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Potential profitability of pearl culture in coastal communities in Tanzania

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ABSTRACT

Artisanal half-pearl culture has been shown to provide livelihood and economic opportunities for coastal communities in Tanzania that depend directly on exploitation of marine resources. However, these pilot research studies have been supported by donor organisations and the economic feasibility of such development has not yet been assessed. Furthermore, there is little understanding of the costs required to establish pearl farms and the relative impacts of farm size on production, running costs, profitability and risks involved in production. The aim of this study was to develop economic models for subsistence level half-pearl culture in Tanzania. Models were generated for various scenarios relating to farm size and products (i.e. half-pearls and juvenile oyster or 'spat' collection) and they give detail on infrastructure costs, operational costs and income generated for various levels of operation. We concluded that the most profitable model for community-based pearl farming is to culture at least 600 oysters for half-pearl production. However, for communities to be able to run a sustainable and profitable enterprise, development of a sustainable source of oysters is crucial. Farmers can also generate income from collection of juvenile oysters and their subsequent sale to pearl farmers, but this is less profitable than half-pearl farming and requires a longer operational period before profits are made. Like pearl farming, there were major benefits or economies of scale with the largest farms tested providing greatest profit and/or a shorter time required to reach profitability. Our results provide a valuable source of information for prospective pearl farmers, donors, funding bodies and other stakeholders, and valuable extension information supporting further development of pearl culture in Tanzania.

1. Introduction

Coastal communities in Tanzania depend primarily on exploitation of coastal and marine resources for their livelihoods (Edward, 2009). Existing livelihood activities include artisanal fishing and mangrove harvesting, agriculture of coconuts and cashews and subsistence farming. However, opportunities for further development of these activities are limited, and this increases exploitation pressures on marine resources which are often harvested using unsustainable methods such as dynamite fishing and beach seining (Andrews, 1998). As a result, natural resources remain in long-term decline against a background of increasing population. To address this underlying dependency on natural marine resources, as well as poverty alleviation, two independent pilot-scale research projects were begun in 2003 to assess the feasibility of developing pearl culture based livelihoods in poor coastal communities at Mafia Island and Zanzibar. They demonstrated that, after basic training, artisanal fishers could routinely produce marketable cultured half-pearls (Fig. 1) and that pearl shell handicraft skills were readily adopted by pearl farmers and other community members (Southgate et al., 2006; Jiddawi, 2008). Production of half-pearls and mother-of-pearl (MOP) handicrafts provides broad income generating opportunities for coastal communities in Tanzania (Southgate et al., 2006; Jiddawi, 2008), and half-pearl culture is compatible with marine conservation efforts (Southgate et al., 2006). As a result of these successes, the World Wide Fund for Nature (WWF) Tanzania Country Office oversaw the Rufiji-Mafia-Kilwa (RUMAKI) Seascape Programme (2005–2012) which was funded by the European Union (EU-ReCoMaP) during the period 2009–2011, to extend artisanal pearl culture activities to another

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Fig 1. Half-pearls grown inside the shell of *Pteria penguin* by pearl farmers at Mafia Island, Tanzania. Pearls can be sold in the shell, with shell value based of the number of pearls it contains, or cut from the shell for individual sale. If cut from the shell, the remaining pearl shell can be utilised for mother-of-pearl handicraft and jewellery production.

77 community members at Mafia Island and 54 others in the Kilwa District of mainland Tanzania.

As well as half-pearl production, an associated coastal livelihood opportunity is provided by collection of juvenile pearl oysters or 'spat' that can be retained and grown for subsequent half-pearl production or sold directly to pearl farmers. Spat can be collected by deploying appropriate materials (or 'spat collectors') into the ocean at an appropriate time to provide a settlement substrate for pearl oyster larvae that are later removed as spat (Beer and Southgate, 2000; Southgate, 2008). Spat collection is a major source of income for coastal communities in French Polynesia (Southgate, 2008; Tisdell and Poirine, 2008) and has become an important sector in the pearl culture industry (Tisdell and Poirine, 2008). Spat collection is still at a very early stage as a means of income generation in Tanzania, but it has considerable potential should pearl farming become established.

Although the livelihood benefits and potential of artisanal half-pearl and MOP handicraft production in Tanzania have been briefly reported (Southgate et al., 2006; Jiddawi, 2008), information on the economic viability of these activities is very limited. Information on the set-up and running costs of pearl farms in Tanzania and estimates of potential income generation from pearl production under various scenarios is not currently available. The aim of this study was therefore to develop economic models to assess the feasibility of artisanal half-pearl production and pearl oyster spat collection in Tanzania. Models were developed to represent various scenarios relating to farm size and product (i.e. half-pearls and spat collection). They detailed infrastructure and establishment costs, operational costs and estimated potential income generation from various levels of operation over a 20 year horizon. The outputs from this research provide a valuable source of information for prospective pearl farmers, donors, funding bodies and other stakeholders, and valuable extension information supporting further development of pearl culture in Tanzania.

2. Materials and methods

2.1. Modelling software and analysis

Economic models were developed using Microsoft Excel and based upon cost-benefit analysis techniques. The modelling software used in this study was adapted from existing software developed by Johnston and Ponia (2003) for analysis of cultured round-pearl production in Pacific island countries (e.g. Tisdell and Poirine, 2008; Hine and Johnston, 2013; https://publications.qld.gov.au/dataset/agbiz-tools-fisheries-aquaculture). For this study changes were made to existing software to account for differences between round pearl and half-pearl production methods and cycles, and differences in inputs, input costs and infrastructure and products (i.e. half-pearl and spat), between the Pacific and Tanzania. The revised software was used to analyse data from inputs related to farming costs (establishment of farm and maintenance), the estimated quantity of half-pearl and spat produced, and value of products (half-pearls and spat). From these data, the software generated information on annual gross revenue, annual production costs, and production costs and revenue per product. Other information generated by this analysis included net present value, annual return and benefit-cost ratio for both half-pearl and spat collection. A discounted cash flow analysis was used to determine the annualised cost structure and likely profitability. The timing and duration of these projects has an influence on the annualised costs and revenues of the project. The single amount calculated using compound interest method is known as present value (PV) of the future stream of costs and benefit. The rate used to calculate present value is known as the discount rate (opportunity cost of funds). All the models developed assumed a project life of 20 years and used a real discount rate of 5 per cent to calculate the net present value (NPV).

Table 1
Infrastructure and production parameters used to develop economic models for half-pearl and spat farms in coastal Tanzania. Numbers in parentheses are the values used in the models.

Infrastructure parameters	Production parameters
Number of rafts	Cost per nucleus
Number of bamboo poles per raft (20)	Average number of nuclei per oyster (3)
Number of mangrove poles per raft (12)	Cost of glue per seeded oyster
Number of floats per raft (8)	Cost of pearl seeding tools
Number of anchors per raft (4)	Time required to seed one oyster (15 min)
Number of rolls of rope per raft	Number of seeded oysters
Man hours to make one raft (4)	Mortality of seeded oysters (6.25%)
Man hours to make anchors (1)	Time to cleaning each oyster (5 min)
Man hours to deploy raft (3)	Frequency of oyster cleaning (2 per month)
Number of nets per raft (10)	Cost of cleaning equipment (brushes etc.)
Cost of nets	Culture period (9 months)
Number of oysters per net (8)	Proportion of unsellable pearls (10%)
Number of nets per raft (10)	Proportion of sellable pearls (90%)
Man hours required to collect oysters	Number of spat harvested
Cost of plastic containers	
Cost of spat collector materials	
Man hours to make spat collectors	
Number of spat collectors (50)	

Data inputs to the spreadsheet-based models included the costs associated with raft-based farming infrastructure (e.g. bamboo poles, ropes, floats, anchors, etc.), pearl production and husbandry (e.g. oyster nets, pearl nuclei and glue, pearl seeding tools, spat collector materials etc.) and labour (Table 1). Values for all economic parameters (outputs) were calculated from value entered. The summary statistics also provide a breakdown of input costs per product (i.e. per pearl or per spat) which allowed the major input costs to be identified. Another feature of the model is the application of risk analysis (Johnston and Ponia, 2003). Risk and uncertainty are features of most business and government activities and need to