Final report for Mini-project MS0507:

Productivity and constraints in tilapia fish and freshwater prawn aquaculture in Fiji

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**Abstract**

The pace of development in Fiji freshwater aquaculture has been slower than expected. The main objective of this study was to find out reasons for this, by gathering evidence on farm performance, and on farmers’ perceptions of problems. Fiji’s freshwater focus is currently on tilapia *Oreochromis niloticus* and prawn *Macrobrachium rosenbergii* aquaculture. Representative freshwater aquaculture farm case studies were selected, to gather data on actual farm and farmer performance in “real world” conditions. Farmers were also interviewed to assess their perceptions about constraints to progress.

All observations and measurements of soil and water quality fell within acceptable ranges, and there was no evidence that farm quality is a source of problems among these case studies. Evidence was found, however, that many farmers lack technical competence, which needs to be addressed by education and training. Farmers that have gone through some training are doing well. It was also found that infrastructure and support to farmers pose constraints, for example timeliness of tilapia fry deliveries, shortage of prawn post-larvae, the cost of feed, and the limited reach of Extension services and advice to farmers. Farmers that are located close to support services are doing well. Access to markets was a constraint for producers of live tilapia who wish to sell in bulk, but marketing was not a problem for prawn farmers.

In Fiji there is huge potential for small-scale freshwater aquaculture to develop, and for farmers to improve their livelihood. Some tilapia farms are capable of becoming larger-scale commercial operators but are constrained by current dependence upon the limited live-fish sales outlets. For Fiji to reach its potential, the following recommendations should be adopted: Extension support and advice to farmers should be improved; there should be tilapia product development (frozen, filleted, smoked) to add value and diversify marketing options; additional market outlets for live tilapia should be established; there should be more farmer training on fish/prawn culture and feeding practices; more prawn PL production is badly needed; better feed formulations are needed to increase quality (e.g. less fines) and lower the cost; the green-water method of tilapia should be promoted for those who are unable or unwilling to buy feed; finance should be more accessible for pond construction and feed purchase; avoid a culture of dependency by farmers upon services given for free by government; foster a private-sector led approach to establishment of a medium-scale industry based upon a “satellite farms” concept, and: collaboration between stakeholders (government departments, farmers association, regional and international organisations, donors, and education and research institutions) should be further encouraged and strengthened.

**Background**

The freshwater aquaculture sector in the Pacific Island Nations (PINs) is a recent development, with most potential in larger island nations with abundant freshwater resources, though there is some potential in nations with limited freshwater availability. Fiji and Papua New Guinea are key leaders among the PINs (excluding New Zealand and Australia), with basic institutional frameworks in place and existing hatchery and grow-out technologies, and available supporting industries.

There are high expectations for development of inland aquaculture industries, but they have been slow to get off the mark and the possible reasons for this are varied and complex. The production conditions, constraints and incentives totally differ among commercial and rural (subsistence) operations. Unlike commercial, scale operations that much affected by wider economic and political conditions, rural aquaculture operations are contained within a different set of socio-economic factors.

**Fiji Freshwater Aquaculture**

Fiji has a land territory of 18,272 square kilometer (Department of Fisheries, 2004), with two major Islands, Viti Levu and Vanua Levu, and it is on these two main islands that freshwater aquaculture developments are concentrated (Fig 1). The Department of Fisheries (DoF) within the Ministry of Fisheries and Forests (MFF) has been the lead agency in development and promotion of freshwater aquaculture in Fiji. The Aquaculture section of this department operates the Naduruloulou Research Centre as a pivotal point of research, training and promotion for Freshwater Aquaculture in Fiji.
Initial development of Fiji freshwater aquaculture stemmed from introduction of Mozambique tilapia *O. mossambicus* in the 1950s, but it was not until the mid 1970s that the potential for inland aquaculture was realized. Conventional aquaculture in Fiji was instigated with establishment of the Naduruloulou Research Centre in 1975, and was off the ground in the 1980s with initiation of the rural pilot project based upon a superior species, the Nile tilapia *O. niloticus* (DoF, 2004, 1998).

**Sector goals**

The overriding goals devised by the MFF (DoF) are to ensure food security and contribute to poverty alleviation, and to bring export revenues (DoF, 1995, 2004). Much effort in development has been directed into rural subsistence aquaculture, where significant proportions (59%) of the population are residing with limited employment opportunities.

The sector comprises four development programmes (DoF, 2002):

1. Tilapia (*O. niloticus*);  
2. Polyculture (*M. rosenbergii, O. mossambicus, Grass Carp*) and integrated farming with chicken/duck sheds;  
3. Ornamental (Koi carp, gold fish); and  
4. Grass carp for river re-stocking as river-weed biological control.

**Culture Species**

The range of species that is currently cultured is limited to tilapia (*Oreochromis mossambicus, O. niloticus*), Giant Malaysian freshwater prawn *Macrobrachium rosenbergii*, Asian carps (grass carp, big head carp) and ornamental species (gold fish and koi carp). Nile Tilapia and prawn *M. rosenbergii* are the two dominant species cultured for food or for sale in the domestic markets.

**The Rural Programme**

From 1975 to mid 1987, freshwater aquaculture was part of the Government development plan. The Rural Freshwater Aquaculture Programme was initiated in 1982, with assistance from the US Peace Corps, and aimed to supplement protein requirements in the rural sectors using tilapia *O. niloticus* (Vereivalu, 1989). Twenty seven farms were initially established and to date, just above three hundred farms are recorded to have been established. The
programme development strategy has seen the method of culture evolve from monoculture to polyculture and into integrated farming practices (DoF, 2002). The development model of the sector is a central system of state control, with the DoF (Naduruloulou) controlling the fry-supply, harvesting and marketing.

Unlike tilapia, prawn production and supply of post larvae to farms have been inconsistent. This is due to technical and staffing setbacks in hatchery operations, and priorities within government in resources allocation (Fiji Fisheries Division, 1992). Efforts to commercialize this commodity have been slow in coming. Despite the technicality involved in culture (compare to tilapia), there have been farmers successfully involved in monoculture of the species. Twenty three small-holder farms were recorded to been supplied with *M. rosenbergii* post-larvae in 2006, and a total of 150,000 post-larvae (DoF data) were supplied.

An indication of the potential for medium-scale commercial production is given by the recent conversion to prawns of a derelict tilapia farm in Navua, now operated by Dairy Farms Fiji Ltd., in partnership with a team from the University of the South Pacific (USP). This should increase confidence in the sector and bring investors from the private sector and abroad, which have been slow to get involved.

The number of inland farms in Fiji has increased, and estimated to number just above 300, with 197 tilapia and 23 prawn farms recorded to have received fry/PL in 2006 from the Naduruloulou Research Centre (DoF data). In 1999, a record of 268 subsistence and 16 commercial tilapia farms was reported by FAO (2002). A survey done by Secretariat of the Pacific Community (SPC) and DoF in 2004, found 34% farms of the 167 farms surveyed were ex-farmers, 46% practicing, and 20% intending farmers (SPC Data, Unpublished).

After so much effort to commercialize tilapia and prawn production in Fiji, the production biomass still remains fairly trivial. Investments from the private sector and foreign investors are still minimal, with the DoF taking responsibility to sustain the industry via production of fingerlings/post-larvae and providing appropriate services, and assistance from supporting institutions. Despite the effort, a large proportion of farms remain as either not operational or awaiting assistance.

**Objectives**

The purpose of the study was to find out why freshwater aquaculture development in Fiji has been slower than expected. Possible problem areas could be: (1) Farm quality (soil chemistry, water quality, local climate, etc); (2) Farmer quality (competence, training); (3) Infrastructure and support quality (technical advice, supply of feed, fry, etc); or (4) Access to markets. The objectives were to gather and analyse data from each of these areas of the Fiji freshwater aquaculture sector and use this data to identify constraints to development. Farm case studies were selected and monitored to assess actual farm performance in “real world” conditions, and the farmers were interviewed to assess their own perceptions about constraints to progress.

This report describes the current status of the Fiji Freshwater Aquaculture sector, identifies constraints and impediments to progress for which evidence was found, and makes recommendations to overcome these constraints.

**Methods**

**Study Sites**

Eight case studies of tilapia and prawn farms were selected in consultation with the DoF (Naduruloulou Research Centre), and represented a cross section of farm types (Household, Institution, community/clan, coastal and interior). A further two farms (at Montfort and Naduruloulou) were stocked and operated by USP staff experienced in culture of both prawns and tilapia, to set a benchmark for production using “best practice” against which the case-study farm performances could be compared. Of the total of ten farms monitored, three farms selected were from Tailevu Province (coastal), four from Naitasiri Province (highlands), two were from Nadroga, and one in Nadi.

**Data Collection**

Data collection was initiated in May 2004, and with the final field work completed in February, 2007. Growth and survival data from individual production cycles of fish or prawns at each farm was used to evaluate the farm performance. Monthly visits were made to the selected farms, with monitoring of growth (length and weight), pond environmental conditions (Dissolved Oxygen, pH, Secchi disk,
temperature, depth, water flow rate, Alkalinity, Total Nitrogen) and observation of ponds (signs of disparity) were made. Chemical analysis of soil, feed and water were done by the Institute of Applied Sciences (IAS) to provide further evidence about the quality of each farm.

A questionnaire was formulated to analyse farmers’ quality and perceptions on farming and constraints, and interviews were carried out at the start and completion of each pond cycle monitored. Data on the extent of government support for freshwater aquaculture was kindly provided by Fiji DoF.

Results and Discussion

Current status of freshwater aquaculture in Fiji

The SPC-Fisheries farm survey (2004) shows promotion and development of freshwater aquaculture by Government of Fiji has been focused in the provinces of Tailevu, Naitasiri, Nadroga and Ba on the main island of Viti Levu, and Cakaudrove in Vanua Levu (Fig 2). This has resulted from the establishment of government hatcheries in these provinces. Fig 3 depicts farms that were recorded to have received fingerlings/post-larvae from the Naduruloulou Research Centre in 2006.

Government freshwater hatcheries in Viti Levu include; Naduruloulou Research Centre, Ba Hatchery and Sigatoka Hatchery; and a private tilapia hatchery in Dreketi, Vanua Levu. Naduruloulou Research Centre remains the pivotal point of freshwater fry/post-larvae production and distribution.

Farmer Perceptions about Fish Farming

Attitudes to Fish Farming

Responses to the questionnaires showed that 100% of farmers are attracted to fish/prawn farming because of improvement of economic status, providing for families, and with an expectation of good growth in the future. Their view of the potential for freshwater aquaculture in Fiji is positive.

Barriers to Entry into Fish Farming

The cost of pond construction, remoteness from market, feed supply, and fingerling supply, were all raised as barriers that hinder entry into freshwater fish or prawn farming by at least half of the respondents (Fig 4). The costs of feed and of pond construction were a major concern among farmers, with inconsistency in supply of fingerling and location of the farm in relation to market places also pointed out. Remoteness in location made marketing of products in a municipal outlet impossible, thus forcing remote farmers to sell on an order basis in rural markets or on site. Tilapia here
sell for FJD3.00 for a plastic bag or bundle (6-8 fish), which is half the price when sold at a municipal market.

Disadvantages in Farming

Farmers were mainly worried about financial risks/losses and losses due to natural disasters (Fig. 5). They generally expressed their satisfaction with fish farming and felt it compared well with alternative livelihoods in inland rural areas. Most were not disheartened yet, and did not want to abandon freshwater aquaculture in order to replace it with other activities (Fig. 6). 90% of respondents expressed willingness to continue operating their fish farm. 50% were satisfied to leave the farm at its present size, 25% expressed willingness to increase the size of their farm, while 25% were undecided on this point.

Benefits from fish farming

Results show that farmers perceive benefits from fish/prawn farming (Fig 7), expressing high levels of satisfaction in; economic returns, school fees, church contributions, improved housing, subsistence consumption, meeting traditional obligations and strengthening their family unit.

Fig.7. Farmers perceptions of benefits from fish/prawn farming.

Training and Competence

A 100% positive response was obtained regarding farmers’ perceptions that they do not know enough about culture techniques, and this was corroborated by observations that the majority of farmers were not familiar with best practice for pond grow-out of tilapia and prawns (Fig 8). There was also a 100% affirmative response to the question about whether farmers felt they needed to improve their farming techniques. The majority of these farmers have not attained very high education (Fig 9), and consideration of a special training programme that can be easily absorbed by farmers is recommended. This should stress the importance of choice of feed type and efficient feeding programmes.
Farm Quality

Fiji freshwater aquaculture is dominated by subsistence (extensive) and artisanal (semi-intensive) culture practices, according to the SPC-Fisheries farm survey (2004) (Fig. 10). These utilise low-input low-yield culture systems based upon small earthen ponds with gravity flow inlets/outlets. Water sources are mainly from streams, drains, or direct rainfall. This trend was mirrored among the respondents to the questionnaire, the majority of whom were farming for subsistence purposes. Here, “artisanal” is used in the sense that any surplus over and above subsistence needs is sold for cash.

Farming practices were mainly monoculture, with ‘Chitrilada’ *O. niloticus* the major species in culture, with a few *M. rosenbergii*, polyculture, and integrated farms. However, the majority of farmers showed interest in farming prawns, due to their higher price and high demand in the domestic Fiji market (Fig. 11).

Water and soil parameters

Water temperatures from a typical pond are as shown in Fig 12, with monthly temperature falling in the 23-30°C range. This is a satisfactory range for tilapia and prawn growth. Fluctuations of daily temperatures were commonly within ±1-2°C. Other water and soil parameters all fell within ranges known to be acceptable for successful tilapia fish or freshwater prawn farming. Farm quality can therefore be discounted as an issue constraining the development of the farm case studies monitored here.

Farmer Quality

Farm Management

Tilapia and prawn growth performance varied widely among farms, and several factors were observed to have contributed to this variation. It is apparent that poor farm management and decisions taking by farmers have a direct impact on the output. Discussions of results from farmers’ perceptions about constraints, and observations of farmer competence, will be made accordingly.
Training and Competence

The extent to which some farmers can successfully assimilate and apply culture methods under rural conditions is questionable at present, even when trained. The majority of the farmers interviewed express familiarity with aquaculture practices and some have gone through aquaculture training, however pond monitoring and results from the questionnaire shows the opposite. Animals were found to be under-fed, ponds unfertilized, un-limed, and overstocked, and farmers had taken wrong options in choice of species, feed type and stocking density. In those cases where knowledge and training are being properly applied, on the other hand, the outputs are much higher and the farms are quite successful.

Figs 13 and 14 illustrate the ways in which growth of tilapia and prawns were affected by the choices made by farmers about the type and level of farming inputs. With proper levels of feed and stock density, harvest of 250 g tilapia and 30 g prawns (average body weight) is possible between 4-6 months. However farmers who limited inputs were found to harvest and sell at below the market size within same period, or had a prolonged culture period exceeding six months.

Fiji Crest Chicken Ltd. and Pacific Feeds Ltd. are currently the major commercial feed producers in Fiji. Aquaculture feeds produced included tilapia grower (mash), tilapia pellets, and recently a prawn pellet has been produced for bulk orders only. Prawn pellets are sold at FJD$1.02/kg, with tilapia grower and tilapia pellets sold at FJD$0.97/kg and FJD$0.75 respectively. Mill mix is commonly used by tilapia farmers, however, because it is very much cheaper at FJD$0.14/kg compared to commercially produced feed.

One farmer was observed to carry out his own feed production, by mixing meat meal, mill mix, and copra meal. Growth performance and formulation of this feed was comparable to tilapia pellets (Fig 15), with the farmer saving close to FJD$300 per cycle by making his own feed. Meat meal, copra mill and mill mix are sold at FJD$0.72, 0.38 and 0.14 respectively. Other farmers fed their tilapia with cassava, pawpaw, taro, scraped coconut and grasses.

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Feed

Fig. 13. Growth performances of freshwater prawns with respect to choice of inputs made by farmers. "Textbook farming" reflect the results obtained from Montfort and Naduruloulou farms where best practice was carried out.

Fig. 14. Growth performance of tilapia with respect to choice of inputs made by farmers. "Good feeding practices" reflect the results obtained from Montfort and Naduruloulou farms where best practice was carried out.

Fig. 15. Growth performance of tilapia on a farm using the farmer’s own lower-cost feed mix, compared with a farm using Crest tilapia pellets.
The percentage compositions of feeds used among farms in Fiji are shown in Figs 16 and 17. The new Crest prawn feed closely resembles an imported shrimp feed in percent composition. Protein levels were lowest for mill mix and chicken grower, with tilapia pellet, tilapia grower and the farmer’s own feed mix all showing no difference in protein levels.

The majority of farmers feel that feed availability has improved and is obtainable all throughout the year (Figs 18 and 19). The general concern raised about feed by household-scale farmers was the price of tilapia and prawn pellets. Commercial farms, on the other hand, had concern about the binding capacity of the tilapia and prawn pellets, because a significant proportion of bagged local tilapia and prawns pellets are in dust form (fines).

Infrastructure and Supporting Services

Supporting industries in Fiji are well established, compared with other Pacific nations. Existence of feed industries, educational institutions (USP, Montfort Boys Town, SPC Community Education Training Centre) government (Naduruloulou Research Centre), infrastructure, and support from multilateral partners, has made establishment of a freshwater aquaculture sector in Fiji possible and raised it to the level that it is today.

Extension Services

The DoF are faced with difficulty in their extension programme, owing to the increasing number of farms and limited resources to cover a wider range of operating farmers. Farmers expressed great concern about the availability of extension services, and felt there has been no improvement in extension services since their establishment (Figs 18 and 19). Those farmers who are not applying their training correctly will need reminders about best practice through regular extension visits.
Supporting Institutions

Other concerns were raised about the availability of finance sources, and support from the government (Figs 18 and 19). Obtaining credit from commercial banks is difficult for the majority of these farmers, with little security available for loans and without paid employment. Establishment of a credit scheme purposely for pond construction, assistance on feed, and other inputs, is recommended.

The USP aquaculture programme was established in 2001 with introduction of the MS324 Aquaculture in Pacific island Countries course, and in 2003 the establishment of a freshwater aquaculture hatchery and model farm. This has resulted in a cadre of trained hatchery technicians comprising nationals of Fiji, Solomon Islands, Vanuatu, Samoa, Tonga and Cook Islands. SPC operates a Community Education Training Centre (CETC) facility at Narere in Fiji which has recently had fish ponds added to it. At the national level in Fiji, Nadurouloulou Research Centre is a venue for freshwater aquaculture training, as is Montfort vocational training school which gives basic hands-on training in tilapia culture to its students.

Markets

Fiji freshwater aquaculture is driven entirely by the domestic seafood market which includes a growing tourism industry. An annual import figure of 400 mt of frozen shrimp products has been reported (Fisheries Division, 2002). The local prawn demand is estimated to stand at 600 tonnes annually, with tourism taking 200 tonnes. This figure would represent both shrimp and prawns which are not classified separately. Though export is a longer-term objective, the local supply is presently insufficient for domestic needs and Fiji is a net prawn importer.

The domestic demand for both tilapia and prawns remain high. Tilapia fetches FJD$5.00-6.00/kg in urban areas, and FJD2.50-5.00 in rural areas. The current central marketing system only allows for tilapia to be sold in municipal markets only on Friday and Saturday, with Saturdays usually recording highest sales. Tilapia marketing is currently limited to a single major outlet in Nausori municipal market (Central Division), with DoF having control over the number of selling farmers, the harvesting process at each farm, and the date upon which each farmer may sell their product. Sometimes remote farmers must wait up to 6-12 months for an opportunity to sell their fish live in Nausori.

Prawns command a lucrative price of FJD$15-30/kg in the domestic market. The majority of prawn farmers sell their produce to fulfil individual orders, or to fish outlets, wholesale buyers, and middlemen. Farmers are assisted by the Nadurouloulou Research Centre with harvesting, which is also responsible for packaging and marketing the prawns on behalf of farmers, with deduction of expenses incurred.

Unlike prawns, wholesale buyers for large volumes of tilapia are non-existent, so farmers are forced to sell fish alive in municipal and rural markets. This poses logistical problems in keeping fish alive, plus these sales points are easily saturated. Value adding and diversification of tilapia products (e.g. smoked, filleted) would provide other marketing options and lessen dependence upon live-fish sales.

Constraints

Farmers Perceptions

Data from the SPC-Fisheries farm survey (2004) showed that feed and fingerlings have been the two most pressing constraints faced by farmers. Respondents to the questionnaire revealed that availability of feed has improved, and their concern is with the prices of commercial fish and prawn feeds.

Access to technical support, and to finance, still remain major constraints among these farmers (Fig 20). Lack of training and unfamiliarity with culture practices also figured highly in farmer responses. They were also concerned about high mortality in ponds. These perceptions are based on the original stocking number and a low final harvest number at the end of each production cycle, and can either be from a lower than expected number received upon stocking, or to mortality in ponds due to poor pond management.
Observed Constraints

A major observed constraint was the unavailability of finance to start and operate farms. Though farmers were hesitant to express their cashflow problems, observations of farm inputs did show their lack of purchasing power. Farmers were found to opt for cheaper feeds (mill mix, scraps (pawpaw, coconut, grass, taro) despite slower growth rates and lower production being the result. Often they under-fed or, in one case, did not feed fish at all, even though they claimed that they did. A majority of farmers were not conscious of the importance of choosing a quality feed, commonly utilizing cheaper feed alternatives. As shown in Figs 21 and 22, quality feeds (prawn pellet, tilapia pellet) result in higher production than cheaper alternatives like mill mix.

Observations showed that most farmers had limited understanding of good pond management, being weak primarily on stocking densities, choice of species, water quality, feed quality and feeding ration, and on the importance of fertilization. These all contributed to low production compared with the “best-practice” benchmark farms. As shown in Figs 21 and 22, growth performance of tilapia and prawns varied widely depending on the feed given.

Ponds were variously observed to be both overstocked and understocked. An appropriate stocking density range that has proved suitable and is recommended for semi-commercial production in Fiji, is 3-5fry/m² and 5-8/m² for tilapia and prawn respectively. Farmers who were observed to use these recommended ranges had better yield and fish/prawn average body weight at final harvest.

Farmers need to be given good advice about the choice of species that they intend to farm. Prawns require more care and attention than tilapia, and a good-quality and readily available water supply is vital. Farmers are attracted from tilapia to prawn farming by the potential for higher income, however in some cases their competence or farm quality is insufficient to raise prawns successfully (Fig. 13). In such cases, these farmers are better off to remain as tilapia farmers.

Farmers on highlands were noted to have plenty of water available, with good flow rates by gravity, and they tend to use this water in large amounts. This approach is best be utilized in prawn farming where less plankton bloom is required. For tilapia, however, these farmers failed to understand that continuous high flow of water through the pond will flush out the plankton bloom and reduce the amount of natural feed available for fish. Pro-
motion of green-water culture via fertilization and water-flow management would be beneficial for those farmers who have difficulty purchasing commercial feeds.

The inconsistent supply of prawn post-larvae was found to be a major constraint to development of a prawn industry. Farmers would understock ponds with whatever option of post-larvae was made available to them. Post-larvae for *M. rosenbergii* are produced at Naduruloulou Research Centre and provided free to farmers, and by the USP hatchery for commercial sale.

Labour and equipment/facilities were two other observed constraints. Tilapia and prawn farmers generally lack equipment (vehicle, nets, holding tanks) for harvesting, and rely on the DoF to harvest, transport and market their product. This stretches the limited resources of the DoF to assist such a large number of farms, and it fosters a culture of dependency by farmers on government.

Farmers in the highlands face difficulty in market access because of the distance involved, so their products are sold in the rural market at a lesser price. The competitive advantage of tilapia versus other fish products is selling it alive and thereby providing customers with a guarantee of freshness. The limited outlets and restricted volume of live fish sales have resulted in farmers (a) waiting a long time for a slot at Nausori Market, or (b) take small orders, and do partial harvests (these are tedious, and time consuming).

The current ‘central’ method of control for stocking, harvesting and marketing has been successful in bringing the Fiji industry to its present point. It does have drawbacks however, whereby farmers do not have full control and accountability over their own fish farming business, such as the time of harvest, quality and quantity of fish sold, and oversight of the revenue less expenses. They also tend to take less care over pond preparation (e.g. eliminating fish predators) when fingerlings or post-larvae are given out for free.

The strategy of government toward the freshwater aquaculture sector is through support in the form of free fingerling production and distribution, extension services, research, and market assistance. The relevance of this programme, for example whether it is benefiting the farmers and whether its goals are being met, need to be regularly reviewed.

An alternative model for development is to foster larger private-sector operated hatcheries and farms for tilapia and prawns. The efficiencies and economies of scale that can result from stronger private-sector involvement will then benefit the smaller, household level operators and also relieve government from some of the burden of supporting a rural small-holder aquaculture industry. Such a cluster of small farming operations benefitting from services made viable by larger operations can be termed a “satellite farms” concept. Providing the right conditions for this to occur could add a whole new dimension to Fiji’s freshwater aquaculture industry, by adding a medium-scale commercial sector to the subsistence/artisanal sector that has so far been the focus of government support for freshwater aquaculture in Fiji.

**Recommendations**

Based on the results of this study, the following recommendations are made:

- Awareness and training programmes on pond management, especially on the importance of feed, choice of species, stocking density, importance of fertilizer, and water management.
- An improved monitoring framework (extension service) is needed, and a finance scheme developed for rural fish farmers.
- There is a need to develop additional sales outlets for live tilapia, and product development and training to diversify the ways in which tilapia can be sold.
- Decentralize hatcheries to improve farmer access to fry/PL and increase post-larvae production.
- Promote green-water method of tilapia farming for those who can’t or won’t buy feed.
- Train farmers on feed preparation and encourage them to make their own feed.
- Avoid a culture of dependency by farmers upon services given for free by government, and foster a private-sector led approach to establishment of a medium-scale industry based upon a “satellite farms” concept.
Collaboration between stakeholders (Government departments, farmers associations, regional and international organisations, donors, and education and research institutions) should be encouraged and further strengthened.

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