

The historical development of seaweed farming, including roles of men and women, and prospects for its future development in Fiji

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Introduction

Aquaculture is a relatively new development in the South Pacific. Many aquacultural techniques are still at an experimental stage. Though Pacific Island countries have sheltered areas of reefs, lagoons and mangrove swamps for aquaculture development, they lack money and technical knowledge. However, with foreign aid, aquacultural techniques for tilapia, milkfish, grass carp, pearl oysters, fresh water prawns and seaweeds have progressed well.

Seaweeds have been used for centuries as a supplement to human food, feed for livestock, fertiliser and recently as a source of chemicals known as phycocolloids, which include agar, alginate and carrageenan. They also provide habitats for the spawning of many marine organisms (e.g. fish, molluscs, crustaceans).

Over 200 seaweed species occur naturally in Fijian waters (Chapman 1977). Three seaweed species were particularly important in traditional subsistence fisheries; these were recorded by Ohno and Critchley (1993) as *Caulerpa* spp. (Nama), *Gracilaria* spp. (Lumi cevata) and *Codium* spp. (Sagati). However, most of these species are not cultivated in Fiji.

This report presents an overview and assesses the historical developmental of seaweed farming in Fiji since 1976. Particular reference is given to *Kappaphycus alvarezii* (still referred to in the industry as *Eucheuma cottonii* species), as it has dominated the Fiji seaweed industry. Statistics were limited in some areas, especially after 1988; nevertheless, through interviews, surveys and literature review, information on the seaweed industry in Fiji was gathered and assessed. Seaweed farming was initially introduced to Fiji in 1976 from the Philippines, and was re-introduced in 1984. The first commercial production began in 1986. In this report, we provide historical details on areas of where farming took place, numbers of farms, marketing, farming methods, production, exports, prices and assistance provided. We also provide an overview of the current

status of Fiji's *Kappaphycus* industry and the relative roles of men and women in rural seaweed farming.

History of seaweed farming and marketing

The Fiji government sees seaweed farming as a potential source of income and employment in the rural areas (Ram 1991). It requires a low level of technology and investment and can be undertaken as a family activity. It has little environmental impact and is normally compatible with traditional fishing and other subsistence uses of the inshore marine environment (South 1993).

Seaweed cultivation was introduced in Fiji in 1976 (Ram 1991), when *Kappaphycus* seed stocks were imported from the Philippines (Solly and Booth 1977). The trials were carried out and maintained for more than two years at Telau Island, near Suva (Prakash 1990). These farms failed due to destruction by a cyclone in 1980 (Ram 1991).

Kappaphycus was re-introduced in 1984 by the Fiji Fisheries Division with the cooperation of Coast Biologicals (NZ) Ltd., with funding support from the Commonwealth Fund for Technical Cooperation (CFTC). The seed stock of *Kappaphycus alvarezii* was imported from Tonga and the trials were conducted at Tavua, Rakiraki and Verata in Tailevu (Ram 1991; South 1993).

The trials were successful, which encouraged Coast Biologicals to assist in the development of the seaweed farming industry in Fiji in collaboration with the Fisheries Division and the Fiji Development Bank, by providing loans to interested farmers.

The first commercial production began in 1986 at Tavua, Rakiraki, Kaba, Kiuva and Rewa. Considerable expansion took place in 1987, with farms established in new areas like Moturiki, Ovalau, Bua, Batiki, Vanuabalavu, Fulaga and Ogea (Ram 1991; South 1993). Coast Biologicals had planned to establish a semi-refined carrageenan (SRC) processing plant in Fiji once the target production of 600

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tonnes (t) was reached. This did not occur for several reasons.

There were substantial setbacks after 1987. The two military coups in 1987 led to trade bans in New Zealand. Banks refused to give credit to farmers. Cyclone Bola in early 1988 destroyed nearly half the crop and the New Zealand dollar strengthened against the US dollar. All of these factors led to near collapse of the industry and, consequently, Coast Biologicals ceased its Fiji operations in July 1988, as economic viability did not appear possible, removing the market as well as the assistance programmes (Robertson 1989; Ram 1991). Coast Biologicals focused its attention instead on operations in Indonesia (South 1993). However, village level seaweed production continued with the help of Fiji Fisheries Division Extension Officers and with marketing arrangements operated by the National Marketing Authority, which is run by the government.

Later, the efforts of UN Food and Agriculture Organization South Pacific Aquaculture Development Project (FAO SPADP) and the Fisheries Division with financial assistance from the New Zealand government revived the industry. The Fisheries Division established a revolving fund with part of the New Zealand aid money so that it could assist farmers to market their seaweed. The National Marketing Authority and the FMC Cooperation, Marine Colloids Division, assisted in marketing seaweeds until the end of 1989 (Ram 1991; South 1993).

From the beginning of 1990, seaweed marketing was carried out by a joint-venture company with local, Australian and New Zealand shareholders called Seaweed (South Pacific), which also provided technical assistance and free planting materials to farmers. The company undertook several activities in a bid to revive the Fiji seaweed industry (Robertson 1989). It set up a farm at Nanuca, Savusavu and planned two more farms at other locations in Fiji. It also planned to start an SRC processing plant in Lautoka once the supply became steady. Unfortunately, Seaweed (South Pacific) withdrew after only a short time in mid-1990 due to the effects of bad weather conditions on cultivation and losses of crops due to damage by cyclone-induced high tides and heavy swells (Pickering 2005). After the withdrawal, the National Marketing Authority took over the marketing of seaweed again. Then Oceania Trading Company handled the collection and marketing of seaweed from 1991. It closed its operations in 1993 due to severe losses after cyclone Kina (S. Mario pers. comm.). The company also suffered because of high moisture content of seaweed and quality control problems which resulted in several of its consignments being rejected by importers. This caused further cash flow problems and discouraged farmers from pursuing seaweed farming.

Additional trial cultures of seaweed farming were carried out in 1997. A joint project by the Fisheries Division, FAO SPADP Phase2 and the University of the South Pacific was set up in February 1997 for the trial culture of *Meristotheca procumbens* in Rotuma. The project aimed to assess the possibility of culturing this seaweed – including assessing its viability and potential for commercial farming, and to select potential culture sites in Rotuma. However, the project concluded in July 1997 due to sedimentation in the netted baskets, which was a result of the trial site being too close to the shore (Arulampalam 1997). At around the same time, the trial culture of *Caulerpa racemosa* was done on Naviti Island.

In 1998, seaweed farming in Fiji took a new turn. Under the Commodity Development Framework to assist economic development, the government expressed its commitment to re-establishing *Kappaphycus* farming. In early 1998, existing farmers in Kiuva were assisted. *Kappaphycus* farming also commenced in areas close to Suva, Nausori and Lami. Planting materials were available in Cakaudrove, Macuata, Lau and Bua. Initial assistance was provided to farmers to purchase boats, engines, raffia and ropes worth FJD 4,000. These items were later transferred to farmers at no cost once they had sold 20 t of dried *Kappaphycus* to the Fisheries Division at a flat rate of FJD 500/t (FJD 0.50/kg). The Fisheries Department came up with the scheme because it was very difficult for the farmers to arrange for capital to start cultivation. Under the scheme, the Fisheries Division recovered money used for farming in less than three years and was also able to make some profits by exporting the seaweed at a higher price (S. Mario pers. comm.).

The Fisheries Division actively trained farmers by conducting workshops on sites and also provided technical advice. The Fisheries Division also planned an SRC processing plant if the target of 12,000 t per year was reached. This plant would have generated employment for about 1400 people (S. Mario pers. comm.).

Cultivation methods

The cultivation methods for seaweed have gone through a number of changes: from the raft or floating method to the long line method and the fixed off-bottom or mono-line method (Ram, 1991). When the trials of *Kappaphycus* cultivation were introduced in Fiji in 1976, farmers used the raft or floating method. This produced a faster growth rate because the seaweed was cultivated closer to the water surface (Solly and Booth 1977) but the method was difficult to manage and the seaweed was easily damaged by rough weather and motor driven boats (Prakash 1990).

The most widely used method in Fiji now is the mono-line or fixed off-bottom method (Ram 1991). This method was used in seaweed farming because it is simple to construct, easy to manage, and less costly, and the farms are easily accessible at low tide. Initially, *Kappaphycus* cuttings, each weighing about 200 grams, were tied to monofilament nylon lines (80 kg test), 10 meters long and fastened to stakes at each end. The technique was later modified to use 3 millimetre polypropylene rope in lengths of about 5 to 7 meters (Prakash 1990), and was eventually further modified to use 10-meter lengths of rope (S. Mario pers. comm.).

Production and exports

Kappaphycus grows very fast, maturing in about 8 to 10 weeks. This allows for about four to five harvests per year. April to November is the best growing season. In October production reaches its peak because of the suitable climatic conditions. After November, production slows. In addition, farmers are advised not to invest much due to the danger of cyclones (S. Mario pers. comm.).

During harvesting, everything is removed from the sea: the stakes, the rope and the seaweed. Pruning is not done. Ten per cent of the harvest is used as seed stock for the next season. One 10-meter mono-line can produce more than 5 kg of dried seaweed in a season (S. Mario pers. comm.). After harvesting, the seaweed is sun dried on racks, usually constructed along the coastal areas, for three to four days until the water content is reduced to no more than 35 per cent (Prakash 1990; Ram 1991).

In 1985, a year after the re-introduction of *Kappaphycus* in Fiji, 30 t of dried *Kappaphycus* were produced by the 35 farms. When commercial production commenced in 1986, the farms increased production to 240 t in 1987, exporting about 200 t of *Kappaphycus*. By mid-1988, about 260 farms had been established but the sudden withdrawal of Coast Biologicals resulted in exports declining to about 60 t of dried seaweed by the National Marketing Authority. The lack of marketing and declining world seaweed prices discouraged farmers, and this resulted in a decline in the number of farms.



Figure 1. Lines prepared on shore. The lines are 10 m long and have raffia tied at intervals.



Figure 2. Rope with *Kappaphycus* propagules bundled up to be taken to sea.



Figure 3. *Kappaphycus* on drying racks.

Only about 80 t of dried seaweed were exported in 1989 and about 87 t in 1990. By 1991, only 33 farms remained and 32 t were exported. In 1992 and 1993, 48 t of *Kappaphycus* were exported each year from 33

farms. All exports of *Kappaphycus* seaweed ceased after 1993.

Though there were no exports after 1993, small-scale production did take place. The Fisheries Division bought dried *Kappaphycus* from farmers and stored it. In 1997, *Kappaphycus* production was about 50 t. A local enterprise, the Makosoi Soap Factory, had an agreement to buy 300 kg of *Kappaphycus* every 3 weeks for the manufacture of soap (S. Mario pers. comm.).

During the first five months of 1998, 2.2 t of dried *Kappaphycus* was bought from the farmers by the Fisheries Division and stored in the bulk store at Lami. By the end of July, 20 t of seaweed were collected and exported to Copenhagen Pectin Company in Denmark (S. Mario pers. comm.).

A resurgence in seaweed farming occurred in 1998 thanks to the Fisheries Division's work to revive the industry. At the end of 1998, there were 37 fully operating farms at Kiuva alone. These farms produced up to 40 t of dried *Kappaphycus* per month (S. Mario pers. comm.). The target for the Fisheries Division was to establish 12 main sites, with each site producing 400 t per year by the year 2000. To help reach this goal, the government provided a subsidy of FJD 176,000 annually until the year 2000 (E. Ledua pers. comm.).

Seaweed prices

During the trial production of *Kappaphycus* in 1985, Coast Biologicals bought the dried seaweed directly from farmers, paying different prices for different grades, depending on the moisture content.

The price at which dried *Kappaphycus* was exported varied after commercial production began in 1986. In 1986, Coast Biologicals marked up the price of grade-1 seaweed by 42 per cent, buying from farmers at a price of FJD 550 per t. This large mark-up was mainly due to high transportation costs and other setup costs.

In 1987 the mark-up was reduced to 15 per cent, and farmers were again paid FJD 550 per t of dried grade-1 *Kappaphycus*. After withdrawal of Coast Biologicals in mid-1988, the export price fell to FJD 350 per t, but the Fisheries Division bought seaweed from the farmers at a flat rate of FJD 450 per t. At the beginning of 1990, Seaweed (South Pacific) bought dried seaweed from farmers. The farm-gate price in 1991 was FJD 0.40 per kg (FJD 400 t⁻¹) and in 1992 it was 35 c per kg (FJD 350 t⁻¹).

The Makosoi Soap Factory signed an agreement to buy 300 kg of dried *Kappaphycus* every three weeks at a price of FJD 0.75 per kg for rain-washed sea-

weed and FJD 0.65 per kg for unwashed seaweed. From 1997 to 2002, the Fisheries Division bought seaweed from farmers at a flat rate of FJD 500 per t. The Fisheries Division bought seaweed from as far away as Ono-i-Lau in the Lau Group between 2002 and 2005.

Seaweed farming assistance

Seaweed farming in Fiji has always been subsidised. A lot of financial assistance comes through aid funds to develop the industry. The seaweed project received aid from New Zealand from its inception until the end of 1992. Initially, farmers received the planting material with the equipment at no cost.

The Fisheries Division, through its technical and extension staff, assisted farmers in negotiating with the marketing companies. The Fisheries Division often provided transportation of dried seaweed from the outer islands. They also facilitated the loans provided by the Fiji Development Bank under which farmers paid an initial deposit of 33 per cent and got 2/3 financed by the bank at an interest rate of 8 per cent (Ram 1991).

In 1988, when the world price of seaweed declined to FJD 350 t⁻¹, the Fisheries Division bought seaweed from farmers at a flat rate of FJD 450 t⁻¹ and then exported it with the help of the National Marketing Authority at FJD 350 t⁻¹. This subsidy was provided to farmers so that the fluctuations in the world market prices would not discourage them.

Under the Commodity Development Framework, the Fisheries Division provided FJD 4000 in financial support to individual farmers for purchasing a 15 hp outboard engine, an 18 foot punt, ropes and raffia from the division (Fig. 4). The farmers were provided with free seed stock. Prior to receiving the support, the farmers were required to plant over 400 lines of seaweed and to agree that the punt and the outboard engine would only be used for seaweed farming and not for any other commercial purpose. Farmers who received the support had to have a minimum of 750 lines in place and were required to maintain that level throughout the year. The farmers were also required to strictly follow the drying process and quality control requirements of the Fisheries Division. The agreement also specified that the Fisheries Division or a company approved by it would be responsible for buying seaweed from farmers and that dried seaweed would be purchased at a flat rate. The punts and outboard engines remained the property of the Fisheries Division until the recipients had sold a total of 20 t of dried seaweed to the division.

At the Kiuva farm, the Fisheries Division constructed 20 drying racks measuring 25 m x 8 m. For this



Figure 4. Eighteen-foot punts with 15 hp outboard engines provided to farmers.

the farmers provided the posts while the Fisheries Division provided other material as well as labour (S. Mario pers. comm.).

Role of men and women in seaweed farming

Kappaphycus farming requires a low level of technology and is ideal for rural Fiji. Farming is organised as a family activity and run as a family business. Men, women and children are involved in farming seaweed because it is cultivated in inshore areas and these areas are also used for subsistence fishing.

Women play an important role in both farming and processing. Women select planting material before the seaweed is planted. This is an important role because if the planting material is of poor quality then the growth of the seaweed will generally be poor. Women and children also help prepare lines at home. At the farm, the women, children and men attach the seaweed planting material to the prepared lines before they are stretched out under water. On the isolated island of Ono-i-Lau, seaweed farming strengthens family units because all family members take part in seaweed farming from the preparation of materials to planting in the farms. Most of the preparations of farming materials are home-based.

Both men and women harvest seaweed. Plants are either removed from the line or are simply pruned back heavily, leaving some for regrowth. The harvested plants are then air dried on a platform. Women take care of this post-harvest processing. After 3–5 sunny days, the dried seaweed is ready for packing in bags. Women and men do the packing, after which the dried seaweed is ready either for storage or for transportation. In general, women carry out quality control.

Status and prospects for the future

In 2005, there were four existing sites under cultivation. Two were in the Lau group, on the islands of Ono-i-Lau and Namuka-i-Lau. One was on Kadavu, near Kabariki village and one was on Vanua Levu, near Namuka village. While production is carried out on a commercial basis in these areas, the volumes are very small (less than 20 t). It was projected that production would be around 100 t.

Two companies undertook marketing, paying a farm gate price range of FJD 0.60–0.70 per kg. This price provided

a relatively low income compared to other alternatives available such as fishing. The rise in fuel and transport costs increased the cost of production so much that seaweed farming was no longer lucrative. Dried seaweed was exported to the Philippines by Agro-Marketing Company while a newly established marketing company exported dried seaweed to China.

The government still sees potential in the seaweed industry and assistance programmes remain in place subject to availability of funding. But the future of seaweed farming in Fiji will depend on a number of factors. If markets are available and steady, the production is bound to increase. To achieve this, a stable company is required. This company would need to make an exclusive deal with the buyer to supply the seaweed for a contracted period of time, with a possibility of extension.

The success of this industry will also depend on world market prices, the cost of freight and currency fluctuations. The development of an SRC processing plant would help reduce cost, making the industry more stable. This would substantially alter the economics and feasibility of seaweed cultivation in the longer term (South 1993). The introduction of new uses for carrageenan, such as food, pharmaceutical, medical and industrial products, will boost the seaweed industry. The development of small cottage industry, such as making soap, should be considered in outer islands where transportation are high, as raw materials like virgin coconut oil are readily available in these areas.

The amount of aid given to the industry in terms of finance and technical advice will also affect the industry. More farmers need to be convinced to

go into seaweed farming and provided with the required support to start their own farms. In Fiji, natural disasters and political instability have significantly affected seaweed farming. Preventive measures should be taken to protect the farms from such risks.

Conclusion

Seaweed farming in Fiji has become very popular because it requires a low level of technology and investment and gets considerable government support. It provides an important source of income to many rural coastal villages and isolated islands.

One of the major problems faced by the farmers is the loss of crops during cyclones. This discourages some farmers and makes it difficult for the Fisheries Division to gain the confidence of prospective farmers. But a major advantage of seaweed farming is that as seaweed takes only a short time to grow, the revival of the industry is quick and easy compared to other aquacultural and agricultural industries. If sufficient manpower is available, farmers can remove their seaweed as soon as cyclone warnings are given.

Another major difficulty faced by farmers is the marketing of seaweed. Even if the seaweed is marketed, there is always a danger that prices will fall due to high freight costs, fluctuations in currency values and the oversupply of seaweed. One way to reduce this risk would be to set up an SRC processing plant in Fiji or somewhere in the Pacific. This would not only increase the yield and improve the quality of seaweed but would also generate employment for thousands of people and would provide another source of foreign exchange for the government.

If the difficulties faced by farmers are addressed, the seaweed industry can be expected to be a viable one. There are extensive potential areas for further cultivation. This will shift the concentration from farms on land to the use of the sea for farming. A major consideration would be to develop larger commercial farms to sustain production. These should take into account customary marine ownership.

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