THE IMPACT OF SEAWEED FARMING ON THE SOCIAL AND ECONOMIC STRUCTURE OF SEAWEED FARMING COMMUNITIES IN ZANZIBAR, TANZANIA

FLOWER E. MSUYA

Israel Oceanographic and Limnological Research,
The National Centre for Mariculture, P.O. Box 1212, Eilat, 88112, Israel
And Institute for Marine Sciences. PO Box 668, Zanzibar, Tanzania.

E-mail: flowerem@hotmail.com

The economic significance of seaweed farming was recognised in Tanzania in as early as the 1950s when wild seaweed was exported from Zanzibar. Following the collapse of export trade in the late 1970s, seaweed farming started on the Zanzibar Islands in 1989. In this regard, the development of seaweed farming as a marine resource was seen as an alternative source of income that could play an important role in improving the living standards of the people in the areas. Before the commencement of seaweed farming people relied more on subsistence farming, small scale business (petty business trading) and fishing as their major sources of income. After the commencement of seaweed farming, peoples´ economic activities were replaced by seaweed farming as the major source of income, followed by subsistence farming and small-scale business. Furthermore, studies have shown that more women abandoned subsistence farming in favour of seaweed farming as compared to men. Ownership of items such as radio cassettes, kitchenware, furniture, and clothes increased significantly after the introduction of seaweed farming. Other results include an increase in the number of bank accounts for the respective villages, improved homes for the seaweed farmers, and a reduction on the number of children suffering from malnutrition.

Introduction

The farming of seaweed (known as “Mwani” in Kiswahili) started in the Zanzibar Islands (please see associated video about the impact of seaweed farming on the East Coast, particularly for the women of the region) in 1989 when private entrepreneurs established commercial farms in Zanzibar using an imported strain of *Eucheuma/Kappaphycus* from the Philippines. The necessity to farm seaweed was realised when the Zanzibar wild product could no longer compete with higher productions and relatively cleaner products from Southeast Asia. The cultivation began in two villages, Jambiani and Paje, on the East Coast of Unguja (Zanzibar) Island (Fig. 1). Two companies named Zanzibar Agro-Seaweed Company Limited (ZASCOL), and Zanzibar East Africa Seaweed Company (ZANEA – see video) established pilot farms in the area and the success of these pilot farms attracted local farmers who established their own farms with assistance from the two companies. The whole idea of farming seaweeds was, however, established by Tanzanian scientists in the early 1970’s (Mshigeni, 1973, 1976, 1985).

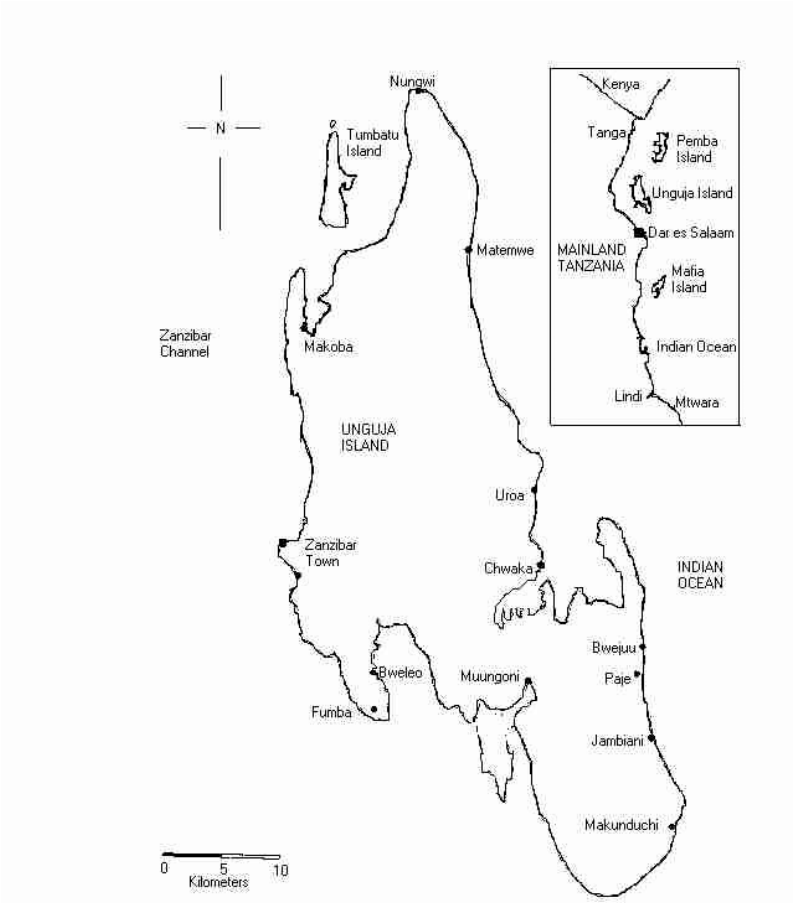


Figure 1. Map of Unguja Island and the coast of Mainland Tanzania showing seaweed farming areas.

Seaweed species that are farmed in Zanzibar are *Eucheuma denticulatum* and *Kappaphycus alvarezii*. The current annual production is ca. 4, 000 tonnes dry weight from approximately 500 ha, which is much less than other areas such as Chile where the production is 74, 000 – 322, 000 tonnes per year for red and brown seaweeds (Buschmann *et al.,* 2001). More than 20, 000 people are involved in seaweed farming on the Zanzibar Islands (Msuya *et al.,* 1996). In Indonesia, it has been shown that 7, 350 families source their livelihood from seaweed farming (Watson 2000). Seaweed is also farmed along the coast of Mainland Tanzania since 1995 (Msuya, 1995, 1996). The seaweed farming industry contributes significantly to the economy of Zanzibar. For example, in 1993 seaweed farming contributed 14.7 % of Zanzibar exports, where as in 1994, it contributed 27.3 % (Msuya *et al.,* 1996).

Why farm seaweed?

Seaweeds are important in a number of industries world-wide-. Seaweeds contain gelling substances; carrageenan, agar, and alginates that are extracted and used as thickening material in pharmaceutical, cosmetic, textile, and food industries. *Eucheuma* and *Kappaphycus*, which are farmed in Tanzania among other countries, contain the phycocolloid carrageenan that is extracted and used in such industries. Seaweeds are also used in similar industries in Asia. Examples of products in which seaweed extracts such as carrageenan, agar, and alginates are used include perfumes, shampoos, toothpaste, medicines, ice cream, milk shakes, and yoghurt. Seaweeds find uses for direct human consumption, where seaweeds are eaten as salad, vegetable, or snack (Abbot, 1996). Seaweeds are also used as fertilisers

(Mshigeni, 1976; Abbot, 1996) and for production of biogas (DaSilva, 1982; Edyvean *et al.,* 1988; Rabesandratana, 1992; Koppel, 1997; Haroon & Szaniawska, 2000). Agar is also used in entomology and genetic engineering (Trono, 1988; Santeliceas & Doty, 1989).

Seaweed farming may reduce the fishing pressure on the reefs depending on the amount of people who previously engaged in fishing that change occupations. Seaweed farming was proposed as an alternative occupation to coastal communities on the Mainland regions of Mtwara and Lindi to reduce the use of destructive fishing methods (RIPS, 1994). In The Philippines, a USAID Livelihood Enhancement and Peace Programme (LEAP) was used to bring peace in Taluk Sangay where US$ 400 were used to turn each rebel to a seaweed farmer (Murphy, 2002 please see the associated videos from the USIAD GEM LEAP Programme). In addition, seaweed farming has been shown to reduce rural-urban migration in Zanzibar (Msuya *et al.,* 1994).

Cultivation methods in Zanzibar

Seaweed cultivation involves tying seedlings onto 3-5 m long nylon ropes using thin nylon stripes called “tie-ties”. The ropes are then tied to wooden pegs previously fixed in the sand. Seaweed has to be submerged at low tides to avoid overexposure to the sun and rainwater that could lead to stress related diseases and bleaching. A seaweed “plot” in Zanzibar (Fig. 2) has at least 50 ropes on which 11 to 15 cuttings are tied. The distance between strings is about 30-30.5 cm, and between cuttings is about 20 cm. Long line or floating method is also used especially on Pemba Island (see Fig. 1) and on mainland Tanzania (Msuya, 1996). The use of floating rafts was also proposed as a feasible method of farming seaweed in Tanzania (Mshigeni, 1976; Msuya, 1996). Raft method is commonly used in other countries such as The Philippines (Doty, 1986), Indonesia (Adnan & Porse, 1987), Fiji (Luxton *et al.,* 1987), China, and USA (Dawes *et al.,* 1976; Glenn & Doty, 1990).

Production trends

Taking export figures as an indicator of production (Table 1), seaweed production has been increasing since the establishment of commercial seaweed farming in 1989. The increase in seaweed production might be a reflection of an increasing number of farmers and farms in the different parts of Zanzibar. For example since the start of seaweed farming to 1995, the farmed acreage increased from nothing to 435 ha (Shechambo *et al.,* 1996). Similar argument was given by Buschmann et al. (2001) who suggested that the increase in seaweed production in Chile is a result of an increase in the number of farms from less than 10 in 1982 to about 322 in 1996. The price of seaweed increased from 45 – 120 Tanzanian shillings (Tshs.) between 1990 and 1999, and so has the commission paid to the government. Despite the changes, the increase in value of seaweed over the years has benefited farmers, the marketing companies, and the government through the commission payable to it (e.g. 4% of the value of exports in 1996, Shechambo *et al.,* 1996). Marine products exports figures (Table 2) show that seaweeds comprised most of the exported products from Zanzibar between 1990 and 1992, in terms of both tonnage and amount of money paid to the farmers.

Table 1. Seaweed export volumes, value, and commission paid to the government 1990-1994. (Source: Shechambo *et al.*, 1996)

Year	Quantity (tonnes)	Value (Tshs.)	Commission paid (Tshs.)
1990	808	11,280,000	451,200
1991	2,497	117,165,000	4,686,600
1992	2,123	120,030,000	4,801,200
1993	2,042	122,630,640	5,084,200
1994	3,652	190,050,00	9,552,000
TOTAL	**10,652**	**561,000,000**	**24,575,200**

Overall pricing of seaweed

The price of seaweeds at farm level is determined by the buying companies, which in turn depends on prices determined in international markets, their costs and profit margins. Prices in international markets depend on many factors, including the quantity supplied, its quality, demand and the market structure but it is reported that world market prices fluctuate heavily. In 1990, the price per tonne was US Dollars 550 but this dropped to 370 US Dollars in 1991 (Eklund & Pettersson, 1992). In terms of local currency, this was equivalent to 82.50 Tshs. per kg in 1991. The world market price in 1993 was US $ 360 per tonne (Shechambo *et al.,* 1996), although Danish Pectin Company was buying the seaweed from The Pacific at US$ 553 per tonne (Bergschmidt, 1997). The price was reported to be US$ 450 per tone in 1992 (Msuya *et al.,* 1996). If we take the Bureau de Change dollar exchange rate of July 1995, this is equivalent to about 284 Tshs. per kg, and, therefore, in July 1995, it can be estimated that farmers were receiving around 26% of the export market price (Shechambo *et al.,* 1996). The remaining is a gross profit margin to the seaweed exporters. There has always been competition between the two companies, which might be one of the beneficial factors to farmers. However, farmers continue to complain that local market prices are low compared with the amount of work required in seaweed production.



Figure 2. Seaweed plots at Paje village on the East Coast of Zanzibar, Tanzania. (Photo by Flower E. Msuya)

Table 2. Exportation of marine resources from Zanzibar, 1990-1992.
(Source: Modified from Msuya *et al.,* 1996)

Product	Tonnes	Paid (Tshs.)	Duty (Tshs.)	Destination
		1990		
Seaweed	261.3	12,616,00.00	539,760.00	Denmark/Sweden
Brahes-Haive	1.42	9,085,300.00	112,040.00	United Arab Emirates
Seacucumber	23.85	7,117,090.00	267,320.00	T. Mainland/ U. K.
Shells	61.17	1,109,150.00	44,026.00	India
Dry/Fresh fish	6.47	1,492,050.00	24,826.00	U.A.E. / Denmark/H.Kong
Prawns/Lobster	6.3	88,712,300.00	412,021.00	United Kingdom (U.K.)
Octopus	0.05	20,000.00	600.00	United Kingdom
Shark fins	1.18	702,799.00	38,193.00	HongKong (H. Kong)
Oyster	0.03	7,000.00	280.00	United Arab Emirates
Crabs	0.02	2,000.00	80.00	Tanzania Mainland
Squid	0.98	625,173.50	8,755.50	United Kingdom
Shells	0.18	30,000.00	104,00	Tanzania Mainland
TOTAL	362.95	41,492,862.50	1,448,005.00	
		1991		
Seaweed	2492.8	33,881,000.00	4,988,200.00	Denmark/France
Brahes-Haive	3.851	7,071,800.00	285,120.00	United Arab Emirates
Seacucumber	37.283	12,866,600.00	2,496,966.00	United Kingdom
Shells	40.027	984,400.00	40,096.00	United Kingdom
Dry/Fresh fish	9.953	1,462,270.00	57,679.00	T. Mainland/ HongKong
Prawn/Lobsters	3.838	4,266,000.00	213,250.00	United Kingdom
Octopus	1.722	326,150.00	158,835.00	United Kingdom
Crabs	0.077	5,700.00	132.00	Tanzania Mainland
Green Snails	0.4	140,000.00	5,600.00	Singapore
Shrimps	0.001	500.00	25.00	Kenya
Shells	0.7	6,000.00	220.00	Tanzania Mainland
Shark fins	3.201	2,331,440.00	106,692.00	HongKong
Total	2593.853	363,341,860.00	8,347,875.00	
		1992		
Seaweed	134	8,040,000.00	321,600.00	Denmark/France
Brahes-Haive	1.45	2,880,000.00	123,600.00	United Arab Emirates
Sea-Cucumber	57.96	28,320,990.00	3,221,506.00	Tanzania Mainland/UK
Shells	20.10	611,000.00	24,420.00	India
Dry/Fresh fish	1.75	287,600.00	17,200.00	United Kingdom
Prawn/Lobsters	12.87	16,877,000.00	844,850.00	United Kingdom
Octopus	0.52	76,500.00	3,295.00	United Kingdom
Shark fins	2.60	2,236,480.00	67,640.90	HongKong
Shells	0.83	28,200.00	1,128.00	Tanzania Mainland
Oysters	0.026	10,000.00	400.00	United Arab Emirates
Total	232.10	59,357,770.00	4,625,639.90	

Overall pricing of seaweed

The price of seaweeds at farm level is determined by the buying companies, which in turn depends on prices determined in international markets, their costs and profit margins. Prices in international markets depend on many factors, including the quantity supplied, its quality, demand and the market structure but it is reported that world market prices fluctuate heavily. In 1990, the price per tonne was US Dollars 550 but this dropped to 370 US Dollars in 1991 (Eklund & Pettersson, 1992). In terms of local currency, this was equivalent to 82.50 Tshs. per kg in 1991. The world market price in 1993 was US $ 360 per tonne (Shechambo *et al.,* 1996), although Danish Pectin Company was buying the seaweed from The Pacific at US$ 553 per tonne (Bergschmidt, 1997). The price was reported to be US$ 450 per tone in 1992 (Msuya *et al.,* 1996). If we take the Bureau de Change dollar exchange rate of July 1995, this is equivalent to about 284 Tshs. per kg, and, therefore, in July 1995, it can be estimated that farmers were receiving around 26% of the export market price (Shechambo *et al.,* 1996). The remaining is a gross profit margin to the seaweed exporters. There has always been competition between the two companies, which might be one of the beneficial factors to farmers. However, farmers continue to complain that local market prices are low compared with the amount of work required in seaweed production.

Local marketing arrangements

Farming materials such as ropes, tie ties, and the seaweed itself for planting, are provided free of charge to the villagers by the seaweed buying companies on agreement that the farmers should sell their harvest to the same company. After harvesting, seaweed is dried in the sun and packed in sacks before being sold to representatives of buying companies who have their offices within the villages. Each buying company is operating in particular villages. The buying companies, on their part, buy the dry seaweed from villagers and keep them in store rooms in the respective villages while undergoing the exports formalities before they arrange for its transportation to Zanzibar port, where it is shipped to overseas buyers in Denmark, USA and France. Exportation of seaweeds depends on several factors most important of which are: the quality of seaweeds which determines the availability of markets abroad; favourable weather condition for faster growth and sun drying of the seaweed, and the liquidity of the buying companies to enable them purchase the seaweeds.

Although there is some impact to the environment (Olafsson *et al.,* 1995; Msuya *et al.,* 1996), this whole innovation has diversified economic activities and brought economic development to the coastal communities involved in the industry, especially those of the east coast of Unguja Island (Eklund & Pettersson, 1992; Mshigeni, 1992; Msuya *et al.,* 1996; Shechambo *et al.,* 1996). On the other hand, it is also possible that some traditional activities such as fishing, petty trade, and crop farming suffered in one way or another with the introduction of seaweed farming. Furthermore, the economic sustainability and the socio-economic impacts to the people's lives have so far not been adequately studied. In addition, tourism and seaweed farming industries have conflicting interests in the use of beach and tidal flat areas, although seaweed farms could be an attraction to tourists (Msuya *et al.,* 1994). For tourists who have not seen a seaweed farm before, seeing one could be interesting.

Sizes of seaweed farms, production, and trends in income earned

The price of one kilogram of dry seaweed is 120 Tanzanian shillings, and the average monthly income of a seaweed farmer ranges from about 9, 000 Tshs. (~US$ 9), from one harvest of a "small plot" (see Fig. 2) of about 50 ropes (Msuya, 1995) to 90, 000 Tshs. per month. Most farmers have more than one plot with up to 1, 000 ropes and harvesting is done every two to three weeks. This income is higher than the minimum wage which is currently 45 US $ per month, and on average, almost 60% of the villagers get amounts of money, per month, that are more than the minimum wage. However, some farmers may mention the amount of cash obtained from a single sell rather than monthly sales (Shechambo *et al.,* 1996), and so the minimum earnings are expected to be higher than what is reported here. In contrast, hat making (a common handcraft activity on Zanzibar) may take three or more months to make one hat that sells at about US$2. An ordinary fisherman receives an annual income of about US $ 565 compared to US$1,000 for a seaweed farmer (Msuya, 2000). The farmers' income from seaweed farming is lower than the income of farmers in other areas such The Philippines where a farmer earns US$ 2,000 (Murphy, 2002), and The Pacific where farmers earn between US$ 49 and 91 per month (Bergschmidt, 1997). Nevertheless, considering that seaweed is farmed throughout the year, the more frequent harvests in Tanzania than in the Philippines (45 days -White *et al.,* 2000), and (Indonesia 5-6 harvest per annum, Watson 2000), and the fact that the actual income from the farmers is not known; this is a considerable income for the seaweed farmers in Tanzania.

Recent world marketing trends have, however, lead to reduction of the price of *Eucheuma denticulatum* to about 80 Tshs. and the rising of the price of *Kappaphycus alvarezii* to about 200 Tshs. This is a result of increase in demand for kappa carrageenan and a decrease in iota carrageenan. Since the two seaweed species grow in different environmental conditions (Msuya, 1996) for some farmers the environments do not allow the farming of *Kappaphycus alvarezii*. While this change may be discouraging to the farmers (Bryceson, 2002), the farmers continue to farm seaweed because it still earns them a reasonable cash, and according to one farmer in Zanzibar, "it is still better than nothing". On mainland Tanzania, seaweed farming is continuing and the earnings and improvements in daily life standards have been observed. One farmer mentioned that she was able to pay school fees of ca. 240, 000 Tshs. (about US$ 240) for her three children using the income from seaweed farming (Luhikula, 2003). This difference between Mainland and Zanzibar is attributed to the farming of only *Kappaphycus alvarezii* on the Mainland, and is a result of the buying companies who wanted to promote only this species (see Msuya, 1996). In 1999, it was estimated that the world market demand for Kappaphycus is 120, 000 tonnes dw per year whereas the world production capacity was 100, 000 tonnes; one seaweed farming promoter had said then that Tanzania can produce up to 20,000 tonnes of Kappaphycus and that "seaweed markets in Tanzania are assured" (PWANI YETU, 1999).

Economic Activities before and after commencement of seaweed farming

Major sources of income

Major sources of villagers' income include agriculture, in which farmed crops include maize, millet, and coconut; legumes inter-planted with cassava & sweet potatoes, and fruit such as mango, papaw, and passion fruit. Before the commencement of seaweed farming, both men and women participated in subsistence agriculture since there were no major cash crops besides coconuts. In addition to crop farming, fishing is another major activity conducted by the villagers. They usually fish with small dug out canoes (ngalawa), using fishing nets, hooks, and lines, methods that are common among men. Another male activity is making lime for construction of houses, an activity that also involves women labourers in collection of firewood and stacking the limestone for burning.

Women are mostly involved in the collection of octopus and shellfish in the intertidal areas. They also practise fishing without boats, using mosquito nets, or clothing materials handled by four or more people depending on the size of the cloth. Other activities done by women include making caps and burying coconut husks along the beach for making rope. However, incomes from these two activities take longer to be earned. One cap may take one to several months to make, whereas the husks are buried for six months to one year before they are beaten to thread mash, which is then intertwined to make . Women are also involved in preparing thatching materials for house roofing, and petty trading such as selling doughnuts, fried fish, and so on. The number of salaried people in the villages is small and they are mostly men. Few women are employed by the seaweed companies for sorting and baling of the seaweed (see video clip of the women compressing seaweed...) before the seaweed is transported to Zanzibar town for export. It is, therefore, clear here that before the commencement of seaweed farming, most of these activities brought limited amounts of cash income to the people.

The importance of economic activities done by the villagers

The relative importance of different sources of income of the villagers before and after the introduction of seaweed farming in four villages was revealed by comparing responses from the villagers both seaweed farmers and non-seaweed farmers (Shechambo *et al.,* 1996). Frequencies of the importance of economic activities as sources of income before commencement of seaweed farming (Fig. 3), showed that the trend in the villages is that small scale business was the major source of income followed by subsistence farming and other activities. Small-scale business and subsistence farming were considered the two most important activities by 50% - 80% of the villagers (Shechambo *et al.,* 1996).

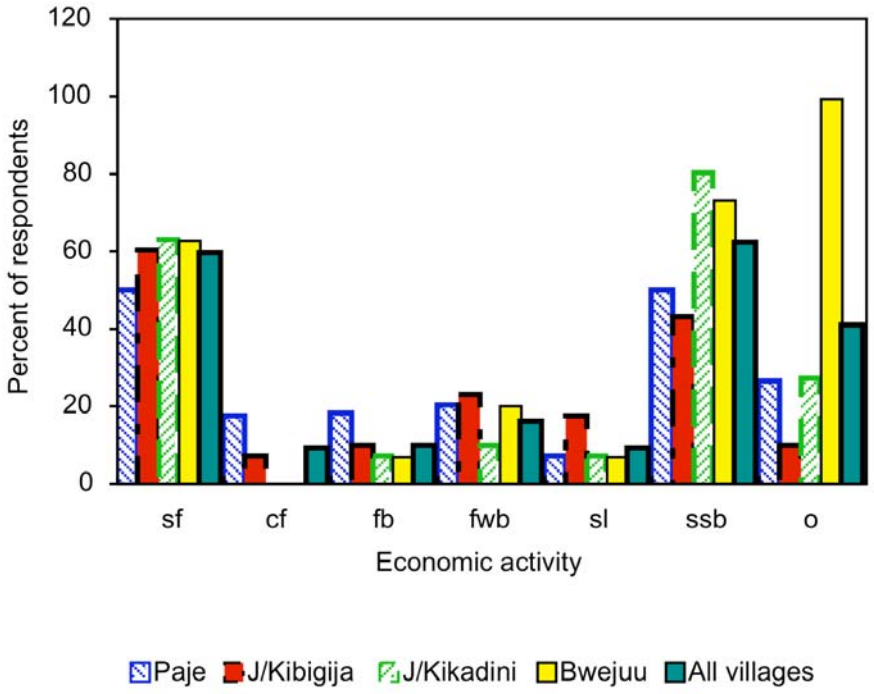


Figure 3. Major sources of income before commencement of seaweed farming.

KEY:

sf = Subsistence farming
cf = Cash crop farming
fb = Fishing with boats
fwb = Fishing without boats
sl = Salary
ssb = Small scale business
o = Other activities

Source: Shechambo *et al.* (1996)

After commencement of seaweed farming (Fig. 4), the major sources of income were replaced by seaweed farming as the most important source of income in the studied villages followed by subsistence farming and small-scale business. Between 87 and 100% of the interviewed villagers turned to seaweed farming after its introduction (Shechambo et al. 1996). The lower percentage was from the villages where there are more alternative economic activities and the higher was from villages where there are fewer alternatives. This may also reflect that there was relatively less response to seaweed farming in some villages than the others. Therefore, small-scale business that was more important than subsistence farming before the start of seaweed farming became less important than subsistence farming after the introduction of seaweed farming. In Mindanao, The Philippines it was shown that seaweed farming had become the main source of income to village communities where seaweed is farmed (Quiñonez, 2000).

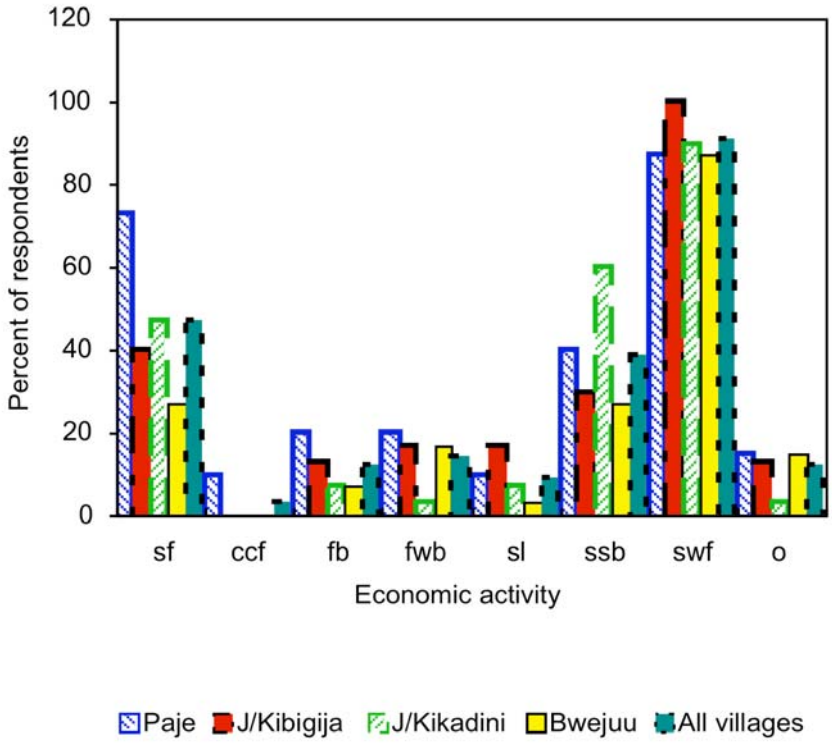


Figure 4. Major sources of income after commencement of seaweed farming.

KEY:

sf = Subsistence farming
ccf = Cash crop farming
fb = Fishing with boats
fwb = Fishing without boats
sl = Salary
ssb = Small scale business
swf = Seaweed farming
o = Other activities

Source: Shechambo *et al.* (1996)

Other activities done by the villagers in the four villages are fishing with and without boats, salaried employment (e.g. teaching in schools and working in health centres), agriculture (cash and food crop farming), burning lime to make white wash, building construction, tailoring, petty trading, and carpentry. Cash crop farming was the least important activity followed by salaried employment (see Figs 3 and 4). Salaried employment rose from 7% to 10% in one village following the introduction of seaweed farming. The results for this village can be attributed to tourism, which was more developed at the village than the rest of the villages. The percentage of villagers involved in cash crop farming decreased by 3% whereas fishing with boats increased by 10% (Shechambo *et al.,* 1996). The percentages of villagers who fished without boats either remained the same or dropped by 7%. Nonetheless, for the other activities the percentage of villagers engaged dropped very much after the introduction of seaweed farming.

Analysing paired samples for differences in activities before and after the start of seaweed farming, (Shechambo *et al.,* 1996) found significant differences between major sources of income before and after the commencement of seaweed farming. In their study, significant differences were found in activities that were more important to the villagers, mainly farming of food crops, fishing with boats, salaried employment, and petty trade. The activities that were less important to the communities such as farming of cash crops, fishing without boats, large-scale business, remittance from

relatives and friends who live away from home and other activities were less affected. The most affected activities were farming of food crops and fishing with boats, whereas large-scale business and salaried employment were the least affected.

Overall, it can be observed that the importance of subsistence farming, petty trading and fishing with and without boats has declined in the villages as the main source of income after the introduction of seaweed farming. Some of the villagers, however, have not abandoned their traditional sources of income.

Participation in seaweed farming

When seaweed farming started in Unguja in 1989, both men and women joined the industry but now more than 90% of the farmers are women (Msuya *et al.,* 1994). Men started leaving the industry to women and returned to fishing and activities triggered by tourism, including road construction, making lime for white wash, construction of houses and working in guesthouses. Men say that they need money every day and that women are more patient to complete the cycle of planting, weeding, harvesting, and selling. Generally, most men are less interested in this activity because of the irregularity in income, which is due to seasonality and low price of the seaweed. Moreover, they find the whole process of seaweed farming to be more intensive in terms of labour and time so they prefer fishing or activities such as lime-making and employment in hotels and guest houses or to work in town. Children assist their parents especially after school hours or during school vocations. On mainland Tanzania, however, both sexes are equally involved and this may be because of the greater geological diversity of the coastline and lower concentration of tourists relative to Zanzibar. In addition, many people realised that destructive fishing methods have destroyed their marine environments and they, therefore, opted on seaweed farming and promoted non-destructive fishing methods (RIPS, 1994; Msuya, 1998, 2000).

Rural modesty of seaweed farmers

Villagers in Tanzania usually live like families where each person respects properties of fellow villager. Seaweed farmers in Tanzania work in unity, keeping their farms in the same areas. Each farmer then knows where his/her farm is and they know who their neighbours are. Even if one gets problems like falling sick, the neighbours usually help him or her to look after the farm until she/he has recovered. In Zanzibar, for example, farmers whose farms are located near the village are capable of recognising their farms when they are outside their houses. In so doing, nobody can go to someone else's farm without permission from the owner. Even if one would do that, the neighbours would go after him/her. This kind of life ensures protection of properties in the village. Another reason that makes seaweed farming a peaceful activity is that there is no land ownership in the sea. Every farmer has an indigenous user right of his or her plot, and this right is recognised by the local communities. When the farm is established it comes the property of the farmer. However, some people outside the village are allowed to farm in these plots with owner's permission. The permission is usually reported to the rest of the villagers (through village leaders) so that the new comer will be welcome and allowed to use the site as long as the agreement holds.

Gender reaction to the introduction of seaweed farming

The change of occupation by villagers from traditional activities to seaweed farming is usually different from one village to another. For example, for subsistence farming in one village there will be 17% of women who change their occupation and 14% men who do the same (Shechambo *et al.,* 1996). In another village, the percentage of women who dropped their subsistence farming activity in order to farm seaweed would be from 44.4% to l6.7% and for men from 58.7% to 4l.7% (Shechambo *et al.,* 1996). For petty trade more men would change their occupation e.g. 29% and only 17% of women would do so. In another village a different picture would be found, whereby women turning away from subsistence farming and petty trading would be 44% and 56% respectively, and the men would not change their occupations at all. Thus in some villages, women did not give up some activities as much as men after the commencement of seaweed farming whereas in another village men did not change their occupations but women did change considerably. The results conform to those of Bergschmidt (1997) who reported that whereas in some Islands in Kiribati, The Philippines, people give priority to seaweed farming, in other Islands people put more effort to traditional activities, mainly the production of copra.

Therefore, after commencement of seaweed farming, villagers changed the importance of some economic activities. However, there are slight differences in the way each village and gender react to the importance of the economic activities. It can also be mentioned that villagers were engaged in many more activities when trying to secure something for their livelihood before they started farming seaweed. After the start of seaweed farming, many villagers dropped activities that were not economically very important.

Economic activities when not involved in seaweed farming

When people are not involved in seaweed farming, for example during high tides, or after working in the seaweed farms, most villagers do not involve themselves much on other economic activities. The highest percentages recorded were between 5 and 10% on subsistence farming, small-scale business, and other economic activities (Shechambo *et al.,* 1996). In The Pacific, seaweed farmers are said to involve themselves in other economic activities such as fishing, copra production, and home baking, when not involved in seaweed farming in order to spread the risk (Bergschmidt, 1997).

Improvements in life standards

This is assessed mainly by looking into the change in life standards, and the ability of the seaweed farmers to meet their daily needs as well as those of the members of the families. Another indicator of improvements in socio-economic lives is the possession of certain items before and after the commencement of seaweed farming, improvements in the dwelling houses and frequency of travels to town.

Daily needs

Seaweed farmers in Zanzibar have used the income generated from seaweed farming to fend for daily needs including food, medicine, consumer items, and services. The farmers are now able to buy school uniforms and books and pay school fees for their children. Similar ability of farmers to pay school fees was reported in Indonesia (Murphy, 2002). Some seaweed farmers mentioned that during religious celebrations they are now able to dress their children even better than those in towns (Msuya *et al.,* 1994). In Mindanao, The Philippines, farmers explained that their lives have changed since they started farming seaweed, and that for the first time in their lives their families can eat three meals a day and they can send their children to school (Quiñonez, 2000).

Status of houses

Information on the houses in which the villagers lived in show that well above 87% of the villagers lived in their own houses (Shechambo *et al.,* 1996). There were few, about 1%, respondents (women) who said that the houses belonged to their husbands. It can be said from the results that most people in the four villages lived in their own houses. Since the information was done four years after the start of seaweed farming, it is not easy to say that high percent of ownership of houses is a result of seaweed farming, but income from the activity has definitely contributed to the kind of ownership.

Whereas majority of the people live in houses whose walls are thatched (about 86%), between 7-13% houses that the villagers live in have walls made of stones fitted with cementing materials made of lime (white wash) and sand (Shechambo *et al.,* 1996). Few houses only were roofed with iron sheets. Regarding the number of rooms in each house, it shows that most families have houses with three rooms.

On the type of toilet used by the members of households, more than 80% of villagers used pit latrines, about 2% used water closets, and about 10-15% had no toilets for the family houses (Shechambo *et al.,* 1996). From the results, it can be concluded that most families in the study villages had toilets for their members of the families. However, the ones without toilets need to be educated/helped through community/mass education, campaigns an so on, in order to urge them to construct their own toilets.

Sources of lights in the houses in the villages showed that most villagers used kerosene candles as a source of light in their respective homes. Kerosene lamps were the second most common sources of light in the villages. Only few people so far used pressure lamps, probably because they are more expensive than the candles and kerosene lamps. Few people have installed electricity in their houses.

Repairs on the houses

Up to 95% of villagers in the coastal villages did repairs on their houses using income generated from seaweed farming. Most of them make repairs on the roofs, walls, and toilets. Few villagers make repairs of the floors, kitchen and by increasing the number of rooms in the houses. Construction of new family houses using money obtained from seaweed farming is not common in these villages, most probably because the income is not enough for such operations. All the people involved in seaweed farming have plans to make more repairs on their houses. In general, villagers have high hopes on seaweed farming because of plans that they have for their houses. Cash income generated from seaweed farming has made it possible for people to repair their houses and make plans for yet more repairs

Ownership of items

The most common items owned by people in the villages are radios cassettes, clothes, furniture, and kitchenware (Msuya *et al.,* 1994). The ownership of properties showed that there were significant differences in the ownership of radios, clothes and furniture before and after commencement of seaweed farming. The ownership of other items such as motorcycles, cars, fishing boats, sewing machines and so on, showed no significant differences before and after commencement of seaweed farming. Paired t test for paired variables showed that ownership of items such as radios, clothes (mostly “Khanga” for women), kitchenware, bicycles, motorcycles, furniture and so on were significantly different before and after commencement of seaweed farming (Shechambo *et al.,* 1996). Women who owned less than five pairs of khanga, can now own up to thirty pairs (Msuya *et al.,* 1994). Similar increase in ownership of items was reported in Indonesia where farmers were able to own houses and out-boat engines among others (Murphy, 2002).

Means and frequencies of travel

Most people in the seaweed farming villages travel on foot, by bicycles, and by public transport. There were significant changes for bicycle users and those travelling on foot after the start of seaweed farming, with significant changes for the use of bicycles, travelling on foot, and use of public transport. It is possible that some people have bought bicycles for day-to-day uses and some have money to take public transport. Other modes including by motor cycle and by personal car showed no significant differences before and after commencement of seaweed farming. The results are attributed to more frequent travels from the villages to Zanzibar town and neighbouring villages.

Frequencies of travels increased following the introduction of seaweed farming. Whereas before commencement of seaweed farming villagers used to travel mostly once in every two weeks, the frequencies increased to more than twice a week. The increase in frequencies can be a result of surplus cash that seaweed farming is contributing to the household economics. It is likely that men travel more after the start of seaweed farming because the cash obtained by their wives takes care of the household needs. Women also having cash may travel more frequently for purchases of necessary items for themselves and their families. Apart from the contribution of seaweed farming, it is also possible that some travels are related to tourism that is booming at the East Coast of Zanzibar.

Bank savings

Information from the bank showed that Bank Accounts for villagers in the seaweed farming villages of the East Coast of Unguja increased from 164 in June 1992 to 403 in June 1993 whereas deposits increased from 6.58 to 10.98 million Tshs. during the same period (Shechambo *et al.,* 1996). This reflects the information obtained from the villages that in the seaweed farming villages, people's surplus cash has increased, and the increase is attributed to seaweed farming that has become the major source of income in the seaweed farming villages.

Other benefits of seaweed farming

It was found from health centres in the villages that the number of children suffering from malnutrition has decreased in the villages where seaweed is farmed (Msuya *et al.,* 1994). Seaweed farming also reduces rural-urban migration by employing the youths in the villages, as they can be self-employed at home rather than moving to towns looking for jobs.

On Mainland Tanzania, a number of villagers who were initially using destructive fishing methods such as dynamite fishing, and use of poison, stopped doing so when they started seaweed farming (Msuya 1998). Similar shifts from fishing to seaweed farming were reported at Olango Island in The Philippines where ca. 200 fishers turned to seaweed farming (White *et al.,* 2000); Likewise, the fisherfolk who used destructive fishing methods in Galicia village, Manila, make a living through seaweed farming (Jaucian, 2002). In Mindanao, also The Philippines seaweed farmers mentioned that seaweed farming protects the fishery because no one fishes in the seaweed farming village (Quiñonez, 2000).

In a village called Ruvu, located on the south of Mainland Tanzania, in Lindi District (see Fig. 1), the villagers were able to built a primary school using income from seaweed farming. Before seaweed farming started in the village in 1996 (Msuya, 1996), there was no school and the nearest school was more than 10 km away.

Some fish species also use seaweed farms as shelter and nursery grounds. This may possibly increase fish biodiversity and provide fish for farmers' consumption. Seaweed farmers usually bring home some fish catch from their farms by catching fish that hide under the seaweed (Mshigeni, 1983; Johnson & Scheibling, 1987; Msuya *et al.,* 1994; Fredriksen & Christie, 2001).

It is also possible that due to financial abilities, seaweed farmers participate more actively in social and family events even those that are not planned before hand, community, and religious duties (Bergschmidt, 1997).

Other factors associated with seaweed farming

Sizes of households

The survey by Shechambo et al. (1996) covered 120 households with 825 members of which 45% were males and 55% were females. An average size of the household in the study area was around 6.8 persons. However, according to Department of Statistics (1989), average household size in the study area was 4.5 persons.

Members of household are engaged in different economic activities such as fishing, agriculture, lime burning, building construction, tailoring, teaching in schools, petty trading, carpentry etc. Normally, they are engaged in more than one activity at a time. Children also have their role in the household economy, they help their parents in different economic activities especially seaweed farming and other activities both in the intertidal areas and on land (Bergschmidt, 1997). Participation in different economic activities including seaweed farming helps to improve the economy of the household.

Age distribution and family heading

The age distribution (Fig. 5a) shows that generally majority of the farmers are young (age class 0 - 30) showing that there is promise for more physical power especially for the seaweed industry, which is still young. With about 35% children, the future of the industry looks even brighter in manpower terms, if the industry will be sustained. These results are different from some places in other countries such as Gilbert Islands of The Pacific where a survey showed that seaweed farmers who were mainly men were 46 – 55 years old (Bergschmidt, 1997). However, in the Line Islands the farmers were said to be younger than in the Gilbert Islands.

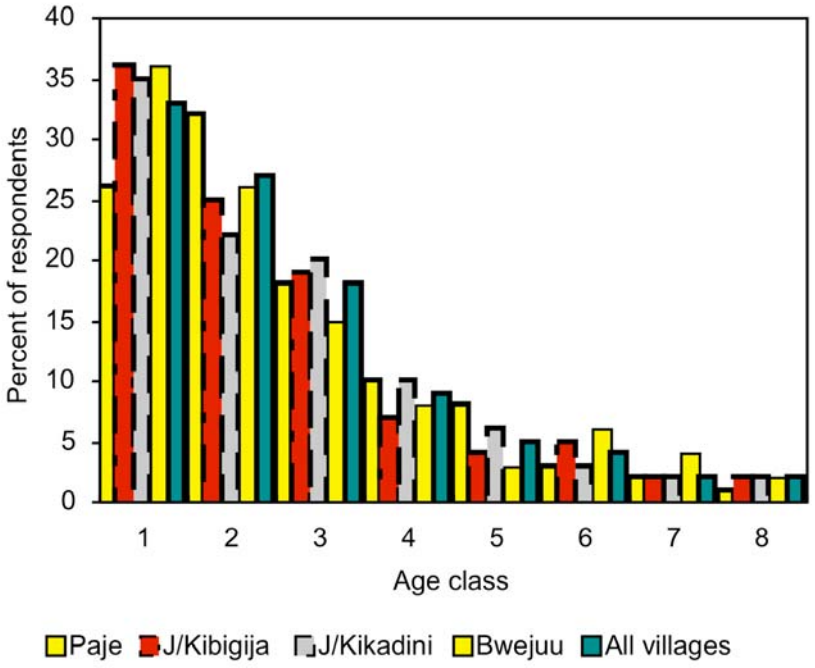


Figure 5a. Age classes for respondents at Paje, Kibigija, Kikadini and Bwejuu.

KEY:

Class 1 = 0-10 ye
Class 2 = 11-20 year
Class 3 = 21-30 yea
Class 4 = 31-40 years
Class 5 = 41-50 years
Class 6 = 51-60 years
Class 7 = 61-70 years
Class 8 = 71+ years

Source: Shechambo *et al.* (1996)

Characteristics of households from the study by Shechambo et al. (1996) in terms of the people living in the household, and who is heading the household, showed a higher percentage of heads of families in the people that were interviewed. Considering this result and the fact that the number of female respondents was higher than male respondents may indicate high rates of divorces and/or people who are not married, so there are more female-headed families.

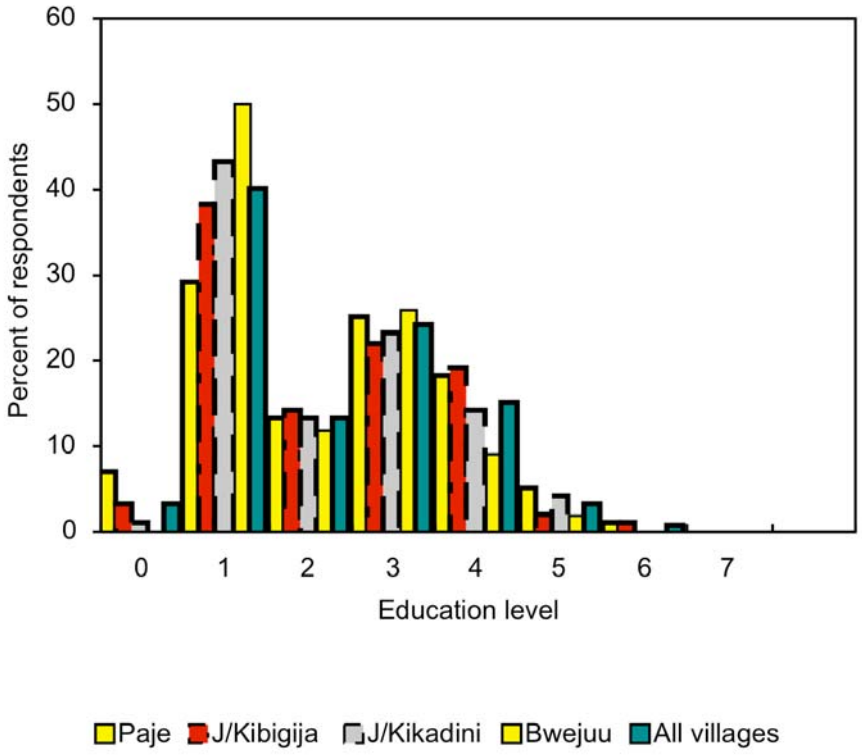


Fig. 5b Levels of education at Paje, Kibigija, Kikadini and Bwejuu, 1993/94

KEY:

No formal education = 0
Standard 1-4 = 1
Standard 5-8 = 2
Form I-III = 3
Form IV = 4
Form V-IV = 5
Certificate = 6
Degree level = 7

Source: Shechambo et al. 1996

Level of education

Level of education in the villages (Fig. 5b) show that 40% of the people interviewed by Shechambo et al. (1996) have been to school in the first four grades (standards), i.e. 1-4. The next highest number of villagers is for those who reached secondary school (i.e. Grades 9-13 and 14, i.e. Forms 1-3, & 4) and the least is for standard 5 to 8. There are very few people who have no formal education but who attended either adult education or quran classes. In some cases, there is exceptionally high percentage of educated people reaching 50% of the respondents who had standard 1-4 level of education.

The fact that most of the respondents are educated at least at primary school levels (Standards 1-8) gives a bright future for economic activities including seaweed farming. With about 20% of respondents having gone up the education ladder to secondary school (Form 1-4), some problems faced by seaweed farmers and other villagers could be more easily reported to the authorities, or solved communally.

Marital status

Marital status of the respondents is shown in Figure 6. From the figure, about 60% of the respondents are married whereas about 30% are divorced. There are also less than 10% of the respondents who were widowed and about 3% who were not married.

These results show that whatever benefits obtained from seaweed farming they are likely to benefit the entire family as majority of the farmers are married. The divorced are most likely to stay with their children (especially women in Zanzibar). Therefore, the children will also benefit from the fruits of seaweed farming. Nevertheless, the high percent of divorcees makes life uncertain to the people, and the benefits obtained from seaweed farming and other activities become uncertain in terms of who will benefit from them.

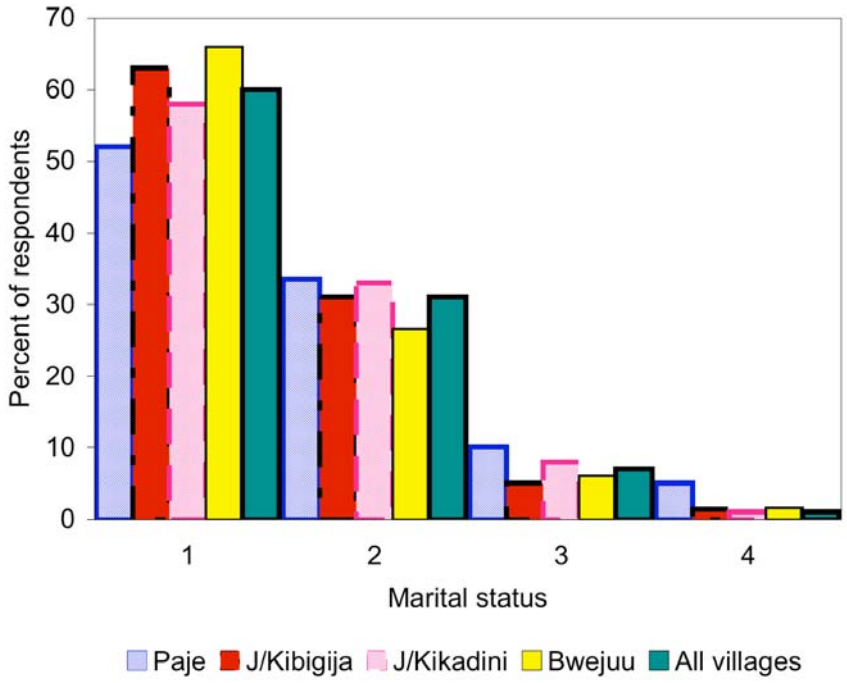


Figure 6. Marital status of respondents at Paje, Kibigija, Kikadini and Bwejuu.

Key:
Married = 1
Divorced = 2
Widowed = 3
Not married = 4

Source: Shechambo *et al.* (1996)

Some negative impacts of seaweed farming

The social relationships of the Zanzibari households have been affected by seaweed farming. Zanzibari women traditionally did not have means of earning money and this new income often brings domestic conflicts. Some husbands say that their wives have become less obedient and some women say that they give their husbands money to 'cool them down' (Msuya, 1997) and allow them to continue seaweed farming. Some men claim that their wives no longer join them in the land based agricultural crops because of seaweed farming (Msuya, 2000).

People have also faced problems of caring for their young children. For example, younger children were left at home to be looked after by older brothers and sisters, many of who were not old enough to care for themselves. In one instance, a child, who had followed the mother to their seaweed farm, died from drowning. As a result, villagers contributed funds to build a day care centre to care for their children when parents are involved in their daily activities including seaweed farming (Msuya, 2000).

At the beginning, seaweed farming had increased the drop out rate for primary school children. Even pupils who had no seaweed plots retrieved and sold floating seaweed that broke off from the ropes in the seaweed plots and accumulated along the beach. The Ministry of Education, however, intervened and solved the problem (Msuya, 2000).

In some studies elsewhere, it has been found that there is increasing gap between seaweed farmers and those who do not farm seaweed. Bergschmidt (1997) reported that there are signs that seaweed farming might accelerate social differentiation and inequality among members of the societies, due to the farmers being richer than the others. This result was, however, attributed to lack of farming areas for non farmers caused by sea tenure rights. Although land tenure aspect does not apply in Tanzania, it is still possible that seaweed farmers are relatively richer than those who do not farm seaweed.

Seaweed farming and tourist/fishing industries

The fact that both tourism and seaweed farming have interests in the same coastal area near the shallow waters is likely to generate conflicts of land-use between these two economic activities. Whereas beach hotel owners would like the beaches in front of their hotels to be clear and clean for swimming, farmers need the shallow waters along the intertidal areas for seaweed farming. The clearing of more land for construction of hotels and guest houses results in high population and housing densities in the areas. This poses the question of possible pollution of the seaweed farming sites from sewage and other effluents, solid waste, etc. (Msuya *et al.,* l994). Possible disturbance of the seaweed through stumbling by the people who swim in the tidal pools cannot be overlooked. Another conflict is between seaweed farmers and canoe fishermen. The latter claim that their canoes are damaged by the pegs used by seaweed farmers to tie the strings as supports for the seaweed. In addition, the pegs become a hindrance to their usual passages when going out to fish and when coming back from fishing.

Problems faced and possible solutions

Farming problems faced by farmers

(please see sections of the associated video for more details)

The problem of strong winds especially during the months of January and February is a problem that is perceived by most farmers. These winds lead to breakage of the seaweed that is in turn washed away causing big losses. The farmers then have to re-fix the pegs and replant the seaweed.
A suggestion was put forward to the farmers on possibilities of buying the raw materials themselves, instead of getting them freely of charge, to reduce monopoly of the seaweed buying companies and increase earnings through competition as suggested by Msuya (1996). Some farmers do not seem to comply with the idea and feel that getting the materials free of charge from the companies is cheaper than buying themselves.

The problem of unavailability of ropes and tie ties at times is also a problem to the farmers.

Some fish such as siganids (rabbit fish), box fish, and sea urchins- see video clip showing rabbit fish, box fish, and seaweed-on top of sea urchins) eat the seaweed whereas others such as crabs and gastropods prick them, thus causing severe wounds on the seaweed.

Likewise, siganids and sea urchins have poisonous spines. If a farmer gets a sting from such organisms, the sting takes long to heal (up to a month).

Since the ropes for seaweed farming are kept in the sea for a long time, as compared to short time experiments (Glenn *et al.,* 1999) seaweed species such as Padina and Laurencia grow as epiphytes on the ropes (Msuya *et al.,* 1994). When this happens, the farmers are forced to scrub the ropes (see video of the woman scraping a rope) and then replant the seaweed.

The farmers also complain that the sunlight that they are exposed to for long hours when tending their farms is too strong which makes their eyes hurt.

Marketing problems

Sometimes the buying companies run out of liquid cash for buying the seaweed, in which case the farmers are forced to wait (Bergschmidt, 1997). Although not common, this discourages farmers especially when it is prolonged, and some farmers are known to have left seaweed farming because of this problem. Likewise, long queues when selling seaweed, especially after staying for some time without selling, make it difficult for clerks to attend all who wish to sell the seaweed. Some farmers are forced by the circumstance to take back the product and sell later.

Few farmers mention that sometimes they feel that the clerks of the buying companies cheat them. They complain that in some cases, the weight of the seaweed product that is written in their receipts is lower than they had expected, thus leading to getting less money than expected.

Some farmers also mentioned that the price of seaweed should be increased to match the hard and long process of farming seaweed.

Suggestions for improvement

Seaweed farmers suggest possible solutions to the above-mentioned problems. The suggestions include raising the selling price paid to the farmers to cover their daily needs, possibly enable them purchase inputs, and remain with a reasonable profit margin.

In addition, the system of getting farming materials from the buyers should continue because it is easier for the farmers.

Some farmers mention that they need to be provided with (or subsidised for) gumboots and sunglasses, by the buyers or the government, to protect them from prickly organisms and strong sunlight.

The farmers also feel that more people should be encouraged to participate and continue with seaweed farming because it pays.

Seaweed buyers' problems

Staff members of the seaweed buying companies report that some farmers, especially men, leave seaweed farming in favour of some other income earning activities because they feel that it is a more time-consuming activity compared with the expected returns. This reduces the amount of seaweed to be purchased.

Seaweed buyers know that farmers complain of the price of seaweed, and they (buyers) would like to motivate the farmers by paying them more, but it is not easy to raise the purchase price for seaweed because of the factors that are beyond the buyers control such as fluctuation of the market prices and market forces abroad.

Siganids retard the growth of the seaweed by eating their tips.

The ideal site for seaweed farming is where the water level is at last 30 cm during the lowest tide, but such areas are limited and the farmers are afraid of going further to look for more favourable sites. As a result, seaweed is bleached during rainy seasons and life span of the ropes and tie ties becomes shorter due to over exposure to the sun and rain. Likewise, some farm sites are somehow rocky or muddy, thus, farmers from one village have to walk for long distances to their farms, which are far from their villages. Similar problems of inability to extend farming areas due to specificity of the seaweeds to certain areas have been reported for Gracilaria farming (Doty *et al.,* 1986; Glenn *et al.,* 1998).

Many farmers dry seaweed on sand and not on palm fronds or other devices, and the seaweed gets covered with sand and become heavier than its actual weight. Some of them try to cheat by putting things such as stones under the seaweed so as raise the weight of the seaweed. There are also farmers who sell the seaweed when it is not thoroughly dried so as to get more weight, and the buyers need to be careful with such farmers. All these cunning behaviours lead to losses to the buyers.

Summary

Whether the improvements in living standards will continue, depends on the extent to which the fast growth of seaweed farming can be sustained. Many factors are beyond the ability of farmers to manipulate, e.g. demand in international markets, liquidity, and capacity of local marketing organisations as well as physical conditions that determine supply of seaweeds. These unpredictable factors put farmers at uncertain position if they depend wholly on seaweed farming.

There are problems arising from conflicts in land-use between seaweed farming and tourist activities. The definition of property rights along the shallow waters is an urgent policy issue to minimise if not to eliminate coming conflicts.

The fact that women's participation is greater than that of the men is a welcome change in terms of providing women an opportunity to earn independent incomes. This is bound to benefit the households but also usher a change in gender balance within the household that will have larger impacts than what is known to date. The long-term impact on the socio-economic set up of the local communities will need to be closely monitored in further research.

As for farming problems raised by farmers, there is need for more extension work on more efficient and sustainable cultivation practices. The marketing problems mentioned by farmers and buyers require dialogue between them in order to come up with operating procedures that are acceptable to both parties. Seaweed farmers may need to improve their bargaining position by establishing independent voluntary farmers' associations. The problem of siganids grazing on the seaweeds could, however, be seasonal and since the ratio of seaweed to siganids at the sites is comparatively high, the problem could be relatively less.

There is lack of transparency in the pricing structure and mechanisms. As mentioned above, in 1996 farmers were receiving ca. 26% of the export market, and the benefits of devaluation do not appear to have been passed on to them. There is need to study marketing margins at different levels within the marketing channels in order to suggest reasonable profit margins for all participants in the seaweed marketing channels.

Conclusions

Despite being a recent economic activity, seaweed farming is showing obvious changes in the quality of life of the farmers. The people now have an alternative source of cash income, which is being used to improve living standards of households. The increased income is inspiring demand for other goods, services, and investments into the area. However, due to a parallel development in tourism, the improvement in living standards cannot solely be attributed to seaweed farming.

Majority of the people who participate in seaweed farming receive cash income from seaweed sales that is above the minimum wage.

Farmers seem to be acting rationally in the allocation of labour to various economic activities. Being aware of fluctuations in income streams from seaweed farming, men,

especially, are not abandoning their traditional activities of fishing and subsistence agriculture.

Most of the studies were, however, done at least four years after the introduction of seaweed farming while tourism was also developing fast on the East Coast of Zanzibar. This means that tourism might have contributed to this positive change. However, since the information presented here comes from people's ideas and observations on seaweed farming, and because the sample had a large number of female respondents who do not usually work in the tourist sector, it may be suggested that seaweed farming played a significant role in these positive changes.

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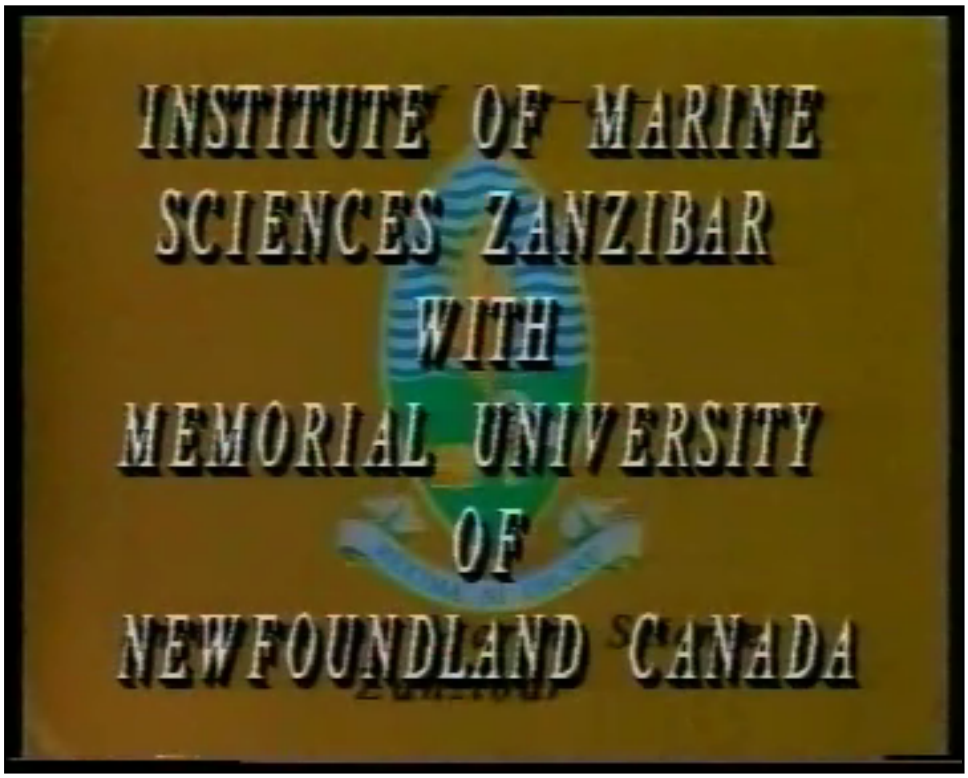
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