



Socio-economic assessment of seaweed farmers in Tamil Nadu - A case study in Ramanathapuram District

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ABSTRACT

Seaweed mariculture is an economically viable livelihood option for the coastal fishing community especially for the fisherwomen. In Tamil Nadu, along the south-east coast of India, the organised seaweed farming on an industrial scale was initiated by the Pepsi Holdings India Private Limited (Pepsi Co) in 2000 in Gulf of Mannar in Ramanathapuram District. After proving the economic viability of seaweed farming, Pepsi Co modified its business model in 2003 by organising the fishers to take up seaweed farming on contract basis through Self Help Groups (SHGs). In this paper, an assessment of the socio-economic status of seaweed farmers in Ramanathapuram District of Tamil Nadu has been made, which is the pioneering district in India in seaweed farming. Fishing and seaweed farming are the most important occupations in this district. The average family size of respondents for the present study ranged from 4.5 in Mandapam to 5.5 in Rameswaram. Significant structural changes have taken place in the socio-economic status of many fishermen who have taken up seaweed farming over the last 10 years. In Ramanathapuram, seaweed farming is estimated to provide employment to the tune of 7,65,000 man days per annum based on the District's plan. The gains, hitherto realised through the SHG model of seaweed farming, should be consolidated with consistent institutional and financial support to the seaweed farmers.

Keywords: Employment generation, Livelihood option, Seaweed farming, Social impact, Socio-economic status, Structural change

Introduction

Seaweed (*Kappaphycus alvarezii*) mariculture is a potential income earning activity and an economically viable livelihood option for the coastal fishing community, especially for the fisherwomen of Ramanathapuram District of Tamil Nadu. Seaweeds are marine algae having diverse uses as food, chemicals, fertiliser and also in pharmaceutical industries (Kaliaperumal and Kalimuthu, 1997; Kaliaperumal, 2004). Although 434 species of red seaweeds, 194 species of brown seaweeds and 216 species of green seaweeds naturally occur in India (CMFRI, 1987), it was only during the beginning of the twenty-first century, the country made progress towards organised seaweed farming. The tardy progress was caused by a number of factors including locational disadvantages, inconsistent performance of species for commercial exploitation, absence of a complete package of farming practices, lack of industry and policy support (Krishnan and Kumar, 2009; 2010a,b; 2011).

In Tamil Nadu, farming of *K. alvarezii* on an industrial scale was initiated by the Pepsi Holdings India Private Limited (Pepsi Co) in 2000 (Personal communication,

Shri. Abhiram Seth, CEO, Aquagri Processing Private Limited, New Delhi). After three years of demonstration to prove the economic viability, Pepsi Co modified its business model in 2003 by motivating the fishers to take up seaweed farming in contract farming mode through formation of Self Help Groups (SHGs). They also guaranteed buy-back arrangements and arranged institutional financial support with 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.

With the help of the above corporate interventions and successful demonstrations, the SHG model of seaweed farming was recognised as an economically viable livelihood option to the fishers, who formed Self Help Groups (SHG's) to take up seaweed farming. Presently, about 50 such groups are successfully practising seaweed

farming in Ramanathapuram District alone. Subsequently, the seaweed farming spread to the neighbouring districts like Thanjavur, Pudukottai and Tuticorin. Thus it is hypothesised that seaweed farming has helped the fishers' households to improve their socio-economic conditions as well as their standard of living. With this hypothesis, the present paper makes an attempt to assess the socio-economic status and the impact of seaweed farming on their socio-economic status in Ramanathapuram District.

Methodology

Ramanathapuram District in Tamil Nadu was identified as the study area for analysing the structure, conduct and performance of seaweed farming, as the district is the centre of seaweed farming in India. The socio-economic status of seaweed farmers cultivating *Kappaphycus alvarezii* was assessed through personal interviews using a pre-tested schedule. The data were collected during September-December 2009. Details on parameters such as family size, age composition, experience in fishing and seaweed farming, asset ownership, income and occupational status, indebtedness, and socio-economic status improvement associated with seaweed farming, were collected from the sample respondents ($n = 437$). The number of organised SHG seaweed farmers at the time of survey was estimated as 1,000. The sample was drawn based on purposive sampling proportionate to size. For comparison purposes, respondents were grouped into two major locations, namely Mandapam and Rameswaram. The selected locations represent the mainland (Mandapam) and island (Rameswaram).

Farmers in the Mandapam region included in the sample were located in Vedalai, Umialpuram, Munaikadu, T. Nagar, Meenavar colony and Thonithurai. The locations covered in Rameswaram were Pamban, Akkamadam,

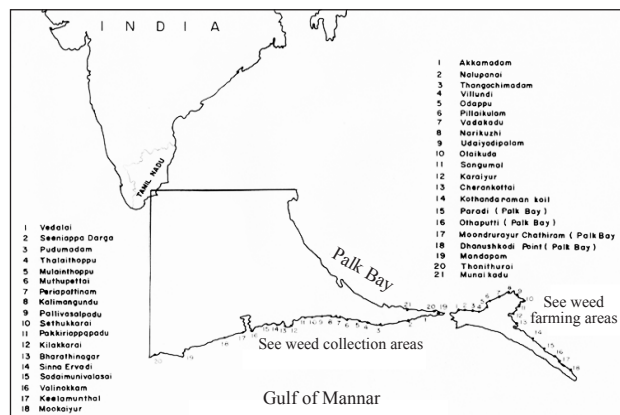


Fig. 1. Map of south-east coast of India showing the study area

Nallupanai, Ariyankudu, Vadakadu, Parvatham, Sambai, Mangadu and Olaikuda (Fig.1).

Conventional tabular and percentage analysis were employed to assess the socio-economic status of seaweed farmers and the social impact of seaweed farming in the study area. The socio-economic impact was assessed through the benefits gained through the income earned from seaweed farming employing percentage analysis. For the socio-economic parameters like age, housing type, pattern, literacy, occupation, consumption and expenditure, the standard classification used by the social scientists were adopted.

Results and discussion

Head of the family and family size

In Tamil Nadu, as in most other states of India, the head of the family is the senior most male in the family. Of late, widows who are the bread winners are also recognised as family head. The analysis of gender

Table 1. Gender composition of the head of family and average family size of respondents involved in seaweed farming in Ramanathapuram District of Tamil Nadu

Category	Mandapam		Rameswaram	
	Number	%	Number	%
Male	145	64	139	66
Female	81	36	72	34
Total	226	100	211	100
Average family size		4.5		5.5

composition of the head of the family of the respondents showed that about 64% of the respondents in Mandapam and 66% in Rameswaram are males and the rest are female seaweed farmers (Table 1). The concept of SHG was on the premise that women are more responsible and have a better disposition to work towards achieving social and economic independence. The initial success of women in seaweed farming motivated men to enter the activity as well. The average family size of respondents ranged from 4.5 in Mandapam to 5.5 in Rameswaram. This is consistent with the national average of 4.5 for fishermen families reported by the marine fishery census (CMFRI, 2005).

Caste/Religion structure

The analysis of caste structure reveals that only a few castes like *valaiyan* (55% of the total respondents in Mandapam and 56% in Rameswaram) and *kadayar* (28% at Mandapam and 9% in Rameswaram) are getting involved in seaweed farming. It must be noted that these castes form the major coastal belt community, who are engaged in fishing and related enterprises. It must also be noted that a number of rich individuals with sound

financial backing but without any local base in the coastal area have entered seaweed farming in Tamil Nadu except Mandapam and Rameswaram. To avoid potential conflicts, Ration Cards (cards allotted to households in India which entitles the holder to periodic subsidised rations of food which also function as identification documents enabling the holder to establish his place of residence at a particular place and time) issued by local self government institutions are being used by the government authorities in allocating the oceanic inshore area among the local stakeholders (Olaikuda village, Rameswaram).

Type of family

Most of the sample respondents' families (97% of respondents in Mandapam and 77% in Rameswaram) belong to the nuclear family type. However, Rameswaram has relatively greater number of joint families involved in seaweed farming. The social development programmes promoted by the Government of Tamil Nadu have led to a general improvement of the socio-economic conditions of the overall population. These programmes have also altered the structure of families, with joint families giving way to nuclear families. This phenomenon is also taking place in coastal villages.

Experience in fishing and seaweed farming

The analysis of the professional experience in the study area indicate that 92% and 72% of the respondents in Mandapam and Rameswaram respectively, have between 11 and 25 years of experience in fishing (Table 2). Since these individuals belong to the middle-aged group, they can be expected to successfully adapt to innovations in farming techniques. The concept of seaweed farming was introduced only after 2001, thus the maximum experience a farmer can be expected to have is nine years (Table 3). About 85% of the respondents in both the areas have about five years of experience in seaweed farming, with 9-13% of respondents already having between 6-7 years of experience. This indicates the level of commitment of stake holders as fishers perceive seaweed farming as a less risky and more sustainable activity relative to traditional fishing practices.

Table 2. Fishing experience of respondents involved in seaweed farming in Ramanathapuram District of Tamil Nadu

Experience	Mandapam		Rameswaram	
	Number	%	Number	%
Less than 10 years	11	6	49	23
11- 25 years	208	92	151	72
More than 25 years	7	2	11	5
Total	226	100	211	100

Table 3. Experience in seaweed farming of respondents in Ramanathapuram District of Tamil Nadu

Experience	Mandapam		Rameswaram	
	Number	%	Number	%
Less than 5 years	196	87	176	84
6 - 7 years	20	9	28	13
More than 7 years	10	4	7	3
Total	226	100	211	100

Age group

The proportion of middle-aged individuals (31- 50 years old) in both groups was around 60% of the total respondents (Table 4). This age bracket corresponds to a productive group of individuals, which is usually receptive to new ideas and is capable of implementing them, even if doing so involves some risk.

Table 4. Age group classification of respondents in Ramanathapuram District of Tamil Nadu

Age group	Mandapam		Rameswaram	
	Number	%	Number	%
Below 30 years old	70	31	53	25
31- 50 years old	138	61	124	59
Above 50 years old	18	8	34	16
Total	226	100	211	100

Literacy level of respondents

The literacy level of respondents in the two areas is comparatively higher than the national average of about 65% (Table 5). It is also seen that about 48% of respondents in Mandapam have undergone elementary schooling while 43% of respondents in Rameswaram have middle-school level education. About 10-20% of respondents have achieved secondary level of schooling. The literacy rate was estimated to be approximately equal to the district average of 52.8%. The infrastructure of educational facilities in the area is poor. The cumulative quality of life (QoL) index was estimated to range from 0.285 at Puliadam to 0.485 in Vedalai,

Table 5. Literacy level of respondents involved in seaweed farming in Ramanathapuram District of Tamil Nadu

Literacy level	Mandapam		Rameswaram	
	Number	%	Number	%
Illiterate	2	1	14	7
Elementary	97	43	17	8
Lower primary	48	21	38	18
Upper primary	49	22	91	43
Secondary	25	11	38	18
Higher Secondary	5	2	13	6
Total	226	100	211	100

with an average cumulative QoL index below normal tending towards unsatisfactory (CSMCRI, 2003.).

Occupational profile

Fishing and seaweed farming are the two most important occupations in these two areas. In Mandapam, 48% of the respondents practised fishing as a primary activity while only 13% chose fishing as the primary occupation in Rameswaram (Table 6). Seaweed farming has become the primary livelihood activity of fishers in Rameswaram, which will have an impact in reducing the pressure on the fish stocks of the area.

Table 6. Occupational profile of respondents involved in seaweed farming in Ramanathapuram District of Tamil Nadu

Occupation	Mandapam		Rameswaram	
	Number	%	Number	%
Fishing	108	48	24	13
Seaweed farming	118	52	187	87
Total	226	100	211	100

Income status

The maximum proportion of annual income earned in fishing in Mandapam area was within the range of ₹10,001 to ₹ 20,000 (69%), followed by those earning less than ₹10,000 (Table 7). In the case of seaweed farming, most of the individuals (57%), earn income between ₹ 20, 001 and ₹30,000 with two individuals reporting even higher earnings (₹. 30,001 to ₹ 40,000).

In Rameswaram, the maximum proportion of income earned from fishing was also in the range of ₹ 10 ,001 to ₹ 20, 000 (57%) while the maximum proportion of income earned in seaweed farming was equally split between the ranges of ₹10,001 to ₹ 20,000 (25%) and ₹20,001 to ₹30,000 (24%) A considerable number of seaweed farming practitioners reported relatively high income levels, up to ₹1,00,000. Table 7 highlights the potential of seaweed farming for lifting the socio-economic status of the communities in both the regions.

Table 7. Income levels from fishing and seaweed farming in Mandapam and Rameswaram

Income levels (₹ per annum)	Mandapam				Rameswaram			
	Fishing		Seaweed farming		Fishing		Seaweed farming	
	Number	%	Number	%	Number	%	Number	%
Less than 10, 000	62	28	20	9	5	2	27	13
10, 001- 20, 000	157	69	76	33	53	25	121	57
20 ,001- 30 ,000	7	3	128	57	51	24	41	19
30 ,001- 40, 000	0	0	2	1	36	17	16	8
40 ,001 – 50, 000	0	0	0	0	46	22	4	2
50 ,001- 80, 000	0	0	0	0	16	8	2	1
80 ,001- 100, 000	0	0	0	0	1	1	0	0
More than 100, 000	0	0	0	0	3	1	0	0
Total	226	100	226	100	211	100	211	100

Housing and livestock ownership

Housing is an important indicator of the socio-economic status of an individual, particularly in small villages. All respondents in both areas were living in their own houses. With regard to the housing type, the proportion of *kutch* houses was high in Mandapam (75%). The proportion of *kutch* and *pucca* houses was approximately the same (49%) in Rameswaram (Table 8). Only four respondents (in Rameswaram) were found to reside in RCC (Reinforced Cement Concrete) houses.

Livestock husbandry is an important source of supplementary income for the fishermen households. Maintaining livestock is also often seen as a symbol of prestige among rural households. About 55% of respondents in Mandapam and 60% in Rameswaram maintain live stock to supplement their income and domestic needs. The most common livestock maintained is poultry (by 30% of respondents in Mandapam and 55% in Rameswaram)

Occupational pattern

On an average, one member from each family is involved in active fishing in both areas (Table 9). One member per family is involved in post-harvest fisheries like peeling, drying, freezing, processing, value addition and related activities in the Mandapam area, while two

Table 8. Housing ownership and type of respondents involved in seaweed farming in Ramanathapuram District of Tamil Nadu

Ownership of house	Mandapam		Rameswaram	
	Number	%	Number	%
Ownership of house				
Owned	226	100	211	100
Rented				
Type of house				
Kutch	171	75	103	49
Pucca	55	25	104	49
RCC	0	0	4	2
Total	226	100	211	100

Table 9. Occupational pattern of respondents involved in seaweed farming in Ramanathapuram District of Tamil Nadu

Name of the occupation	Mandapam			Rameswaram				
	Average number of members per family	Number of days employed per year			Average number of members per family	Number of days employed per year		
		Normal	Lean	Peak		Normal	Lean	Peak
Active fishing	01	179	0	0	01	181	66	98
Post-harvest fisheries	01	96	0	0	02	100	0	0
Seaweed culture/harvest	02	144	0	0	02	161	95	106

members per family in the Rameswaram area. For seaweed farming, an average of two members per family is involved in the activity in both Mandapam and Rameswaram. The average annual employment in fishing and post-harvest activities is marginally higher in Rameswaram (181 and 100 days) than in Mandapam (179 and 96 days). A similar trend was also observed for seaweed farming (161 days in Rameswaram as opposed to 144 days in Mandapam).

Consumption expenditure patterns

The household consumption basket includes expenses on items such as food, oil, meat, fish, clothing, medical and children education expenses. The average annual expenditure per household amounted to ₹28,417 in Mandapam and ₹31,625 in Rameswaram (Table 10).

The maximum expenditure share in both areas corresponded to the purchase of fish (28 and 30%, respectively). Total food expenditures (including food, oil, meat and fish) amounted to ₹18,525 (65% and ₹19,819 (63%) in Mandapam and Rameswaram, respectively. These large expenditure shares are characteristic of households with relatively low incomes. Seaweed farming has enabled the families to raise their economic status

Table 10. Consumption expenditure patterns of respondents involved in seaweed farming in Ramanathapuram District of Tamil Nadu

Item	Mandapam		Rameswaram	
	Expenditure (₹ yr ⁻¹)	% to total expenses	Expenditure (₹ yr ⁻¹)	% to total expenses
Food	5,569	19.60	5,462	17.27
Oils	2,358	8.30	2,704	8.55
Meat	2,568	9.04	2,205	6.97
Fish	8,030	28.26	9,448	30.00
Clothing	2,027	7.13	3,407	10.77
Children education	1,210	4.26	1,749	5.53
Medical expenses	4,284	15.08	3,668	11.60
Electricity	836	2.94	851	2.69
Fuel	1,193	4.20	807	2.55
Recreation	0	0.00	583	1.85
Social function	342	1.20	701	2.22
Others	0	0.00	0	0.00
Total	28,417	100.00	31,625	100.00

significantly, with members of SHG families actively participating in the activity and contributing handsomely to total family income, thus enabling comfortable family consumption expenditure.

Indebtedness

The seaweed farmers prefer institutional loans mainly due to awareness that has been created since the advent of seaweed farming in the region (Table 11). They now realise that though institutional loan procedures may be slightly more cumbersome, the post loan experiences are decent and transparent and hence worth the trouble of going through the paper work. The households avail loans for different purposes including domestic activities and social obligations. The absolute amounts availed as loans clearly indicate the preferences of the respondents in Ramanathapuram District for institutional sources of credit. The comparative absolute levels of outstanding also indicate the easy terms of repayment in respect of the institutional loans.

Estimated labour force in the seaweed farming sector

The total employment potential (man-days per annum) in seaweed culture in the Mandapam and Rameswaram regions is estimated and provided in Table 12. Assuming that two members in each household are engaged in seaweed farming for 144 and 161 days in a year in Mandapam and Rameswaram respectively, the sector would be providing 148,896 and 155,526 man-days of employment per year in the two areas (this calculation assumes a total of 1,000 families engaged in seaweed farming in the Ramanathapuram District). With the institutions promoting and developing seaweed farming in the region targeting 5,000 families in the near future, the seaweed sector could provide an annual employment support of 7,65,000 days assuming 153 days of employment per annum in the sector in Ramanathapuram District.

Social impacts of seaweed farming

The socio-economic impact of seaweed farming was examined by means of a series of questions asked to participants in the study. The evaluation revealed that 68% and 48% of respondents in Mandapam and Rameswaram respectively were able to purchase or renovate their

Table 11. Level of indebtedness of respondents involved in seaweed farming in Ramanathapuram District of Tamil Nadu

Region and source	Average loan availed per household (₹)	Average loan repaid per household (₹)	Outstanding loan per household (₹)
Mandapam			
Institutional	4,350	3,050	1,300
Money lenders	1,505	1,292	213
Rameswaram			
Institutional	8,071	7,607	464
Money lenders	5,089	4,763	324

existing house using the income earned from seaweed. In Rameswaram, about 4% of the respondents were able to purchase agricultural land with their income earned (Table 13). Seaweed farming also had a large positive impact on the ability of the respondents to purchase livestock, quality clothing and consumer durables. Respondents in Rameswaram also reported a large positive impact of seaweed farming on their ability to celebrate marriages in the family. Seaweed culture has also allowed respondents to engage more frequently in social and religious travelling. Besides, during the last five years, the surveyed households were able to acquire

electronic appliances such as TVs, DVD players and mobile phones in addition to household appliances such as mixers and grinders. A total of 135 respondents (60%) and 141 persons (67%) purchased cell phones in Mandapam and Rameswaram, respectively, over the last five years.

The responses from the participants reveal that seaweed farming has indeed emerged as a new, sustainable livelihood option for the fishing communities in the district. Encouragement of seaweed aquaculture with appropriate policy, financial, technical and institutional support may also serve to divert pressure on overexploited fish stocks. Significant structural changes in the socio-economic status of many fishermen have taken place over the last 10 years: a number of seaweed farmers actually started as hired labour for other farmers; however, many of them used this initial experience to become members of a SHG. After a few production cycles, a SHG member can aspire to operate his own set of rafts and transform himself into a farmer capable of hiring labour to look after his own plots.

Seaweeds are renewable natural resource found in sea, backwaters and estuaries. The seaweed collection as

Table 12. Estimation of employment generation in seaweed farming in Ramanathapuram District

Area	(1) Number of sample household	(2) Average number of family members engaged in seaweed farming	(3) Days of employment in seaweed farming per person per year	(4) Days of employment in seaweed farming per year for sample households (1)x(2)x(3)	(5) Proportion of (1) to total sample size (437) (%)	(6) Total number of families (N = 1000)	(7) Man-days per year in seaweed farming (2)x(3)x(6)
Mandapam	226	02	144	65,088	51.7	517	1,48,896
Rameswaram	211	02	161	67,942	48.3	483	1,55,526

Table 13. Social impact of seaweed farming in Ramanathapuram, Tamil Nadu

Using the income earned from seaweed farming, were you able to...	Mandapam				Rameswaram			
	Yes	%	No	%	Yes	%	No	%
Purchase or renovate the existing house	154	68	72	32	103	48	108	52
Purchase agricultural land	0	0	226	100	08	4	203	96
Purchase cattle/poultry	168	74	58	26	177	84	34	16
Purchase quality clothing	223	99	03	1	188	89	23	11
Purchase consumer durables and modern electronic appliances	156	69	70	31	139	66	72	34
Celebrate a marriage in the family	9	4	217	96	97	46	114	54
Engage in social and religious traveling outside the district/state	75	37	151	67	53	25	158	75
Transfer to a better educational institution	0	0	100	100	9	4	191	91
Increase expenses on entertainment	0	0	226	100	0	0	211	100
Engage in any other activity	0	0	226	100	0	0	211	100

well as farming has been proved to be an economically viable livelihood option for the coastal fishers especially fisherwomen. In Ramanathapuram, the seaweed farming is estimated to provide employment to the tune of 7,65,000 man days in the country subject to the assumptions. The income of the seaweed farmers was also found to be a sustained income throughout the year, which will help the fishers' household to meet their financial requirements especially during lean season. Seaweed farming has also helped the respondents to purchase livestock, quality clothing and consumer durables, and to celebrate marriages in the family with ease. Significant structural changes have been taken place in the socio-economic status of many fishermen who undertook seaweed farming, over the last 10 years, wherein a number of seaweed farmers actually started as hired labour for other farmers. Thus the gains of the SHG model of seaweed farming should be consolidated with consistent institutional and financial support to the seaweed farmers. A continuous buy-back arrangement for seaweeds, both fresh and dried, is very much essential for providing sustained income to the seaweed farmers. The diversification planned by seaweed industries to develop sap from fresh seaweed is a welcoming feature of this sector. The seaweed sector in India thus has all the potential to rise from a low level equilibrium trap that is normally associated with livelihood interventions to higher levels of employment-income-consumption relationships in coastal India.

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References

- CMFRI 1987. Seaweed research and utilization in India. *Bull. Cent. Mar. Fish. Res. Inst.*, 41: 116
- CSMCRI 2003. CSMCRI - PepsiCo Interaction. *CSIR News*, 53:13
- CMFRI 2005. *National Marine Fisheries Census, 2005*. Ministry of Agriculture and Central Marine Fisheries Research Institute, Volume IIa.
- Kaliaperumal, N. and Kalimuthu, S. 1997. Seaweed potential and its exploitation in India. *Seaweed Res. Util.*, 19: 33-40.
- Kaliaperumal, N. 2004. Prospects of seaweed farming in India. In: *Proceedings of ocean life food and medicine expo*, 27-29 February, 2004, Chennai, Aquaculture Foundation of India, Chennai, p. 384-393.
- Krishnan, M. and Kumar, R. N., 2009. *Socio-economic dimensions of seaweed farming in India*, Consultancy Report, Personal Services Agreement, FAO of UN, Rome, 103 pp.
- Krishnan, M. and Narayanakumar, R. 2010a. Socio-economic dimensions of seaweed farming in India - *CMFRI Special Publication*, No.104: 90 pp.
- Krishnan, M. and Narayanakumar, R. 2010b. Structure, conduct and performance of value chain in seaweed farming in India, *Agricult. Econ. Res. Rev.*, 23: 505-514
- Krishnan, M. and Narayanakumar, R. 2011. Socio-economic dimensions of seaweed farming in India. In: Diego Valderrama (Ed.), *Social and economic dimensions of seaweed aquaculture, a global review*. FAO Fisheries Technical Paper No XX: 331 pp.