

# MONOCULTURE OF THE NATIVE FRESHWATER PRAWN *MACROBRACHIUM LAR* IN VANUATU, AND INTEGRATED WITH TARO IN WALLIS AND FUTUNA

## Introduction

For a number of years SPC has promoted aquaculture as a means of contributing to rural food supplies, income generation and foreign exchange. One of SPC's objectives has been to promote extension and research on the sustainable multiple utilisation of inland waters, including integrated aquaculture-agriculture, marshlands and small water bodies.

The integration of aquaculture with agriculture and inland fisheries, and its use in marginal aquatic habitats is a sustainable practice that offers potential for increasing the supply of fish protein as well as income, particularly in rural areas of Pacific Island countries (PIC). Integrated fish farming embraces a diverse set of technologies, which link fish culture to terrestrial farming systems. It is recognized as a sustainable form of aquaculture-agriculture, and as a major contributor to the world's production of farmed fish. Its importance lies in its ability to provide fish protein at a relatively low price to rural communities, and it is therefore considered to be significant in contributing to PICs' food security.

It is common knowledge that integrated fish farming makes a major contribution to world aquaculture and that inland aquaculture is the fastest growing sector of aquatic animal production. Integrated fish farming systems, especially in Asia, have proven highly productive, economically viable and environmentally stable over a long time. However, it has not always been

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possible to transfer these systems to PICs, which have little tradition of fish farming. It is SPC's belief that there is considerable potential for extension of integrated fish farming, in the broadest sense, to many rural areas in PICs. There is also an interest in developing cottage industries.

The goal of an SPC project will be to investigate the potential of growing *Macrobrachium lar*, a native prawn, in monoculture (Vanuatu) and integrated systems as well as determining the feasibility of integrating *M. lar* with taro farming systems (Wallis and Futuna).

## Background to *Macrobrachium lar* culture

The number of species in the genus *Macrobrachium* is approximately 125 worldwide, and these are widely distributed in fresh and brackish waters, mainly in subtropical and tropical areas. Several species are known to occur in Vanuatu, and Wallis and Futuna, one of which, *Macrobrachium lar* has been harvested for commercial sales.

In Vanuatu, *M. lar* that are caught in remote rural areas are an important source of cash income, but because catches have greatly declined recently, this resource is gradually being lost. *M. lar* is believed to make up the bulk of the freshwater

catch, and is the most important species caught from freshwater systems. The various methods used for harvesting are by hand, push nets, woven traps or even fine spears. Most species survive for some time out of the water and are often sold alive, wrapped in taro and banana leaves. Vanuatu Fisheries staff has indicated that local commercial sales at roadside stalls, supermarkets and restaurants have increased recently. In urban areas *M. lar* is a priced food item, affordable by high-income earners only. The average price has gradually increased from 800 vatu per kg in 2000, to 1200–1500 vatu per kg in 2003.

## Background to taro-prawn culture

Swamp-based taro plantations are common throughout the Pacific and are found in both Vanuatu and Wallis and Futuna. In rain-fed areas, taro is grown during the wet season and ponds remain fallow during the rest of the year. In irrigated conditions, taro growing continues throughout the year.

Taro is a common staple food in the diet of Pacific Islanders. Its cultivation is etched into the social fabric of the subsistence lifestyle, particularly in the rural areas where the custom of feasting is an important part of life and ceremonies. Growing taro is demanding work and farmers often spend many hours working their plantations. Plantations have normally been tended for generations and there is a keen awareness of the tenure system.

One of the main attributes for integrating freshwater shrimp farming with taro farming is that it could possibly create added benefits to existing practices with minimal impact. At its most basic approach this project will test whether, for example, prawns could be

stocked directly into taro plantations under normal farming techniques and planting routines. Since wild prawns occur naturally in the taro beds of Wallis and Futuna and Vanuatu it is hypothesized that the farmed prawns could derive most of their dietary needs from the organic micro-fauna already present. This basic system could be modified to fit more productive and commercially oriented systems whereby fallow ponds could be used for monoculture prawn farming with feed inputs to supplement dietary needs. Adopting semi-intensive systems is likely to be relatively easy to establish and this will enable production to grow in accordance to market demand.

In modern times, natural stocks of *M. lar* have declined in many places due to over-exploitation, illegal fishing and habitat modification as a result of an increase in sediment load, pesticides, fertilizers or introduced exotic fish species. Also, some varieties of taro available today are very different from those produced in the past. Many of the ancient varieties of taro have disappeared through lack of cultivation and commercial cultivators consequently have brought in new varieties.

Many island nations are looking to develop integrated aquaculture-agriculture to supplement their food requirements. While exotic species have been trialed in culture in some nations (e.g. tilapia in Samoa and Fiji), indigenous species present less of a threat to natural ecosystems. *M. lar* has been suggested as a potential candidate for culture in taro-prawn culture systems, but some preliminary work undertaken on this prawn species has suggested that it is not an easy species to culture in artificial pond conditions.

Therefore, before any serious attempt is made to evaluate *M.*

*lar* as a culture species, it is necessary to develop appropriate technologies for grow-out of juveniles in culture environments.

The development of these technologies can provide two important outcomes:

1. Provide farmers in PICs with the technology to culture this species in integration with taro, rice, or other food crops.
2. Permit trials to be undertaken to evaluate *M. lar* as a culture species and thus improve our knowledge on the ecology of this species.

The objective of the SPC study is to undertake rigorous trials of integrated taro-prawn culture systems in various combinations to determine the specific environmental conditions that need to be satisfied in order to allow successful juvenile growth to adult prawn. Thus, the study will concentrate on the optimization of parameters that affect the growth of juvenile prawns to adult stage in taro fields. Major parameters will include monitoring and, where applicable, measuring water exchange, stocking density, feeding rate, nutrition, temperature, dis-

solved oxygen (DO), salinity and general maintenance of the culture ponds.

Wild *M. lar* juveniles from discrete water bodies on Efate Island (Vanuatu) and Futuna, where they are native, will be collected and conditioned in tanks. These juveniles will be identified, weighed and stocked into taro plots.

#### Activities carried out before stocking of juveniles (pre-conditions)

Site selection in Vanuatu was carried out in 2004 and the following factors were considered:

- The field must hold water continuously for several months, and in fact, the longer, the better. The field must have an abundant and dependable water supply. Irrigation water, ground water, diverted streams, spring and other water sources (tap) to be used should not be contaminated by pesticides. Good results can be expected if the taro field is covered to a depth of about 30 cm. It is not a serious problem if some areas are shallower or deeper than this, as long as the taro is not affected adversely. However, dikes



***Macrobrachium lar***

(Source: [www.hawaii.edu/hsrc/photos/img001.jpg](http://www.hawaii.edu/hsrc/photos/img001.jpg))

and field boundaries must be above maximum flood level. Sites should be chosen with good drainage in mind, and should be free from flooding.

- Clay holds water better (prevents seepage) and may also be good for taro farming. It should be ensured that water is retained and that the soil or area is suitable for taro farming, or is an existing taro-farming site.
- The site must be close to the farmer's house or station. This makes checking the farm and feeding the prawns less time-consuming. It will also help discourage theft.
- Farmers should be aware that preparing the prawn-taro field for prawn culture entails work. Farmers and staff need to take advantage of existing conditions on the land to save costs. Some examples are:
  - If the land is sloping, a high dike on the uphill side of the field is usually not needed. The layout of the land will help confine the prawns.
  - Existing sites that have ponds or canals within the taro field will be best. If a pond can be included in the system, there may no longer be a need to dig a trench or pond.
  - If the taro field is basin-shaped or oval-shaped, this will save considerable work. For example, in a basin-shaped taro field, the middle of the field is the deepest point and little effort will be needed to raise dikes, and trenches can be dug around the taro field.
- Ease of prawn movement into the taro field is considered and prawns should be free to move quickly into canals or pond refuges when water level is very low.
- Size of taro-prawn plot considers the existing natural partitions of the field and recommended size is 100 m<sup>2</sup> of surface area for taro planting and 50 m<sup>3</sup> of water for *M. lar* rearing.
- Dikes are made strong and big enough to withstand the pressure of the water level at all times.
- Appropriate fencing structures using plastic lining to be constructed around the periphery of the ponds to avoid prawns escaping.
- Prawn refuge to be placed in the ponds.
- Designs with pond refuge, which hold more water and is less risky, are preferred over trench refuge. Refuge size proposed is 20–50% of taro field area. A bigger refuge or a pond adjacent to the taro field may also be connected to it through a canal (depending on the site availability).
- For construction of a refuge, the pond/canal is excavated manually around the field and connected to the field so that the prawns can have excess to the area planted with taro.
- Inlets and outlets to be screened.
- Inlets and outlets to be made of PVC pipes or existing materials or other low-cost materials. Screens prevent the escape of stocked prawns or entry of unwanted fish into the field.
- Follow standard procedures for pond preparation, ensuring all unwanted fish are removed from the pond site.

### Stocking of juveniles

- Timing: Prawns should be stocked after the taro is planted and is well established.
- Stocking rates: No references are available and may not be appropriate in any case. For this trial, five juveniles per cubic meter of water volume will be stocked in all the ponds.

### Feeding

*Macrobrachium* prawns will eat most potential feed material. In the wild, this species consumes worms, snails, clams, fish, rice, wheat, beans, nuts, aquatic plants and some fruits. *Macrobrachium* favor fish/prawn pellets, pieces of fish and clams. Feeding should commence a day after stocking.

- Feed: Monodon starter pellets will be used, starting at 15% of the total body weight and reducing gradually by 5% every month (i.e. after every sampling to four months of culture cycle).
- Sampling of juveniles should occur once every month (10% of the population stocked) using standard procedures.

### Routine maintenance

- Measurement of water temperature, dissolved oxygen (DO), pH, water depth, turbidity, flow rate, monitoring and recording the progress of juvenile growth.
- Daily feeding.
- Maintain weeds and other activities (clean screens).

### Design and size of field

- Independent filling and draining of each taro-prawn pond compartment is considered appropriate.

## Harvesting

- Harvest prawns by draining the water very slowly one week before taro harvest to avoid trapping the prawns in the middle of the field.
- Measure individual weight and length.
- Select large prawns for consumption and confine the smaller prawns for further culture.

## Taro agronomy

- 1 Taro varieties: use existing high-yielding varieties, maturity period of 120–130 days, tolerant to 30–40 cm of water, resistant to diseases.
- 2 Seedbed preparation and planting space: follow as per guidance provided by staff and farmers in country.
- 3 Land preparation: after clearing and removing all rubbish, level the field evenly so that every part of it will be evenly irrigated.
4. Taro transplanting:
  - Age of tubers: 25–40 days (obtain young tubers where possible).
  - Cut old leaves but retain young leaves and shoot.
  - Cut tuber in half.
  - Planting distance: use existing practice or 50–70 cm intervals.
  - Water depth: 10 cm below the water surface
  - Begin harvesting the prawns after 4–5 months.

**Weed control:** prawns stocked in taro fields may help to control certain weeds. Weeds to be controlled through:

- thorough land preparation;
- flooding the field at an effective water depth for 1–2 weeks immediately after transplanting; and

- manual weeding.

**Water management:** water depth in the field when taro is newly transplanted is 3–5 cm. This is then gradually increased to 10–30 cm to provide better living space for the prawns as they grow bigger.

**Other controls:** ensure farm is secure from theft from humans and other pests such as pigs, cattle and eels.

## Progress to date

Wild stocks of juveniles were collected using various methods from streams and creeks in Vanuatu and Wallis and Futuna, and stocked in holding tanks. Prawns were conditioned and thereafter identified. Individual weight and length were recorded and individuals stocked into ponds at 5 prawns m<sup>2</sup>. Two ponds at Sarete village in Santo, Vanuatu and a pond each at Tuatafa and Fiua villages in Wallis and Futuna have been stocked. The stockings in Sarete were carried out from 14–18 February, and in Wallis and Futuna from 22–28 February 2005.

## Anticipated benefits of the study

Results from the growth studies will be used to prepare a report that tabulates basic growth and survival data for *M. lar*. Results will also provide baseline data on the performance of *M. lar* in aquaculture, and indicate directions for future research into the development of husbandry techniques.

Results will not only help to optimize grow-out procedures for *M. lar*, but may also be applied to developing techniques for other indigenous freshwater and brackishwater species for which grow-out rearing conditions are unknown (e.g. there are a number of other

*Macrobrachium* and *Palaemon* species with culture potential). This study could therefore be used as a model when attempting to define the grow-out requirements for other species in the future. Also, data obtained from this study on the optimal conditions for survival and growth of *M. lar* will add to our knowledge of the general ecology of this species, wild caught or hatchery reared. This work has never been carried out successfully in the past.

A national and Indo-Pacific fishery essentially already exists for *M. lar*, but our present knowledge of hatchery technology of this species is limited. The optimisation of pond grow-out environments forms the basis for development of an economically viable production system for most aquatic species. Successful grow-out of *M. lar* would facilitate further culture trials of this species as wild stocks have declined in some places and attempts will be made to culture it. Supplementing wild stocks of various species of prawns and fish with hatchery-reared ones has already been attempted in the Indo-Pacific region. Numerous reports have indicated that stock enhancement needs to be continued and expanded as human impacts on inland environments increase.

Compared with many technologies, taro-prawn culture or other integrated systems are a relatively low-risk technology. Financial inputs are low and technologies are not demanding for farmers so few conflicts are likely with other farm activities in PICs.

Income from prawn sales can provide additional financial benefits to small-scale poor farmers. And since this is a subsistence activity, to a large extent there is little competition in the market among current producers.

Hundreds of individual taro farms that engage thousands of farmers are impacted by low returns from mono-crop taro farms in the Pacific. Many of these farms, their owners or clan members could benefit if we can demonstrate, document and extend information relating to a more sustainable farming system, compared with the existing model of taro-prawn farming. The results will be documented and the findings will be shared through this publication and meetings presented by SPC.

Experiments will be conducted in collaboration with the Department of Fisheries staff in respective countries. Integrated taro-prawn farming is commonly practiced in the Pacific. Improvements in this system will provide an appropriate strategy for small-scale rural farmers in terms of technical, environmental and economic aspects. It will be of interest to all NGOs involved in rural development and specifically on aquaculture extension and outreach activities.

The project involves collaboration with Vanuatu and Futuna Fisheries departments, the Australian Centre for International Agricultural Research (ACIAR), Queensland University of Technology (Brisbane), University of the South Pacific and various Fisheries Departments of Pacific Island countries.



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