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# Structure, Conduct and Performance of Value Chain in Seaweed Farming in India§

**M. Krishnan[a]* and R. Narayanakumar[b]**
[a]Central Institute of Brackishwater Aquaculture, Chennai - 600 028, Tamil Nadu
[b]Central Marine Fisheries Research Institute, Kochi - 682 018, Kerala

**Abstract**

Among the three types of technologies available in the fisheries sector in India, seaweed farming, initially promoted as a livelihood option, has emerged as the one area which probably has the maximum potential for up-scaling. This paper has examined the structure, conduct and performance of the value chain in seaweed farming in India inquiring into the production, institutional, marketing, social and community relationships in small-scale seaweed farming in the Ramanathapuram district of Tamil Nadu and the concept of self-help groups (SHG) as an increasingly workable option for coastal resources management. The value chain analysis of the sector has substantially proved that committed and synergistic production, marketing and institutional arrangements enabled by corporate leadership, offers considerable savings in transaction costs. The SHG model has also shown strong gender orientation in the initial years of seaweed culture in the district contributing to strong structural foundations to the movement. The seaweed sector in the coastal India has all the potential to rise from the low-income conditions normally associated with basic livelihood activities to higher levels of employment-income-consumption relationships.

## Introduction

Fisheries technologies can be broadly classified into livelihood options which require very little capital investment and ensure supplementary income for primary stakeholders; intermediate technologies that require limited capital and correspondingly deliver larger gross incomes, the management of which requires keen value chain supervision; and commercial technologies that are accompanied by demands of capital investment and professional management of value chain to ensure substantial and sustained levels of higher income (Krishnan and Narayanakumar, 2010).

In India, seaweed farming, as common pool resources, stands out as the best example of community-based coastal resources management (CBCRM) approaches that have enhanced the levels of employment and income among coastal communities. Even as open access persists in most of the country's fishing grounds and state policies are unable to catalyze the development of an efficient and sustainable fishing and fishing-related activities, CBCRM approaches based on self-help group (SHG) concept centred on property rights are being increasingly adopted by the fisher folk, private sector, department of fisheries and non-governmental organizations (NGOs) supported by research and funding institutions in seaweed farming as both tactical necessity and strategic imperative.

The success of SHG movement in the seaweed sector must be juxtaposed with the unprecedented and rapid rise in the prices of cottonii (*Kappaphycus* spp.) during late 2007 and through the summer of 2008, severely affecting the international carrageenan industry. This was labelled by many researchers as a seaweed crisis (Neish, 2008).

This paradox of market uncertainties is further embedded in the phenomenon of rapid global economic

* Author for correspondence;
Email: mkrishnan57@gmail.com

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integration, which if not managed properly, threatens to exacerbate the plight of coastal communities. Specifically, there are dangers of unsustainable production spurred by the strong demand of global markets and breakdown of emergent community property rights regimes [Jacinto (Jr), 2004].

## Objectives of the Study

This study envisages developing linkages conceptually between value chain analysis which is used as a tool for inquiring into production, institutional arrangements, marketing, and social and community relationships in small-scale seaweed farming and the concept of self-help groups as an increasingly workable option for coastal resources management. The paper has addressed seaweeds as means to assess the applicability of value chain analysis as they relate to the current situation of production, institutional arrangements, marketing, and social and community development.

## Data and Approach

The Ramanathapuram district in Tamil Nadu was identified as the study area for analysing the structure, conduct and performance of seaweed value chain in India in view of its historical background, locational advantages, industry interactions, socio-economic and institutional framework and opportunities for expansion and growth. The sample comprised 437 seaweed farmers at 17 locations in Mandapam and Rameshwaram. The population of organized SHG seaweed farmers at the time of survey was estimated at 1,000 (Krishnan and Narayanakumar, 2009).

A value chain describes the full range of activities which are required to bring a product or service from conception, through different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to consumers and final disposal after use (Kaplinsky and Morris, 2001). In the context of seaweeds as in fisheries, increased trade poses a significant risk to the valuable ecosystems, but on the other hand, has great potential as a source of desperately needed income for local fishing communities [Jacinto (Jr), 2004]. Trade can enhance employment and income generation, both directly, and through multiplier effects, in developing countries but of equal importance is the need to consider distributional impacts of trade to ensure that it is the poor producers who actually reap the economic benefits of trade by effecting reduction in transaction costs rather than mere increase in macroeconomic indicators (Macfadyen *et al.,* 2003, Van Mulekom *et al.,* 2004).

### Seaweed Farming

In Tamil Nadu, the seaweed farming of *Kappaphycus alvarezii*[1] on industrial scale was initiated by the Pepsi Holdings India Private Limited (PepsiCo) in 2000. After three years of demonstration to prove the economic viability of seaweed farming, PepsiCo modified its business model in 2003 by motivating the fishers to take up seaweed farming in a modified contract farming mode through formation of self-help groups. They also fostered guaranteed buy-back arrangements and arranged institutional financial support with the State Bank of India (SBI) and National Bank for Agriculture and Rural Development (NABARD). The contract farming model proposed an allocation of 45 rafts for each individual member of a SHG and a harvest cycle of 45 days. The model assumed that each individual within the group would be able to conveniently plant and harvest one raft per day. A farmer should be able to harvest around 260 kg per raft, out of which 60 kg would be used as planting material for the next cycle, leaving 200 kg of fresh weed or 22 kg of dry weed available for sale. The dry seaweed was priced at Rs 16/kg and a farmer earned a minimum of Rs 352/day and a family of two adults handling two rafts could earn as much as Rs 1500/day (2009). The seaweed farming season extends for 9 months in a year, except the North-East monsoon period.

Presently, about 50 such groups are successfully practising seaweed farming in the Ramanathapuram district alone. Due to demonstration effect, the seaweed farming is gradually spreading to the neighbouring districts of Thanjavur, Pudukottai and Tuticorin.

### Production Value Chain

Neish (2008) has described three types of value chain models in seaweed farming and postulated the

[1] For a complete understanding of the biology, historical perspective, species and socio-economics of seaweed collection and seaweed farming, please see, Kaladharan and Kaliaperumal (1992); Kaliaperumal and Kalimuthu (1997); Kaladharan and Jayasankar (2003); Krishnan and Narayanakumar (2010)

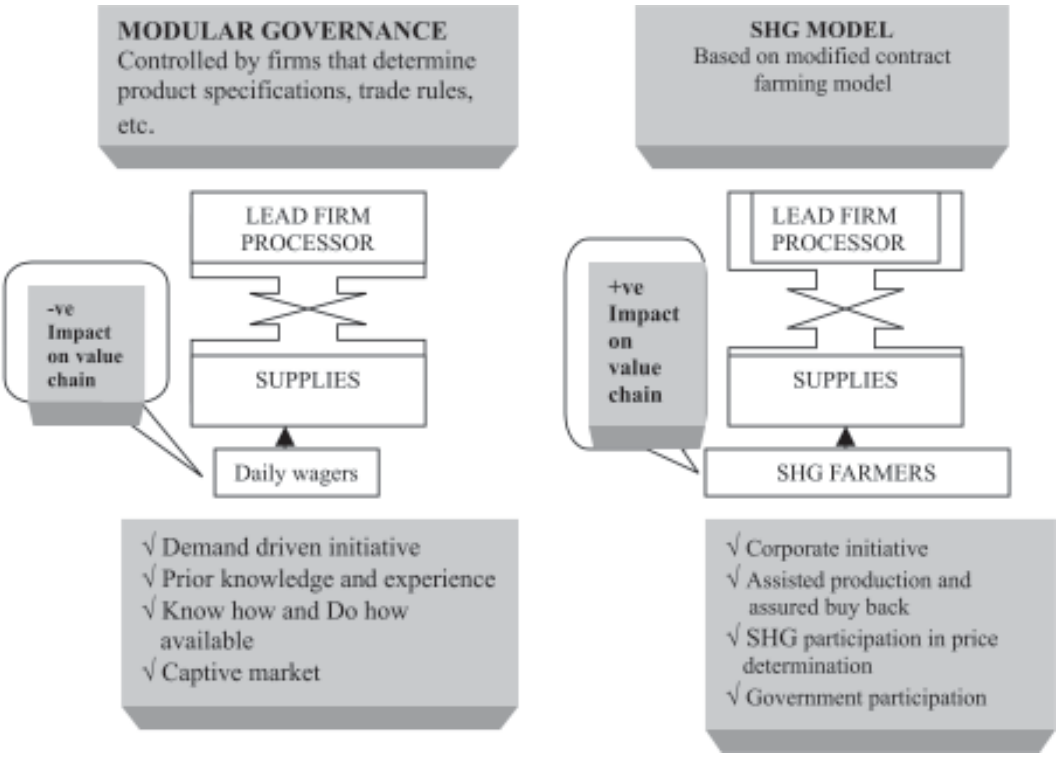


**Figure 1. Structural relationships in value chain across models of production**

development of a relational value chain model in seaweed farming in future. PepsiCo launched itself into seaweed farming in India by adopting the daily wage model and then shifted to modified contract farming model (Figure 1). The primary deterrent to the modular model of governance (MMG) of seaweed farming that the company faced was human resource management. Though fishers were the willing learners and were quick to learn the nuances of seaweed farming, the negative externalities associated with employer-employee relationships proved to be a major hindrance to achieving optimal production targets and a drain on value chain.

The SHG model of production relationships was based on inclusive development. Basic infrastructure such as rafts and ropes and accessories were provided by the company to the SHG in the first instance. Seed material was also provided by the company for the first crop. The executives and field officers of the company along with the NGO involved in the coordinating efforts, supervised the crop vigorously and made periodic evaluations until such time the group could manage the crops independently. The harvests were made by the groups and the dried weed was procured by the company from the farmers at the beach and transported to the processing plant.

The value chain in the SHG model was considerably enhanced in comparison to the MMG. In the MMG, the transaction costs in the value chain were high owing to the negative externalities, like the fishers being only paid daily wages without any incentives for committed performance (FAO, 2003). The value chain also suffered further leakages in MMG by the social and cultural alienation that a multi-national company faced in a new, field level environment. These operational constraints especially of human resource management, were the reasons that made PepsiCo to hive off the seaweed division officially to Aquagiri Processing Private Limited in 2008, stating that it was not their core strength. The SHG model scored high in respect of the independence, involvement and incentives. It maybe noted that the SHG model reflects the essence of the relational governance model (RGM) envisaged by Neish (2008) and Hurtado *et al*. (2001).

## Institutional Value Chain

The positive coordinates of the institutional value chain were developed and sustained by the low levels of initial investment requirement which was borne by the company, backed by technical inputs on the technology provided by the Central Marine Fisheries

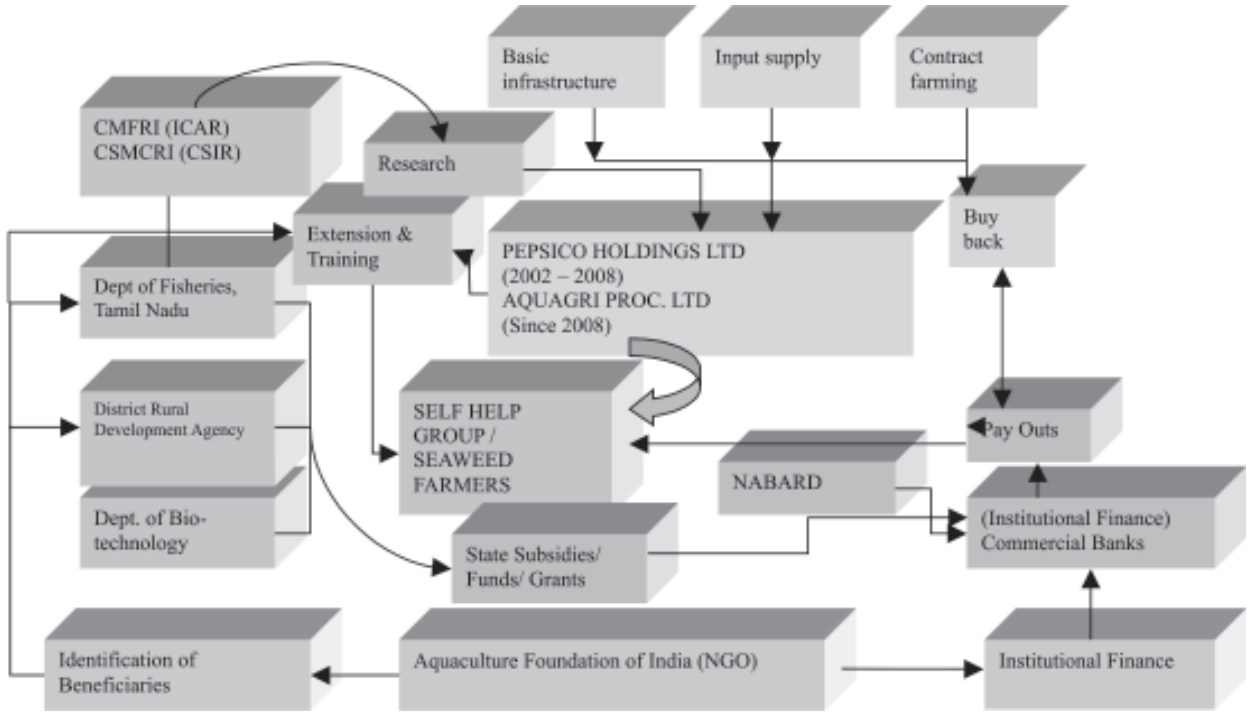


**Figure 2. Structure of institutional value chain in seaweed farming**

Research Institute (CMFRI) and the Central Salt and Marine Chemicals Research Institute (CSMCRI), with funding through the District Rural Development Agency (DRDA) and the Department of Biotechnology (DBT), Government of India. Refinance for seaweed farming was made available by NABARD and the selection of SHGs was done by a committed NGO and class room cum field level training was organized and imparted by the Department of Fisheries, Tamil Nadu. Commercial banks held the accounts of the SHGs and the remittances for seaweed delivered to the company were made to these accounts directly by the company. Complete transparency and effective coordination among the direct and indirect partners in this development of seaweed farming (in Ramanathapuram district) led to minimization of transaction costs substantially and added to both economic and social value chains (Caddy and Santelices, 1988) (Figure 2).

## Marketing Value Chain

The marketing value chain for seaweed is illustrated in Figure 3. Basic prices are arranged to the satisfaction of the farmers taking into account the effort invested (Gereffi *et al*., 2005). In 2009, Aquagri was offering Rs 16/kg of dried weed. Although it has been argued that Aquagri currently holds the monopsony advantage, competing companies with an interest on *Kappaphycus* have routinely induced the farmers to break the contracts by offering a marginally higher price (Krishnan and Narayanakumar, 2010a,b). However, Aquagri has developed its own price incentive schemes for loyal farmers and high-volume producers. In addition, non-price measures such as providing assistance to farmers with their economic and social obligations, have contributed to building bondages of mutual trust and loyalty. Dried seaweed is exported by PepsiCo to the carrageenan conversion plants of MARS, the international chocolate, foods and pet foods manufacturer, in Indonesia (Townsend and Young, 2005). International price fluctuations, which have disrupted the development of seaweed farming at other locations in the world, have had relatively little impact in India due to the large demand from the domestic market (Luxton,1993).

Seaweed exports data are available from the Marine Products Exports Development Authority (MPEDA) and are shown in Table 1. PepsiCo had exported 113 containers of dried seaweed between 2000 and 2008 (valued at USD 0.923 million). It maybe noted that PepsiCo exports are not reflected in MPEDA statistics.

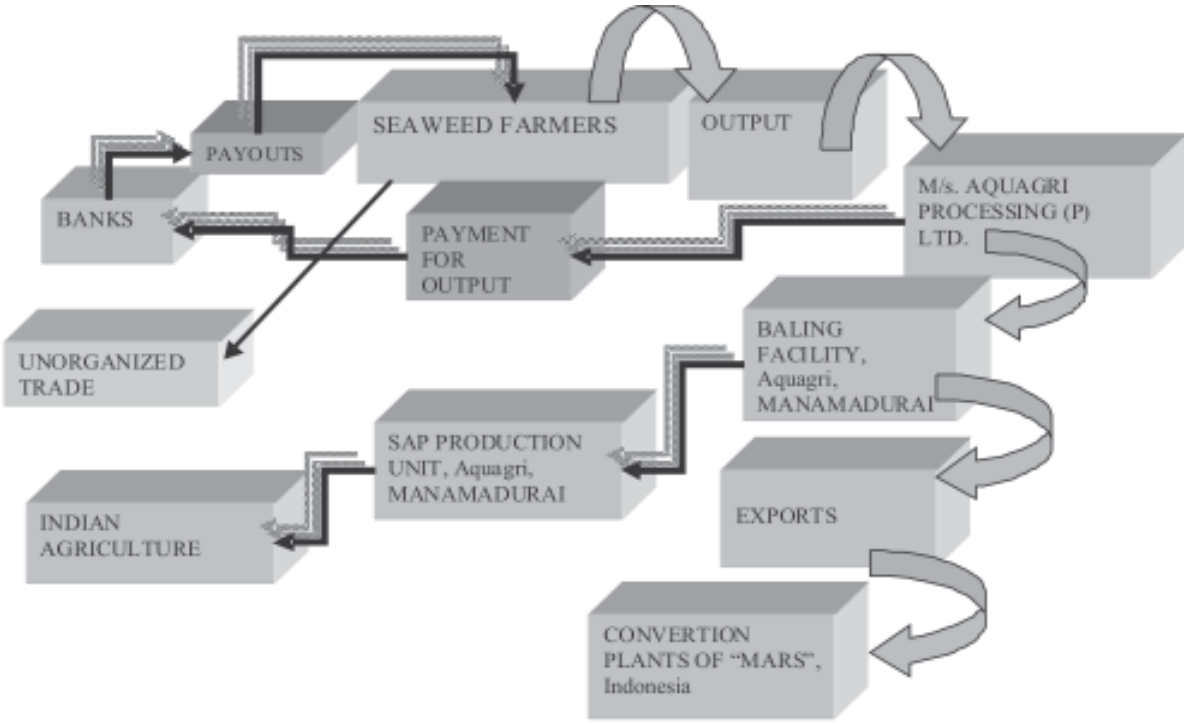


**Figure 3. Marketing value chain in seaweed farming**

**Table 1. Exports of seaweeds from India**

| Year | Quantity (tonnes) | Value (million Rs ) | Value (USD million) | Exports of PepsiCo (FCL dry) |
|---|---|---|---|---|
| 2000-01 | Negligible | Negligible | Negligible | 1 |
| 2001-02 | Negligible | Negligible | Negligible | 4 |
| 2002-03 | 0.37 | 0.149 | 0.00 | 7 |
| 2003-04 | Negligible | Negligible | Negligible | 6 |
| 2004-05 | Negligible | Negligible | Negligible | 6 |
| 2005-06 | Negligible | Negligible | Negligible | 12 |
| 2006-07 | 21 | 0.538 | 0.01 | 15 |
| 2007-08 | 74.25 | 1.991 | 0.05 | 28 |
| 2008-09 | 855.82 | 38.438 | 0.86 | 34* |

*Sources:* MPEDA (columns 3 and 4); Aquagri (column 5). FCL: Full Container Load (1 FCL: 21 tonnes).
*Incomplete data for 2008-09

## Social/ Community Value Chain

The *Kutumbam* (family) model of cultivation (KMC) is a farming system initially introduced by PepsiCo and then widely adopted for *Kappaphycus* culture in Tamil Nadu (Sakthivel, 2006). All seaweed farming in the Ramanathapuram district is under the KMC. Cultivation is organized by the members of a SHG who normally belong to the same family, but may include other members from the same community (Jayasankar and Kaliaperumal, 1991). Collectively, the group prepares the rafts, seeds the lines, provides maintenance and harvests on the due date. Basic infrastructure is facilitated by the company, the harvest is purchased on a buyback basis and payments are effected by the company through the bank accounts of the SHG.


**Figure 4. Loop diagram illustrating social and community value chains in organized seaweed farming in India**

The advantages of the SHG/KMC model are manifold (Figure 4). The major advantage is that fishers are provided an opportunity to become entrepreneurs in an activity with growth potential (Rao and Mantri, 2006). The seaweed farming initiative in Ramanathapuram started with a strong positive gender bias. Women took up the gauntlet with ardour as the activity empowered them with a highly productive, non-hazardous work environment (Rao, 1974). The overall economic and social quality of life improved by leaps and bounds. Convenient hours and stress-free work of 4-6 hours a day enhanced their quality of life. It has been argued that seaweed farming development has also led to alleviate pressure on fish stocks and reduced dependence on agriculture, although these facts are not well documented (Ravindran *et al.*, 2004). It has been estimated that substantial employment and income opportunities can be provided to more than 50 thousand families for every 10 thousand hectares brought under seaweed farming (Mantri and Rao, 2005).

## RAGS Value Chain Products

The various stages of value chain in *kappaphycus* carageenan are depicted in Figure 5. *Kappahycus* is one of the red algal galactan seaplants (RAGS) which are the source of a hydrocolloid known as kappa-carrageenan, a food additive (Mairh and Tewari, 1994). The value of the seaweed chain increased by almost as much as 14-times on the base price from dried weed

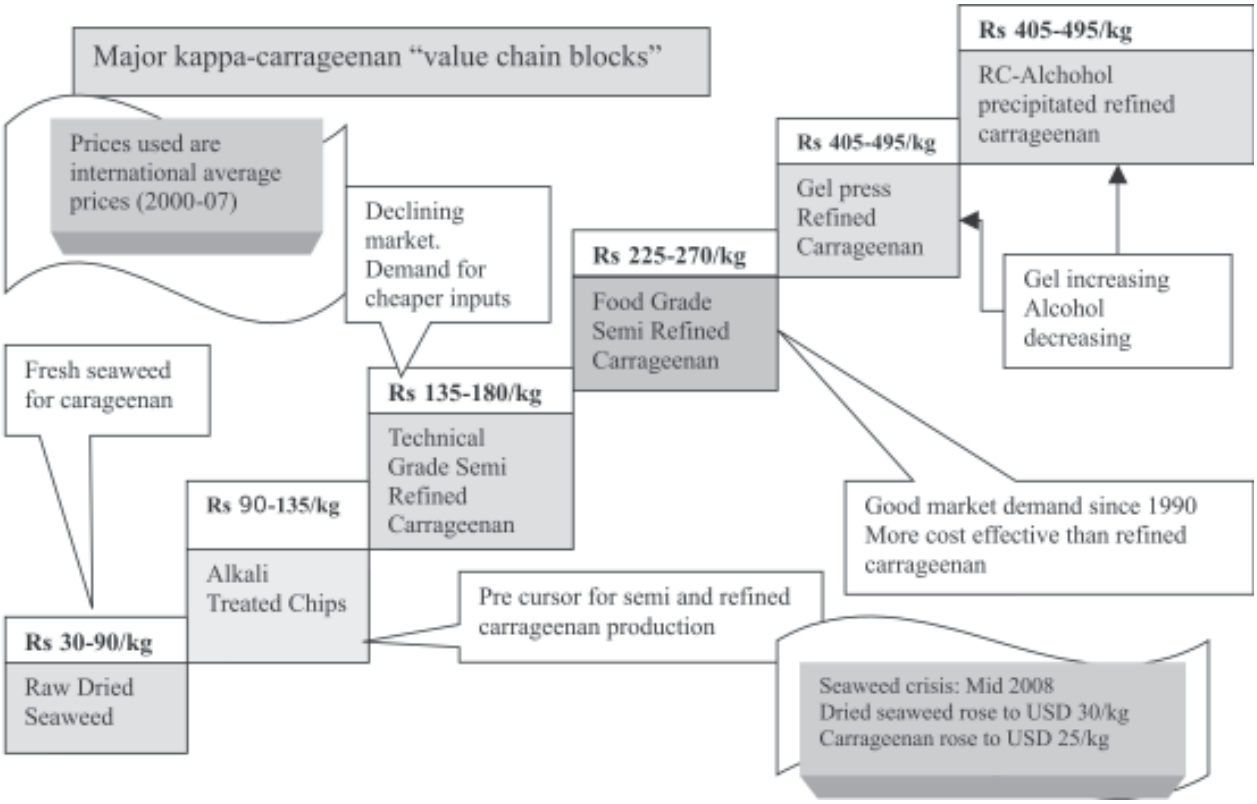


**Figure. 5 Stages of value chain in *kappaphycus*-carrageenan**

*Source:* Adapted from Neish (2008)

price to refined carrageenan. Value addition in processing of the dried seaweed passes to alkali-treated chips (3-times gain in value over base price) to technical grade semi-refined carrageenan (4.5-times) to food grade semi-refined carrageenan to gel press refined and alcohol precipitated carrageenan (14-times).

The global carrageenan production is about 50,000 tonnes per annum. About 30 per cent of the industry demand for carrageenan comes from the dairy, 25 per cent from pet food, 20 per cent from gels, 15 per cent from meat, 5 per cent from water viscosity and 5 per cent from others. The contribution of India to carrageenan production is negligible. The first exclusive carrageenan plant is being put by Aquagiri Processing Private Limited at Manamadurai, Tamil Nadu. It is expected to go into full capacity production this year. The entire raw material for the plant is to be sourced from the output of the SHG seaweed farmers in the Ramanathapuram district. The resultant savings in transaction costs get exemplified when compared to the losses sustained in seaweed collection — agar and alginate production value chains ( Coopen and Nambiar, 1990).

### Evaluation of Value Chain Models

Following Neish (2008), the value chain in seaweed can be evaluated across four forms of governance, namely, captive, modular, market and relational. Table 2 attempts to present the pros and cons of these different forms of governance of value chain in seaweed farming. The distinct advantage in the late entry of India into seaweed farming is that it has directly developed and adopted the modified contract farming SHG model which is a relational form of value chain governance that can now be replicated in similar environments across the world.

It may be noted that market governance is more applicable for the seaweed collection value chain, the discussion of which is beyond the scope of this paper.

## Conclusions

The adoption of the SHG model introduced by PepsiCo in 2003 has apparently allowed Indian farmers to circumvent most of the socio-economic problems haunting the development of the seaweed sector in other developing countries in the world. A participatory

**Table 2. Relative characteristics and entrenched value chain elements in different forms of governance of seaweed farming sector**

| Captive governance | | Modular governance | | Market governance | | Relational or SHG model of governance | |
|---|---|---|---|---|---|---|---|
| Characteristics | Value chain | Characteristics | Value chain | Characteristics | Value chain | Characteristics | Value chain |
| • Many small sellers and few major buyers (oligopsony) | Many farmers | • Rapid growth driven by SRC | Many farmers | • Rapid growth driven by SRC | Many farmers<br>Many collectors | • Fewer & larger sellers as farmer enterprises aggregate | Aggregated farmers |
| • Carrageenan dominated by a few innovative SMEs | Few processor controlled buying stations | • Major agnsts & traders become processors | Local collectors<br>Many traders | • Major traders become processors | | • Processing sector consolidating | Transparent systems of price quantity determination |
| • Processor investment led to seaweed cultivation | Major processors | • Innovation stagnated as “R&D” was limited | Several processors | • Innovation stagnated as “R&D” became “copy & follow” | PRICE | • Recognized need for transparent links from seaweed source to value solution | Institutional support |
| • R&D programs were linked to academia & government | | • Farm development done through supplier alliances | | • Farm development done through supplier alliances | Many traders<br>Many processors | • Farm development and processing moving toward integrated systems (multistream, multi-product) | Full support of R&D |
| | | • Farm development driven by price manipulation | | • Farm development driven by price manipulation | | • Essential that standards be applied rigorously, transparently and globally | Clear policy guidelines |
| | | • Development self-funded by farmers or trader-funded | | • Development self-funded by farmers or trader-funded | | | Direct links and alliances |
| | | | | | | | Fewer larger processors |

*Source:* Modified from Neish (2008)

approach to culture and management via modified contract farming has enabled rapid expansion in India. An activity that began as a livelihood option, has now led to an institutionalized socio-economic transformation of the farming villages in Tamil Nadu. The insights gained from the development of SHG model of value chain in seaweed farming in India are listed below.

- The successful performance of value chain in seaweed farming through the SHG model is the consistent support provided by the banking sector led by NABARD and other commercial banks such as State Bank of India, Indian Overseas Bank, and Bank of Baroda, and dramatic reduction in transaction costs.
- The policy and financial support provided by the Government of India through development agencies and research institutions has given a substantial fillip to the sector.
- The sector has been affected by poaching; however, the extent of the practice has been limited by the organizational structure and efficiency of the SHG model.
- Corporate commitment is at the core to translate the concept of seaweed farming into tangible benefits to the farming community through social corporate responsibility.
- Better coordination between the Tamil Nadu Department of Fisheries and the Department of Environment and Forests will allow stakeholders to conduct activities, with a greater degree of confidence and trust (NAAS, 2003).
- The seaweed sector in coastal India has all the potential to rise from the low income conditions normally associated with basic livelihood activities, to higher levels of employment-income-consumption relationships.

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