Farming of the seaweed *Kappaphycus alvarezii* in Tamil Nadu coast - status and constraints

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Kappaphycus alvarezii is one of the economically important red algae, which yields carageenan, a commercially important polysaccharide. Carrageenans are used in a variety of commercial applications as gelling, thickening, and stabilizing agents, especially in food products such as frozen desserts, chocolate milk, cottage cheese, whipped cream, instant products, jellies, pet foods and sauces. Besides, carrageenans are used in pharmaceutical formulations, cosmetics and industrial applications such as mining. Commercial cultivation of *K. alvarezii* originated in Philippines in the year 1960. Since then, countries like Japan, Indonesia, Tanzania, Fiji, Kiripati, Hawaii and South Africa have been cultivating this species on a large scale. In India, cultivation of this seaweed started at Mandapam on the south-east coast of India, during 1995–1997. Initially, net-bag technique was practiced. Later, based on the results of more than 120 trials, the bamboo raft technique emerged as the most suitable commercially viable method. The contract farming method with PepsiCo was successfully implemented in March 2003. Later in the year 2008, Aquagri took over the PepsiCo project. Experience obtained from experimental and field cultivation of *K. alvarezii* in several Indian coastal areas indicate the possibility of large-scale commercial cultivation and a means of additional income generation for the coastal fisherfolk. Commercial cultivation of *K. alvarezii* started in 2003 along the Tamil Nadu coast. At present, *K. alvarezii* production is carried out in five coastal districts of Tamil Nadu namely Ramanathapuram, Pudukottai, Thoothukudi, Thanjavur and Kanyakumari.

Culture techniques

Along Tamil Nadu coast, floating raft method (Fig. 1) was found to be commercially viable method in *K. alvarezii* farming. Floating raft is made of bamboo with 12' × 12' for mainframe and 4' x 4' for

Fig. 1. Floating raft method in *K. alvarezii* farming

diagonals. In each raft, 20 polypropylene-twisted ropes are used for plantation. The fragments (approximately 150 g) are tied at a spacing of 15 cm in a rope (Fig. 2). Totally, at 20 points the fragments are tied in a rope. Thus, for one raft the plantation requirement is 60 kg. To protect the *Kappaphycus* from grazing, fishing net of 4 m x 4 m size is tied at the bottom of the raft. One anchor of 15 kg can hold a cluster of 10 rafts. During rough season two to three anchors are required to hold a cluster of 10 rafts.

Fig. 2. Seaweed fragments being tied in the rope

The unit cost per bamboo raft for *K. alvarezii* farming works out to be ‘ 1000. Details are given in Table 1.

Table 1. Unit cost per bamboo raft for seaweed cultivation

Item	Quantity required	Cost per raft (₹)
3-4" dia hollow bamboos of 12’x 12’ for main frame + 4’ x 4’ for diagonals (without any natural holes and cracks) @ ₹ 3.75 per feet of bamboo	64’	240.00
Five-toothed iron anchor of 15 kg each (@ ₹ 50 per kg) – one anchor can hold a cluster of 10 rafts	1.5 kg	75.00
3 mm PP twisted rope for plantation – 20 bits of 4.5 m each (@ ₹ 130 per kg)	420 g	55.00
Cost of HDPE braider pieces (20 pcs x 20 ropes = 400 pcs of 25 cm each) (@ ₹ 190 per kg)	165 g	31.00
Braider twining charges @ ₹ 1.00 per 20 ties. For one raft 400 ties = ₹ 20	20 ropes	20.00
Raft framing rope 6 m x 12 ties per raft *i.e*., 36 m of 6 mm rope (@ ₹ 130 per kg)	650 g	85.00
Used HDPE fishing net to protect the raft bottom (4 m x 4 m size) (@ 60 ₹/kg) + labour charges ₹ 10	1 kg	70.00
2 mm rope to tie the HDPE net (28 m) (@ ₹ 130 per kg)	100 g	13.00
Anchoring rope of 10 mm thickness (17 m per cluster of 10 rafts) (@ ₹ 130 per kg)	100 g	13.00
Raft linking ropes per cluster 10 rafts – 6 mm thick – 2 ties x 3 m x 9 pairs = 54 m length (@ ₹ 130 per kg)	100 g	13.00
Seed material (150 g x 400 ties @ ₹ 2.50 per Kg)	60 kg	150.00
Raft laying + maintenance cost	-	100.00
Miscellaneous expenses	-	135.00
Total cost per raft		1,000.00

Self Help Group model in *K. alvarezii* cultivation in Tamil Nadu coast

In *K. alvarezii* cultivation, self help group model promoted by District Rural Development Agency (DRDA), Department of Biotechnology (DBT) and Tamil Nadu State Fisheries Department with the assistance of Non-Governmental Organizations (NGOs) is found to be more effective (Fig. 3). A group of five members including men and women is formed, which is called as Joint Liability Group (JLG). Some of the eligibility conditions, which a group has to fulfill are:

Fig. 3. Planting of 150 g grows up to 500 to 1000 g in 45 days

- Each member in the group has to undergo three days training programme on seaweed cultivation.
- Should be Below Poverty Line.
- Preferably, they should have place near the sea shore.
- Should not be a defaulter with any financial institution / government.
- Interest and willingness of the farmer to take up *K. alvarezii* farming.

The group that fulfills the above conditions is eligible to avail ₹1.54 lakhs as loan for 225 rafts (45 rafts per member). Out of this ₹1.54 lakhs, ₹ 77,000 is given as subsidy through the concerned promoting agency. Remaining ₹ 77,000 is availed by the members through bank loan at nominal interest, which has to be repaid within three years.

Economic impact due to adoption of *K. alvarezii* farming

The farming is taken up for nine months (*i.e.*, February to October) in a year. The crop is ready for harvest after 45 days from planting (Fig. 4). From the 45th day, one raft is harvested every day (Fig. 5) and subsequently planted and floated in the sea. Hence, one crop / cycle duration is 45 days. In the first year, four crops are harvested. During the second and third year, three crops are harvested. On an average three to four crops are harvested in an year.

Fig. 4. Self Help Group model in *K. alvarezii* cultivation in Tamil Nadu coast

Fig. 5. Raft ready for harvest

Average yield per raft (12 x 12 feet) is 240 to 260 kg. They retain 60 kg as planting material for the next crop. If 240 kg of seaweed is dried, it results in 24 kg dry weight (Fig. 6). The current price is ₹ 2.50 per kg on wet weight basis and ₹ 18 to 20 per kg on dry weight basis. A fisherman family earns around ₹ 9000 per month (if hired labour is engaged @ ₹ 100 per raft). In this farming mostly family labour is involved, hence a fisherman family earns around ₹ 12000 per month (Table 2).

Fig. 6. Seaweed dried in sandy beach

Income model for one cycle (45 days)

Table 2. Income generation in one culture cycle of 45 days

Particulars/Description	Cost (₹)
Strength of SHG – 5 nos. per group	
Number of harvest per day	One raft
Seaweed biomass harvest per day (wet weight) (retaining 2700 kg as seed for the next crop)	9,000 kg
Seaweed dry weight @ 10:1 ratio dry weight basis	900 kg
Selling price @ ₹ 20 per kg (20 x 900)	18,000
Selling price excluding technical labour cost @ ₹ 100 per raft (100 x 45 = 4,500*)	13,500
Income of SHG member per day	300
Income of SHG member per month	9000
Income for 4 cycles in the 1st year per SHG member (Approximately 200 days)	60,000
Income for 6 cycles in the 2nd and 3rd year per SHG member (Approximately 150 days per year)	90,000

**Mostly family labour is involved*

***K. alvarezii* production in Tamil Nadu coast**

From the year 2003 to 2009, *K. alvarezii* production has shown a steady increase from 147 t to the maximum of 865 t in the year 2009 (Fig. 7). A decline in production was noted in 2010, which may be due to heavy storm and high temperature. At present, around 1000 to 1200 families are dependent on *K. alvarezii* farming for their livelihood in Tamil Nadu coast. Around 180 and 70 families in *Sambai* and *Mangadu* village respectively in Ramanathapuram District, depend entirely on *K. alvarezii* farming for

their livelihood. In these villages there are around 8000 seaweed culture rafts floated in the Palk Bay region.

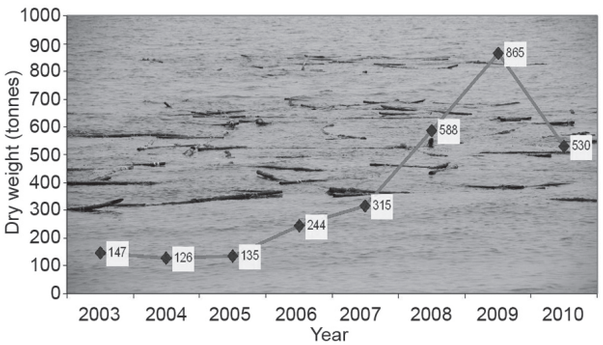

Fig. 7. Seaweed (*Kappaphycus alvarezii*) production in Tamil Nadu (2003-2010)

Constraints in *K. alvarezii* farming

Grazing

Nibbling by herbivores like siganid, acanthurid, sea urchin and starfish on tips of branches is the major problem faced by the seaweed farmers (Fig. 8). During the month of May – June, the grazing intensity is more, which affects the yield up to 50-80%.

Epiphytism

It is the attachment of undesirable seaweeds to the cultured species (Fig. 9), which is common among tropical seaweeds that usually occur at the onset of monsoon brought by change in water temperature, trade wind and water movement. Availability of limited substrate for the drifting seaweeds contribute to epiphytism that compete for space, nutrient and sunlight. During the month of May – June, majority of the seaweed farmers face this problem.

Fig. 8. Portion of *K. alvarezii* grazed by herbivores

Fig. 9. Bamboo raft with *K. alvarezii* completely covered by *Lyngbya* sp.

Disease

Diseases are generally caused by low salinity, high temperature, and light intensity. When the plant is under stress whitening of the branches occurs, which results in crop loss (Fig. 10).

Fig. 10. Bleached seaweed fragments

Apart from the above mentioned problems, natural calamities like heavy storm and cyclone cause complete damage to *K. alvarezii* farming.

The acceptance of this farming practice is indicative of the fact that a low cost simple technology, which can provide substantial returns, can find a better adoption among the coastal fisherfolk. There still exists a controversy regarding the exotic status and the invasive nature of *K. alvarezii.* The current introduction of *K. alvarezii* to Tamil Nadu coast for farming by CSMCRI was of exotic origin. Bioinvasion of *K. alvarezii* on branching corals (*Acropora* sp.) in the Krusadai Island of Gulf of Mannar has been reported. The fear of bioinvasion of the seaweed is mainly based on the propagation through spores. However, it has been reported that the propagation through spores is not viable in the case of *K. alvarezii*. Incidental observations based on short-term studies

are noted on invasive nature of *K. alvarezii*. Therefore, it is premature to comment on the adverse impacts of *K. alvarezii* on corals, sea grass and associated organisms. Long-term investigations are required for making conclusive remarks on the invasive nature of *Kappaphycus* on coral reef ecosystem. It is also suggested to undertake a research programme with integrated and multi-stakeholder approach involving researchers, seaweed farmers, traders, industrialists, conservators and fisheries developmental agencies to investigate the impact of *Kappaphycus* farming on the livelihood of fisherfolk and coastal environment.