h/week × 4 TOP/h	6 h/week × 4 TOP/h
	Scenario b	36 h/week × 4 TOP/h	
Revenues			
Profit margin		0.50 TOP/kg	0.40–0.50 TOP/kg

^a TOP: Tonga Pa'anga; exchange rate 1 TOP = US\$ 0.4916, 15 March 2002.

Table 5
Cost and revenues (TOP^a) of agricultural mixed cropping scheme

Item	TOP/acre
Establishment cost	
Kava	2000
Yams and taro	2000
Cassava	200
Harvesting cost	
Kava	375
Yams and taro	375
Cassava	150
Processing cost	
Kava level I	375
Kava level II	2000
Operational cost	
Weeding (each for year 1–4)	900
Weeding (year 5 cassava only)	150
Revenues	
Taro	3750
Yams	5000
Cassava	1645
Kava unprocessed	12000
Kava processed	31645

^a TOP: Tonga Pa'anga; exchange rate 1 TOP = US\$ 0.4916, 15 March 2002.

3. Results

3.1. Fishery systems

Economic assessment of Tongan subsistence and small-scale artisanal fisheries and marketing systems shows a great variability. Hourly NPVs for case

studies in any of the four fishery groups range from 0.34 to 15.96 excluding labour costs (Table 6a), and from –3.78 to 13.22 when labour costs are included (Table 6b).

The artisanal fisheries represents a small-scale economy, and in simple economic systems the fishery and marketing systems are vulnerable to production costs and prices. Labour costs (time spent fishing and transporting the catch to the regional markets), transport costs, productivity (CPUE equalling total volume caught per time unit) and the market price for the catch determine economic viability of production and marketing systems.

Table 6a and b shows how sensitive net revenues from artisanal fisheries are to labour costs alone. For example, simple coastal fishery systems represented in group I with low productivity (CPUE ≤ 3 kg/h) and low catch volumes (≤ 50 kg/week) cannot offset labour costs. Similarly, productivity is too low (CPUE 2.8 kg/h) amongst spear fishers in group III to yield revenues which exceed labour and input costs. Spear fishers have high input costs as they need to rent all means of transport commercially. The imbalance between revenue and cost does not change if lobsters, a comparatively high value product, are added to the usual finfish catch.

Net returns for groups II and IV show highest variability. Both groups represent single or multi-geared fishery systems with motorised boat transport and, for fishers in group IV choice of markets. Cost of boat services combined with a higher number of fishing gears used (≥ 2 techniques) were found to influence the

Table 6
NPV (in TOP^a) calculated for fishing systems groups I–IV

	Group I (simple coastal fishery systems)	Group II (single-to multi-geared motorised boat owners/users)	Group III (exclusive spear fishers with rented transport)	Group IV (single-to multi-geared motorised boat owners/users with market choice)
(a) Labour cost excluded				
Median NPV/h	3.46	6.94	2.64	7.71
Minimum NPV/h	2.97	2.64	1.35	0.34
Maximum NPV/h	4.27	15.96	3.93	15.17
(b) Labour cost included				
Median NPV/h	0.32	4.19	–0.49	4.69
Minimum NPV/h	0.23	–0.11	–1.81	–3.78
Maximum NPV/h	1.52	13.22	0.84	13.12

^a TOP: Tonga Pa'anga; exchange rate 1 TOP = US\$ 0.4916, 15 March 2002.

Table 7
Selected case studies of fishers group IV with market choice

Fisher	Selling at	NPV (TOP ^a /h) labour included
Lofanga–Ha'apai	Lofanga (middleman)	3.96
Lofanga–Ha'apai	Pangai (Ha'atafu main island)	4.62
Ha'atafu–Tongatapu	Ha'atafu village	4.76
Ha'atafu–Tongatapu	Nuku'alofa	13.12

^a TOP: Tonga Pa'anga; exchange rate 1 TOP = US\$ 0.4916, 15 March 2002.

viability of the fishery system. Fishers in group II who receive payment for boat services to accompanying fishers, or who do not pay for any boat services used tend to make the most competitive net incomes (NPV of >4.19–13.22 TOP/h). Fishery systems with a productivity and catch volume exceeding 6 kg/h and 95 kg/week, respectively, are no longer sensitive to costs of ice and bait.

The strategies of fishers in group IV are similar to those in group II. However, access to Nuku'alofa's markets where selling prices are doubled result in the overall highest net returns (13.12 TOP/h) for highly productive fishery systems (CPUE ≥ 5.8 kg/h, catch volume ≥ 105 kg/week) (Table 7). When catches from the same fishery systems are sold within the village at a social rate far below market price, economic rentability is reduced to the lowest scale (NPV 4.76 TOP/h).

Analysis of fishers in group IV highlights that the cost–benefit ratio determines the choice of markets. Additional fuel and labour costs needed by the isolated small island fishers of Lofanga are insufficiently compensated by higher selling prices (additional

0.50 TOP/kg fresh fish) at the Pangai market on Ha'apai's main island (Table 7).

3.2. Marketing systems

Similarly, the range of net returns calculated for the various marketing systems varies significantly from 1.04 to 10.93 TOP/h (Table 8). Again, a small-scale economy also characterises the marketing systems. Differences in hourly NPV are mainly explained by market volume, operational cost and profit margins involved.

Both Ha'apai agents turn over a similar volume of reef and lagoon fish. The additional costs (wages, fuel and ice) of the Holopeka based agent for his middleman operations at Lofanga reduce his NPV rates by $\sim 8\%$ compared with the Koulo agent.

Mataika village shop owners handle fish sales as a complementary activity to their usual shop operations. Total annual volume of reef and lagoon fish and the profit margin determine NPV added by fish sales only. By comparing the scenarios of shop owner I to the other three shop owners, it can be shown that a weekly minimum volume is required to render the income levels economically attractive. A 20% reduction of profit margins reduce hourly net revenues substantially as illustrated by comparing Mataika shop owner II with shop owner IV (Table 8).

There is a marked difference between agents, middleman and shop owners. Both Ha'apai agents are entirely dependent on this income source. The middleman at Lofanga is also an acknowledged fisher and boat owner. All of the four shop owners at Mataika make their living with or without adding fish sales to their

Table 8
Hourly NPV of small-scale artisanal reef and lagoon fisheries marketing

	Boat investment and maintenance	Operational costs	Labour (total hs/5 years)	Fish volume (kg/week) ^b	Profit margin (TOP/kg)	NPV/h (TOP)
Middleman Lofanga	Motorised	No	3600	n.a.	n.a. (salary)	1.04
Agent at Koulo	No	Ice, freezer box	7200	900	0.50	5.96
Agent at Holopeka ^a	No	Ice, freezer, electricity, wages	7200	900	0.50	5.50
Shop owner I Mataika	No	Freezer, electricity	1200	40	0.50	1.60
Shop owner II Mataika	No	Freezer, electricity	1200	120	0.40	4.85
Shop owner III Mataika	No	Freezer, electricity	1200	210	0.50	10.93
Shop owner IV Mataika	No	Freezer, electricity	1200	120	0.50	6.18

^a The agent at Holopeka maintains the middleman services at Lofanga, hence pays his wages and cost for ice and fuel.

^b Total fish volume marketed is based on an effective 40 weeks/year working and hence catch basis.

Table 9
Hourly NPV (TOP^a) for wages obtained during a 5-year period

Scenario	Wage/h	Hours/week	Hours/year	NPV/h
a	4.00	30	1200	2.75
b	6.00	30	1200	4.12
c	8.00	30	1200	5.49

^a TOP: Tonga Pa'anga; exchange rate 1 TOP = US\$ 0.4916, 15 March 2002.

operations. However, from an economic viewpoint it is important to highlight that shop owners who turn over an additional 150 kg of fish per week will add more net return to their business than either of the two agents. In economic terms, NPV calculations show that the presence of a middleman makes no sense if returns fail to compensate for the added costs. For the middleman at Lofanga low net revenues from marketing fish may help to raise his income from fishing above the average village income. Also, his marketing does not include any risk taking as he is paid a wage and his operational costs are covered.

3.3. Alternative forms of employment

To put net revenues achievable from fishery and marketing systems into perspective, alternative income sources are examined. Firstly, the risk free net revenues obtainable from unskilled waged labour are presented in Table 9. Taking into account the fact that fishing requires a certain amount of skill and expertise, an NPV based on a wage of 6 TOP/h (scenario b) is used as a threshold to determine the economic viability of fishery and marketing systems. Accordingly, all fishers falling into groups I and III (simple coastal fishery systems and spear fishers) are clearly not economically viable.

Some fishers in groups II (single- to multi-gear, motorised boat owner/user) and IV (single- to

multi-gear, motorised boat owner/user and market choice) operate at least on equal if not better terms when compared to wage based net income. Those fishery systems that range slightly over the threshold set at NPV of 4.12 TOP/h (see Table 9, scenario b) receive additional revenues from transport services with little or no additional fuel costs, and also enjoying a high productivity (CPUE ≥ 6 kg/h).

Those in group II who enjoy incomes higher as from wage labour include the motorised boat owners who are fully compensated for any transport services rendered. In group IV all fishers who sell their catch for the highest price in Nuku'alofa's markets regardless of whether boat transport is compensated or not, exceed the level of returns from wage labour. Moreover, marketing systems, except for the Lofanga middleman and Mataika shop owner I, add a net return above the threshold set by wage paid labour (Table 8).

Over the 5-year mixed cropping cycle, the NPV of 4 acres with unprocessed and processed kava as major cash output, range from 30 612 to 67 269 TOP (Table 10). Comparison between the NPV of agricultural production and fisheries and marketing systems reveal only two categories, one each in groups II and IV, where fishery systems render higher net returns. Both include highly productive fishers and motorised boat owners who are compensated for transport services rendered (CPUE 7.5 kg/h). In group IV these fishers also sell catch at highest price level, i.e. Nuku'alofa's market. Additionally, both Ha'apai based agents achieve competitive NPV rates (Table 10).

A major difference between the agricultural and fisheries systems is that net revenues for both kava production schemes do not include any significant labour input on the part of the land owner but only for contracted labour, whereas most fishery and marketing systems involve substantial labour inputs from the operator.

Table 10
Comparison of net revenues (TOP^a) from agricultural production schemes, salaries and fishery and marketing systems

NPV (TOP ^a /year)	Agriculture	Wage labour	Fishery systems			
			Group I	Group II	Group III	Group IV
Median	48941	24718	829	11471	5150	21093
Minimum	30612	16479	728	–388	–8701	–24196
Maximum	67269	32958	6097	63447	4022	74049

^a TOP: Tonga Pa'anga; exchange rate 1 TOP = US\$ 0.4916, 15 March 2002.

Fig. 2. Comparison of annual NPV (median values) in TOP from different income sources.

3.4. Summary

From an economic viewpoint three major conclusions can be drawn (Fig. 2). Firstly, agricultural production with processed kava as the main cash crop output renders highest net revenues. Compared to fisheries it requires access to at least four acres of arable land, considerable financial investment (labour, seeds, fertiliser), relatively long-term planning, organisation and management of hired labour but little or no labour input from the owner. Secondly, net revenues achievable on the basis of low skilled wage labour are a more realistic and attractive alternative to a number of subsistence and small-scale fishery systems. Thirdly, as far as small-scale fish marketing strategies are concerned, low risk operations involving a complementary activity to an established shop business, is the most viable option. Furthermore, rentability of such an operation is likely to be higher than most of the fishery systems analysed. By comparison with marketing, fishing systems tend to include a great number of risks — weather dependency and exposure to natural disasters (cyclones, etc.) — together with comparatively high costs of investment, maintenance and repair.

Furthermore, the results suggest a number of thresholds for achieving an economically viable fishery system: a minimum catch volume of 90–100 kg/week, a catch per unit effort of ≥ 5.8 kg/h, the lowest possible operational cost and easy access to markets where selling prices of fish reach ≥ 5 TOP/kg. Handlining

complemented by another technique, is most likely to meet the requirement for higher productivity while spear fishing is comparatively low in productivity and is unlikely to achieve economic viability.

Fishing systems in general have the potential for a high rate of return, are expandable and may also be progressive, but most of the Tongan subsistence and small-scale artisanal fishers were not found to behave accordingly, and thus fall short of achieving competitive economic returns.

4. Discussion

The foregoing analysis prompts the question as to why Tongan rural people continue to fish even though in many cases it is economically not viable or at least less attractive than alternative sources of income?

Unlike western economic systems, the social conditions governing production and thus fisheries in Tonga are not usually those of a capitalist system (Halapua, 1982). Although Tongan life is increasingly developing into a cash based economy, traditional attitudes and values towards production in general, continue to shape socio-economic behaviour and performance. Accordingly, Tongan coastal fishery and marketing largely follow the traditional social rather than a profit-seeking private enterprise controlled organisation and distribution system. The objectives of coastal fishing operations generally do not prioritise catch maximisation, risk minimisation, competition and innovation principles but reflect the need to satisfy subsistence, social obligations and the choice of fishing as a form of lifestyle and part of traditional livelihood and social institutions (Iwariki and Ram, 1984). Thus, an economic tool such as NPV is not sufficient to explain the nature of fishery systems in Tonga, as it fails to accommodate the social and cultural factors underlying the modes of economic operations.

A predominant traditional value system also complicates attempts at cost-benefit analysis. Labour and time are not considered important production factors. Approaches that seek to minimise the time and effort in the fishery are not aimed at cutting costs and maximising output but at maximising non-productive time — relaxation and social interaction — to the extent that even subsistence needs may not be sufficiently

met by the individual but may have to be provided by the community's social network.

The community's social network is a result of two major Tongan principles. "*Manumanu*" (Halapua, 1982) imposes social barriers to the adoption of innovation or additional efforts aimed at material benefits. "*Fetokoni'aki*" (sharing) is considered an effective informal social insurance and welfare system (Bender, unpublished; Bender et al., 2002). In more recent times, this system has progressed to encompass not only the sharing of food, including fish, but all kinds of goods and money-matters. Thus, within a system that restrains incentives for increased efforts and gain-maximising strategies, it is still deemed prestigious to reach a level of productivity that allows sharing and thus raises the social status of the provider (Chakraborty, 2002).

Therefore, a Tongan small-scale fisher does not associate cash with profit but with need and as a substitute for social obligations, subsistence requirements and occasional wants. Hence, coastal fisheries operate on a self-regulating basis that limits market participation of fishers to the allocation of catch, the proportion of catch sold and used for other purposes (Halapua, 1982, Iwariki and Ram, 1984). Such a self-regulating production system is short-term and does not consider medium- to long-term investment planning.

Taking into account these major socio-economic and traditional characteristics of Tonga's small-scale artisanal fisheries the following behaviours, lying beyond economic reasoning, may be elucidated. The lack of investment planning, efficiency principle and profit-seeking strategies may explain why certain fisher groups continue to favour handline and spear fishing rather than switching to more effective and also economically more attractive fishing strategies.

Traditional concepts may also help an understanding of the socio-economic mechanisms associated with motorised boats within a coastal Tongan community. The purchase of a motorised boat constitutes the largest proportion of investment expenditure for most individual fishers, and is largely dependent on the traditional system of mutual obligation ("*fetokoni'aki*") and redistribution (Halapua, 1982). On one hand, the "*maanumanu*" ideology constrains the necessary diversion of resources into savings for such an investment. This conclusion is confirmed by slow or failed repayment of loans provided by the Tongan Development Bank for small-scale fishery projects, although support is offered

by the Bank to overcome social networking obligations (Leta H. Kami, pers. comm.). On the other hand, the sharing attitude of relatives working overseas is linked to the transfer of remittances that are often used for self-financing schemes, such as motorised boats. The achievement of owning a motorised boat raises the social status of the proprietor; it also requires social compensation, and hence a non-cost sharing attitude. The progressive acceptance of cash payments must be seen as a consequence of modern cash economy influence, although most socially accepted rates do not reflect the cost of transport but compensation for services provided (Halapua, 1982). Results have shown that costs of motorised fishing vessels make fishery systems seem non-competitive and sometimes non-viable when analysed economically. A successful fisher with catches above the marginal volume who can debit a substantial part of his costs by "paying for" transport on a social share basis has economic advantages over a motorised boat owner. Incentives to invest in a motorised boat are associated with social status and, from an economic viewpoint with returns from transport services rendered. It is therefore argued that returns from motorised boat transport is not a parameter that determines the viability of fishery systems but represents an additional income source. This argument is supportable only if using the motorised boat for hire is economically more attractive than using it for fishing.

The fact that traditional values have intermingled with, rather than been replaced by, commercial principles makes it difficult if not impossible to distinguish between commercial and subsistence small-scale artisanal fishers. Additional parameters such as the licensing of commercially operating boats by the Tongan authorities, traditionally determined consent systems for commercial fishing activities on common grounds by neighbouring communities, and commitment of fishing for sale, scarcely apply. Public regulations suffer from a lack of efficient monitoring and enforcement, while social rules are subject to changes and exceptions that are determined by kinship and other societal factors.

All fishery systems assessed in this paper are — to a varying degree — part of the subsistence economy. A proportion of the catch is consumed by the fisher or shared with his kins and does not enter the market (Hunt, 1997; Tu'avao et al., 1994). Fish that enters the market is a result of cash need and not a response

to market demand. Consequently, the basic tool for effective market operations does not exist and prices do not respond to the balance of supply and demand (Iwariki and Ram, 1984).

This conclusion is supported by two major findings. First, the marked differences in prices for fish sold amongst village members and at a regional or urban market: as with any other primary product, fish continues to be treated as a means of exchange amongst village community members rather than as a commodity, although its cash value is well known and recognised. If fish is marketed rather than shared within the village system in response to an increasing cash-economy influence, it will command a price based on “friendship value”, which is far below the external market value. The choice of the fisher to sell his catch at an outside market is limited by traditional social impediments and attitudes to production.

Second, the price of reef and lagoon fish marketed in Tonga does not fully reflect the production cost or the balance between supply and demand but a combination of cost development of imports and socially acceptable rates. For instance, there is no steady price increase of reef and lagoon fish but rather fluctuations that follow import prices of fuel and alternative food items such as mutton flaps and chicken (Seini Filiai, Tonga Stat. Dept., pers. comm.). The latter is of less influence in rural Tonga due to more traditional oriented diets. In the case of Nuku'alofa, Bataille-Benguigui (1988) reported average prices close to today's price level for fresh reef and lagoon fish of 4–4.50 TOP/kg, while 7 years later Tulua and Udagawa (1994) observed an average price of only 2.50 TOP/kg. Significantly, Rohorua (1994) has suggested that an increase in the existing market price of fish is the most important condition for making the Tongan fishery sector viable.

Supply and price factors determine the marketability of the coastal fishery's products. Agents and shop owners confirmed that demand for coastal fish is generally much higher than supply. Other sources suggest that demand from markets both locally and overseas for fish from Tonga are unlimited (Rohorua, 1994). However, the considerable fluctuations due to natural and social conditions and needs, a lack of consistency in supply, and prices that are socially rather than cost determined create a high-risk and unpredictable business situation. In addition, agents and shop owners still take part in the social network and a certain share of

their marketable volume may not change hands on a monetary basis. Similarly, exporting reef fish from rural surpluses to Nuku'alofa's markets is affected by the traditional “*fetokoni'aki*” sharing system. Highlighting socio-economic and traditional factors that determine Tonga's informal coastal fisheries market may clarify the reluctance to develop market structures, and the relatively few agents, middlemen and export activities involved.

5. Conclusions

The subsistence and small-scale artisanal Tongan fishery and its associated marketing are quite sophisticated; they aim to satisfy social networking values and obligations, fulfil traditional principles and accommodate changes that accompany a society in transition from an exchange system based on reciprocity and a direct sustenance system to a cash based economy. For the coastal rural people in Tonga, fishing is still part of a way of life. Therefore, while economic instruments such as NPV may be useful in comparing alternative income sources, they lack the ability to valorise the societal and traditional values ascribed to fisheries in Tonga, and in the wider context of the South Pacific. Based on the results obtained, Tongan fishers do not fish for economic fortunes. However, they may fish for food, social support, subsistence requirements and traditional values, and therefore cannot be regarded as pursuing an occupation of the last resort (King and Mcllorm, 1989).

There seems to be no doubt that coastal small-scale fisheries will continue to be essential to the livelihood of rural people in Tonga and the South Pacific realm (Veitayaki, 1993; Dalzell et al., 1996; Zann and Vuki, 2000; Ruddle et al., 1992). Due to its inefficiency and low productivity, the fishing pressure generated by Tonga's artisanal fisheries is low and beneficial to the fish stocks. It may therefore be worthwhile investigating how far non-profit and non-catch maximising fishing strategies can be maintained to mitigate the negative impacts of a cash economy based resource exploitation so as to achieve long-term sustainable and equitable use of coastal marine resources. Gordon (1953) and Schaefer (1957) suggested that, under certain circumstances, an economically inefficient fishery might be preferred. In addition to the political and social

difficulties of economic transition environmental considerations may also contribute to this argument.

Acknowledgements

I would like to thank the MacArthur Foundation which funds the ongoing DemEcoFish project, and the Secretariat of the Pacific Community for the support provided. I also wish to thank all those who assisted with information, comments and discussions, i.e. all staff members from the Tongan Ministry of Fisheries, in particular the Secretary 'Akau'ola, and the PFO 'Ulungamanu Fa'anunu. Special thanks are due to Siola'a Malimali, Silika Ngahe, Tevita 'Ahoafi, Tala'ofa Loto'amea, Soiosiu Halavatau and Taniela Hoponea and their colleagues who all helped with the field surveys. Thanks to Leta H. Kami from the Tonga Development Bank, and to all fishers and village people in the six communities visited. I am also grateful to Pierre Labrosse, Joeli Veitayaki, and Gerhard Zieroth for their useful comments.

References

- Allison, E.H., Ellis, F., 2001. The livelihoods approach and management of small-scale fisheries. *Mar. Policy* 25, 377–388.
- Bataille-Benguigui, M.-C., 1988. The fish of Tonga: prey or social partner? *J. Polynesian Soc.* 97 (2), 185–198.
- Bataille-Benguigui, M.-C., 1989. La pêche artisanale aux îles Tonga: antagonisme entre projets de développement et traditions. *Aquat. Living Resour.* 2, 31–43.
- Bataille-Benguigui, M.-C., 1992. Pêcheurs de mer, pêcheurs de terre, la mer dans la pensée Tongienne. *Etudes Rurales* 127–128, 55–73.
- Bender, A., Käger, W., Mohr, E., 2002. Informal insurance and sustainable management of common-pool marine resources in Ha'apai, Tonga. *Econ. Develop. Cult. Change* 50 (2), 427–440.
- Chakraborty, R.N., 2002. Sharing rules and the commons: evidence from Ha'apai, Tonga. In: Paper Presented at the 7th Biennial Conference of the International Society for ecological Economics, Sousse, Tunisia, 6–9 March 2002.
- Dalzell, P., Adams, T.J.H., Polunin, N.V.C., 1996. Coastal fisheries in the Pacific islands. *Oceanogr. Mar. Biol.: Annu. Rev.* 34, 395–531.
- Gillet, R., Lightfoot, C., 2001. The contribution of fisheries to the economies of Pacific Island countries. Asian Development Bank, Pacific Studies Series, Manila, Philippines.
- Gordon, H.S., 1953. An economic approach to the optimum utilization of fishery resources. *J. Fish. Res. Bd. Canada* 10 (7), 442–457.
- Gustavson, K., 2002. Economic production from the artisanal fisheries of Jamaica. *Fish. Res.* 57, 103–115.
- Halapua, S., 1982. Fishermen of Tonga, their means of survival. Institute of the Pacific Studies in association with the Institute of Marine Resources, University of the South Pacific, 100 pp.
- Hunt, C., 1997. Cooperative approaches to marine resource management in the South Pacific. In: Larmour, P. (Ed.), *The Governance of Common Property in the Pacific Region*. National Centre for Development Studies. Pacific Policy Paper 19 and Resource Management in Asia-Pacific, The Australian National University, Canberra, pp. 145–164.
- Iwariki, S., Ram, V., 1984. An introductory study of the socio-economic aspects of household fisheries in the small islands economies of the South Pacific. *Mem. Kagoshima Univ. Res. Center S. Pac.* 5 (1), 53–65.
- Kataoka, C., Ishimura, M., 1989. Land tenure and fisheries in Tonga. In: Iwariki, S. (Ed.), *Report of the Monbuso International Scientific Research Program*. Kagoshima University, Japan, pp. 71–84.
- King, M., McIlgorm, A., 1989. Appraising inshore fishery resources in Pacific island countries. In: Campbell, H., Menz, K., Waugh, G. (Eds.), *Proceedings of the International Conference on Economics of Fishery Management in the Pacific Islands Region*, Hobart, Tasmania, Australia, 20–22 March 1989. *ACIAR Proc.* 26, 78–84.
- Kirch, P.V., Dye, T.S., 1979. Ethnoarcheology and the development of Polynesian fishing strategies. *J. Polynesian Soc. NZ* 88, 53–76.
- Kronen, M., 2002. Women's fishing in Tonga: case studies from Ha'apai and Vava'u islands. *SPC Women Fish. Inform. Bull.* 11, 17–22.
- Martin, J., 1817. *Histoire des naturels des îles Tonga ou des amis situées dans l'océan Pacifique (sure les détails donnés par W. Mariner)*, 2 volumes. Gide et Nicolle, Paris, 796 pp.
- Passfield, K., 2001. Profile of village fisheries in Samoa. Samoa Fisheries Project. Technical Report. Government of Samoa, Fisheries Division, Ministry of Agriculture, Forests, Fisheries and Meteorology.
- Poulsen, J., 1977. In: Rutherford, N. (Ed.), *Archeology and Prehistory, Friendly Islands, a History of Tonga*. Oxford University Press, pp. 4–26.
- Rohorua, H., 1994. Sectoral Report Fisheries Industry. Economic and Research Division, Agricultural Lending Division, Tonga Development Bank.
- Ruddle, K., Hviding, E., Johannes, R.E., 1992. Marine resources management in the context of customary tenure. *Mar. Resour. Econ.* 7, 249–273.
- Sabri, J., 1977. Small-scale fisheries and development in Peninsula Malaysia — problems, prospects. In: Lockwood, B., Ruddle, K. (Eds.), *Proceedings of the Planning Meeting on Small-scale Fishery Development: Social Science Contribution*. East–West Food Institute, 6–11 September. East–West Center, Honolulu, pp. 63–74.
- Schaefer, M.B., 1957. Some considerations of population dynamics and economics in relation to the management of the commercial marine fishes. *J. Fish. Res. Bd. Canada* 14 (5), 669–681.
- Tu'avao, T., Kava, V., Udagawa, K., 1994. The present situation of fisheries in the Tongatapu Island group. *Fish. Res. Bull. Tonga* 2, 27–42.
- Tulua, S., Udagawa, K., 1994. Operation pattern of fish markets on Tongatapu island. *Fish. Res. Bull. Tonga* 1 (21), 21–28.

Veitayaki, J., 1993. Village-level fishing in the Pacific. In: South, G.R. (Ed.), *Marine Resources and Development. The Ray Parkinson Memorial Lectures*. PIMRIS, University of the South Pacific, Suva, Fiji, pp. 73–97.

Zann, L.P., Vuki, V.C., 2000. *The Status and Management of Subsistence Fisheries in the South Pacific*. Ocean Yearbook No. 14. The International Ocean Institute, The University of Chicago Press.