Seaweed Farming in Mauritius and Rodrigues

Phase I: Capacity Building in Seaweed Farming for Technical Personnel of Mauritius and Rodrigues in Zanzibar

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1 INTRODUCTION

Seaweed farming in Tanzania is among the most important industries especially on the Zanzibar Islands where it contributes more than 90% of its export of marine products. Two species, *Eucheuma denticulatum* (commercially known as Spinosum) and *Kappaphycus alvarezii* (known as Cottonii-Fig. 1) are farmed, not only in Tanzania but worldwide. The industry in Tanzania employs about 20,000 farmers, 90% of whom are women. The importance of the industry can also be measured by its socioeconomic impact to the farmers and communities around them. It has been shown that farmers are able to cater for their livelihoods with income from seaweed farming. Such benefit of the industry include paying school fees and general needs for school children, repairs of houses, purchase of food, acquisition of more clothes, furniture, and even building new houses (Eklund and Petterson 1992, Msuya et al. 2004, Shechambo et al. 1996, Msuya 2006). It has also been shown that seaweed farming does have impact on the intertidal organisms and the environment in general (Msuya et al. 1996, Eklof et al. 2006) although the impact is said to be minimal.

Fig.1 The seaweeds *Eucheuma denticulatum* and *Kappaphycus alvarezii* farmed in Tanzania

Despite the importance of the industry, recent events of the world market preferring *K. alvarezii* to *E. denticulatum* because of its stronger gel, kappa carrageenan, compare with a weaker iota carrageenan from *E. denticulatum* has caused price difference between the two species. Whereas *K. alvarezii* sells at USD 0.2 per kg of dry seaweed, *E. denticulatum* sells at 0.3-0.4 USD. Unfortunately, the higher priced species is more prone to climate change and massive die-offs have been experienced worldwide. Although seaweed farming can be expanded to many other countries, the problems of climate change and marketing can also be experienced in other countries.

Mauritius and Rodrigues are among the countries that have similar topography with Tanzania/Zanzibar and, thus, seaweed farming can be done in these countries. It is for this similarity that the Mauritius Research Council contacted the author of this report for possible starting of seaweed farming in Mauritius and Rodrigues. The project thus started is "Seaweed Farming in Mauritius and Rodrigues" under a contract "The MRC Solicited Research Grant Scheme, MRC/RSO/ SW09/01, and it has three phases. Phase I is "Capacity Building in Seaweed Farming for Technical Personnel of Mauritius and Rodrigues in Zanzibar" which forms the content of this report.

2 THE TRAINING

Three research trainees from Mauritius and Rodrigues were trained in Zanzibar on important aspects of seaweed farming. The training was conducted from 10 – 24 October 2011. The first two days were used for lectures and the rest of the days were used for field work. The lectures were conducted at the conference room of the Institute of Marine Sciences (IMS).

2.1 Over view of seaweed farming in Tanzania

A lecture on the overview of seaweed farming in Tanzania was given on the first day of the training, 10 October 2011. The trainees learnt about the nutritional value of seaweeds and the seaweed farming industry in Tanzania in general and Zanzibar in specific. The topics covered in the lecture included the following:

- Nutritional value of seaweeds
- Traditional use of seaweeds in Tanzania
- Initial trade based on collection from the wild
- Initial scientific studies, commercial farming and expansion
- Production and marketing trends
- Importance of the industry, socioeconomic and environmental impacts
- How to select a seaweed farming site
- Farming materials
- Farming methods including innovative farming –this session combined farming in shallow water as well as in deep waters
- Harvesting and post harvest handling
- General challenges that can be faced in farming seaweed
- Problem of die-off of *K. alvarezii* and actions taken by different stakeholders to combat/cope
- Example of severe impacts of climate change – based on a study by Msuya and Porter (2009) in southern Tanzania as a challenge to researchers, officers and so on.

2.2 Other methods of farming seaweeds, seaweed innovation-innovative farming, and value addition

On day two of the training, 11 October 2011 a lecture on other methods of farming seaweeds as well as innovative farming and value addition was given where the trainees learned the following:

- Other methods of farming leafy seaweeds and more fragile species such as *Ulva* and *Hypnea* -these methods included sea cages and land-based tanks
- Materials needed for deep-water farming-the lecture insisted on using less expensive, locally available materials
- Comparison of farming methods-in this session the trainees learnt about comparing the advantages and disadvantages of shallow and deep water farming methods
- Value addition including required machinery and production of value-added products
- Research in seaweed farming- the session focused on studies of practical aspects of farming seaweed such as effect of substrate, seasonal changes, and climate change.

2.3 First hand observations and practical training in seaweed farming

On day 3, 12 October 2011, the trainees paid a visit to seaweed farms in Paje to have first hand observations and practical training in farming. The trainees were thus able to follow, participate and practice on:

- Various stages of production cycle-from selecting seed, to tying seaweed and planting starting with observation of the farmed seaweed *Eucheuma* (Fig. 2).
- Cultural practices involved in farming from planting to harvesting including family participation, relationships between husbands and wives, and rural modesty in farming-taking care of each other's farm.
- Harvesting of Seaweeds (Fig. 3) showing what stage of growth should the harvesting take place, how to harvest, proper containers to put the harvest in, and how to carry to the drying areas.
- Tying the tie ties and seaweed seed on the ropes and planting seaweed in off-bottom farms (Figs 4 – 8). The trainees also had a chance to taste fresh seaweed! (Fig. 9).
- Drying of seaweed-comparison of different drying facilities such as palm fronds, grass, and elevated platforms. Areas of drying e.g. at the beach, homes, and the "modern" Seaweed Centre (Fig. 10). Drying seaweed on palm fronds, plastic (fertiliser) sheets, clothing materials, on cemented areas outside the houses were observed in other villages including Bweleo (Fig. 11).

Fig. 2 Trainees being shown the farmed seaweed at the seaweed farms in Paje village, East Coast of Zanzibar by the trainer

Fig. 3 Trainees participating in harvesting seaweed, fixing pegs in the sediment and planting seaweed in an off-bottom farm

Fig. 4 Trainees being shown how to tie seaweed, trainees fixing pegs to the sediment, and planting seaweed in off-bottom farms

Fig. 5 Trainees tying tie tie on ropes

Fig. 6 Trainees tying seaweed seed on ropes

Fig. 7 Trainees fixing pegs in the sediment and planting seaweed

Fig. 8 Trainees observing an off-bottom farm with fully grown seaweed

Fig. 9 The trainees tasting fresh seaweed while working in the off-bottom farms

Fig. 10 Trainees observing seaweed drying facilities-drying on palm fronds at the shore (top photo) and in elevated trays at the Seaweed Centre

Fig. 11 Drying seaweed in palm fronds, plastic sheets, and cemented home premises

2.4 Seaweed taxonomy

A knowledge on seaweed taxonomy was important for the trainees especially to be able to know and compare seaweed species of interest found in Zanzibar and Mauritius. This was done on the 4th day, 13 October 2011. The day was spent in collecting and identifying seaweed species of interest in Chwaka Bay on the East Coast of Zanzibar. The intertidal area was surveyed and species found were identified at the spot or taken ashore to be identified to species levels using identification keys (Fig. 12). Some species were also carried back to town for further identification. *The native Eucheuma was also found in Bweleo village on the SW Coast where patches of the seaweed growing naturally attached to rocks in the intertidal area were seen (Fig. 13).* Species that were identified included several varieties of:

- *Ulva*
- *Hypnea*
- *Gracilaria*

- *Sargassum*
- *Borgessenia*
- *Padina*
- Native *Eucheuma*
- Farmed *Eucheuma*

Fig. 12 Identification of seaweed species of interest in Chwaka village, Zanzibar

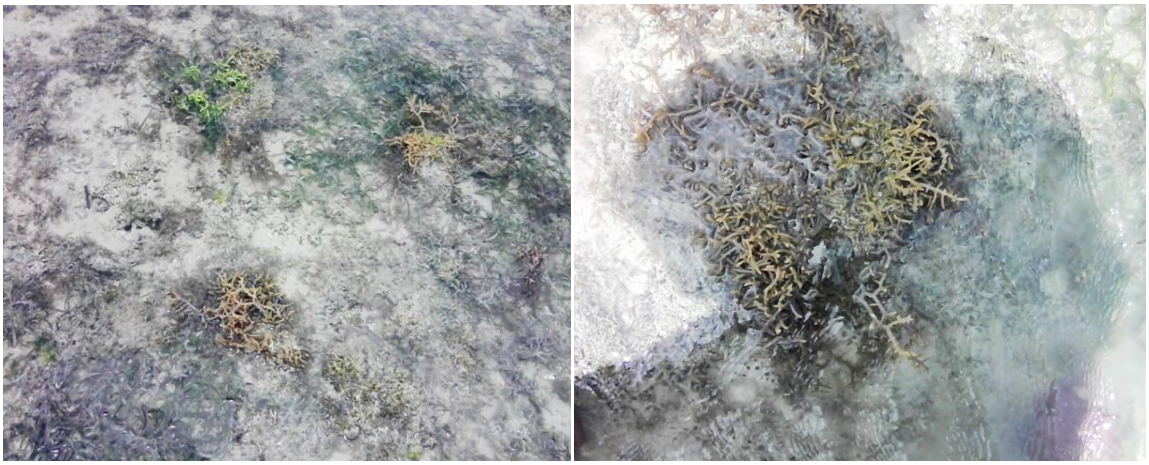

Fig. 13 The native *Eucheuma denticulatum* growing naturally in the shallow intertidal area in Bweleo village, SW Coast of Zanzibar

When coming back from the sea, some seaweed drying facilities were encountered and discussed. These were defined as bad drying facilities as the seaweeds were placed directly on the ground/sand (Fig. 14).

Fig. 14 Seaweed placed directly on the sand to dry: not a good way of drying seaweed

2.5 Preparation of farming materials, construction of floating systems & bamboo rafts, and planting of seaweed

2.5.1 Preparation of farming materials, construction of floating systems & bamboo rafts

The trainees were taught how to prepare seaweed farming materials and to prepare devices used to farm in deep waters. These activities were done on the 5th day of the training (14 October 2011) and were conducted in Bweleo village, SW coast. The main activities of the day were:

- Preparation of farming materials. Ready purchased materials (bamboo poles, ropes and tie ties, Fig. 15), recycled cooking oil cans, recycled plastic water bottles, and stones for anchors

were used. The ropes and tie ties were prepared by cutting to the required lengths depending on the material. Ropes were of 12mm, 8mm, and 4mm diameters.

- Construction of 2 floating systems. The process of constructing two floating systems (floating rafts made of ropes only, Fig. 16) was started on this day. The trainees learnt to tie knots to make the sides of frames of the floating systems and also knots for tying anchors (Fig. 17).
- Preparation of bamboo poles. These were prepared by cutting the bamboo according to the required lengths, in this case 5m.
- Construction of 3 bamboo rafts which involved learning appropriate knots to tie the sides of the bamboo rafts (Fig. 18). The process also involved learning how to join the support poles to the main frame (Fig. 18). The process of making the bamboo rafts were, thus, initiated on this day.

The process of constructing the rafts and floating systems was continued on the next two days, day 6, 15 October 2011 and day 7, 16th October 2011.

Fig. 15 Trainees holding ropes used in seaweed farming with bamboo poles at the background

Fig. 16 Trainees learning how to tie knots on ropes

Fig. 17 Trainees preparing a floating system

Fig. 18 Trainees tying notes on bamboo poles to make bamboo rafts. Note also the fixing of a side pole to support the main frame (lower-right photo).

2.5.2 Planting of seaweed and anchorage of floating systems and bamboo rafts

The training session on planting of seaweed involved tying seaweed on the ropes (5m long ropes) using tie ties (thin nylon ropes-Fig. 19). Seaweed branches (seed) of about 50g were tied at 30cm intervals. Trainees were also shown how to estimate the intervals by using hand palms for the benefit of farmers in commercial farming; it is not easy for farmers especially in rural areas to measure 30cm at each planting. Therefore the distance between the thumb and the second finger is estimated as 20cm-in most cases this is a correct measurement. This is how seaweed farmers in Tanzania estimate the distances when planting seaweed. The researchers joined some farmers who were assisting in the training to tie seaweed branches on the ropes while on a boat (Fig. 20).

The trainees learnt that anchorage of the floating systems and bamboo rafts in deep waters is done by diving (Fig. 20). Anchorage started with tying the anchors (stones and plastic fertiliser bags filled with sand) on the frames of the floating systems and bamboo rafts. When the anchors were tied on the four sides, seaweed lines (ropes containing seaweed) were tied on the frames. While the other members of the working team sat on the boat and continue to tie seed, the divers took the seaweed lines and tied them on the bamboo rafts and floating systems (this is typically how seaweed is farmed in deep waters in Tanzania involving family members –men and women or farming groups comprising of both sexes). Recycled oil gallons (20L) were used as markers whereas recycled mineral water bottles were used as floats on seaweed lines (Fig. 21). The trainees participated in all the planting and anchorage activities (Figs 19 – 22). Tying seaweed seed on ropes and anchorage of the floating systems and bamboo rafts were done on day 6, 15th October and day 7 October 16, 2011.

Fig. 19 Cutting tie tie into required lengths

Fig. 20 Anchorage of floating systems and bamboo rafts

Fig. 21 Preparing anchors and floats for planting seaweed

Fig. 22 Tying seaweed to the ropes by working from the boat

2.5.3 Collection of baseline data

While planting seaweed, the trainees were taught the importance of taking baseline data when planting the first seaweed seed mostly the initial weight of seaweed and water parameters. These activities were conducted concurrently with planting of seaweed and were, thus, done on days 6, 15th October and day 7, 16 October 2011. The two types of baseline data were obtained as follows:

- 2.5.3.1 Measurements of water parameters and recording of weather conditions

In this activity, the trainees measured water parameters of salinity, temperature, pH, and dissolved oxygen. Salinity was measured by using a refractometer (Sper Scientific Ltd.), water temperature and pH by using a portable pH meter (HANNA Instruments) and dissolved oxygen was measured by using a portable oxygen meter (OxyGuard Handy). The instruments were hired from scientists who own them in Zanzibar. Apart from measuring water parameters the trainees learnt the importance of recording weather conditions such as sunny days, rain days, strong winds, and rough sea, and how to record them. It was insisted in the training session that weather conditions give much information about seaweed growth including showing effect of seasons and unpredictable weather.

- 2.5.3.2 Weighing of seaweed

The trainees learnt how to take the initial weight of seaweed for the purpose of monitoring the growth rate of the seaweed. Three lines from each setting were weighed. The trainer also insisted on weighing the same lines every low tide i.e. every two weeks. Weighing of the lines was done by using a commercial weighing scale.

2.6 Visit to the Paje Seaweed Centre and practical training in value addition

On day 8, 17 October 2011 the trainees visited a well established Seaweed Centre (www.seaweedcenter.com, Fig. 23) in Paje village on the East Coast of Zanzibar. The Centre is a joint initiative between the Chalmers School of Entrepreneurship-Chalmers University in Sweden, and The Seaweed Cluster Initiative (www.secitz.com). At the Centre the trainees learnt and actively participated in performing the following activities:

- Post-Harvest handling-this activity included drying of seaweed "in a proper way" where the seaweed is dried in elevated racks placed under an open drying facility fitted with a transparent roof (Fig. 24). The trainees participated in spreading the seaweed for drying on the racks.
- Preparing the dried seaweed for storage-dried seaweed is placed in sacks and stored before it can be sold. The sacks can be the plastic (fertiliser) bags (Fig. 25) or sisal sacks.
- Quality Management of produce-the trainees learnt the importance of maintaining the quality of the seaweed when drying including making sure that the seaweed does not come into contact with rain water which would bleach the seaweed (Fig. 26-note the reddish colour of the seaweed that did not get rain water). Bleached seaweed may be difficult to dry as it can become gel-like and in this state it cannot be sold. However, bleached seaweed that is dry enough (moisture content 10 – 34%) can be sold. The second important aspect in quality control of the seaweed that the trainees learnt is cleanliness-making sure that the seaweed does not contain sand, debris, wild (fouling) seaweeds and so on.
- Value addition-making seaweed soap. This training session involved learning how to make seaweed soap including materials needed and actual making of the soap. Two ways of mixing soap ingredients were studied: using soap making machines (soap mixer) and manual mixing using plastic containers (Fig. 27A). A soap block that was prepared previously by the women at the Centre was used to make soap bars. To make good bars the block was made into "spaghetti" and then soap bars were extruded (Fig. 27B).
- Value addition-packaging and marketing of seaweed soap. Packaging and marketing of the soap is another aspect of value addition that was studied at the Centre. The trainees participated in packaging of the soap where local materials (coconut and banana tree barks) were used as packaging materials (Fig. 27C). Marketing aspects included discussions on how to prepare and present the product in a competitive way and to look for markets.
- Value addition-making of seaweed salad. Seaweed salad was the second value-added product that the trainees learnt about. Seaweed salad was made using fresh seaweed and it formed part of the lunch. A discussion was also held on making seaweed salad using dry seaweed.
- The trainees also visited the shop that sells seaweed value-added products such as soap and Vaseline located at the Seaweed Centre (Fig. 28).
- An experience of "Seaweed Tourism". It was an opportunity for the trainees to experience the Seaweed Tour conducted at the Centre. The trainees participated in the different stages of

seaweed farming starting from farming at sea, followed by drying on the elevated racks, drying further in the solar drier, grinding to make the powder added in the soap, using the powder to make seaweed soap, making seaweed salad and seaweed juice, displaying seaweed soap in a shop, and welcoming the guests for a seaweed meal (e.g. salad). A discussion was held on how such a tour can be conducted in Mauritius at a later stage.

Fig. 23 The Seaweed Centre in Paje village, East Coast of Zanzibar

Fig. 24 A seaweed drying facility (left) with a transparent iron sheet roofing at the Seaweed Centre

Fig. 25 Dry seaweed stored in plastic (fertiliser) bags

Fig. 26 Properly dried seaweed with deep red colour and seaweed bleached by rain water (whitish colour)

Fig. 27 Making seaweed soap in Paje, East Coast of Zanzibar. A: manual mixing of the ingredients B: making "spaghetti" followed by soap bars by using an extruder C: manual cutting of the soap into pieces and packaging

Fig. 28 Trainees paying a visit to the shop that sells seaweed value-added products at the Seaweed Centre in Paje village, East Coast of Zanzibar

2.7 Discussion on the field works & visits and purchase of seaweed farming materials

The day started by a recap of theory/discussions. It was necessary to revisit the theoretical training aspects where discussions, concerns, and so on were held as well as the practical sessions already conducted so as to put the trainees in an up-to-date situation. This activity was followed by identification and purchase of seaweed farming materials in the commercial shops to be able to evaluate the difference between whole sale and retail prices. A walk in Zanzibar town to visit a number of shops both at the central area (near the central market) and shops placed about 500m from the central area gave the trainees knowledge on how to get the materials and make the budget accordingly. This activity was conducted on day 9, 18th October 2011.

2.8 Preparation of farming materials (ropes and pegs) and on-land demonstration of an off-bottom farm

On day 10, 19th October 2011 the trainees participated in purchasing and preparing wooden pegs for farming in shallow waters (off-bottom farm) as well as cutting ropes and tie-tie in lengths required for off-bottom farms. The trainees were equipped with the understanding that in off-bottom farms seaweed farmers can have longer seaweed lines of 10 – 20m compared with the 5m for bamboo rafts. They also learnt that for a commercially profitable floating lines systems farm, the floating system should be made of a 10 × 10m frame and the seaweed lines should, thus, be at least 10m long (Larger frames and thus longer seaweed lines can be used but they are difficult to manage). On-land demonstration of an off-bottom seaweed farm was also conducted. The trainees learnt about distances between ropes (i.e. 30cm), pegs (30cm), and tie ties (20cm intervals)-the distances were measured and recorded.

2.9 Measurement of water and weather parameters and keeping a log book of data

In the afternoon of the same day, day 10, 19 October 2011, the trainees repeated the session on how to measure water parameters. The same water parameters measured in the deep water were measured in the off-bottom farms to show the difference in readings (especially water temperature) between deep and shallow waters. In conducting the activity, trainees also learnt how to keep a log book of seaweed weight, water parameters, and weather conditions.

2.10 Setting up of an off-bottom farm

Following the preparation of farming materials for the off-bottom farm the day before, the trainees learnt how to prepare an off-bottom farm on day 11, 20th October 2011. The day started by purchasing wooden pegs for the off-bottom farm from the village (Bweleo). The pegs were then sharpened at one end so as to be fixed in the bottom. Other farming materials (ropes and tie ties) were prepared. The next material needed was seaweed seed and this was provided free of charge by the farmers. All the farming materials were then taken to the shore where seaweed seed was tied to ropes (Fig. 29) and the pegs sharpened further to make sure that they are of the required standards. The materials and seaweed lines were then taken to the planting site. Before the farm was set-up, water parameters were taken to show the importance of taking baseline data. The values of the different parameters were recorded in log-books. An off-bottom farm was then set up by tying one end of the ropes containing seaweed (seaweed lines) on one peg and stretching the lines to the opposite peg so that the seaweed line was stretched between two pegs. The exercise was repeated until all lines (50 lines) were tied (Fig. 30). The farm was named "The Mauritius farm" by the farmers who were working with the trainees. After setting up the off-bottom farm, the trainees then joined the farmers in the village for a discussion on various aspects of farming including possible problems that can be faced, possible solutions, monitoring of the farm, effect of unpredictable weather and so on.

Fig. 29 Tying and planting seaweed to create an off-bottom farm in Bweleo village, SW Coast. The farm was named "The Mauritius farm".

Fig. 30 Planting of seaweed to make an off-bottom farm. Note: the tide was coming in during the planting (bottom photos)

2.11 Visit to Kidoti women cooperative group

a. Making of seaweed soap

On day 12, 21st October 2011 the trainees visited a women cooperative group named "Tusife Moyo" which means "we should not loose heart" situated in Kidoti village in northern Zanzibar (Fig. 31). Various types and designs of soaps produced by the group were observed (Fig. 32).

Fig. 31 The premises of the Kidoti Women Cooperative in NW Zanzibar. Top right photo shows the trainees with the trainer

Fig. 32 Different patterns and types of soaps produced by Kidoti women group, NW of Zanzibar

In Kidoti the trainees learnt how to make seaweed soap from the beginning to the end without using machines (Figs. 33 – 35). The mixing of soap ingredients was done in plastic buckets and soap bars were cut by using specially made wooden bars and a piece of wire (Figs. 36 – 37). This is unlike at the Seaweed Centre in Paje (East Coast) where the soap bars were produced by using the soap extruder. Soap pieces were cut using knives like at the Seaweed Centre.

Fig. 33 A trainee preparing a plastic tray (applying Vaseline) for putting the soap mixture

Fig. 34 Trainees mixing the soap ingredients

Fig. 35 Trainees pouring the soap mixture into trays

Fig. 36 Trainees cutting the soap block to make soap bars

Fig. 37 Trainees cutting soap bar to make soap pieces

b. Making of seaweed Vaseline

Trainees also participated in making seaweed Vaseline. The Vaseline was made by heating the Vaseline found in commercial shops (in this case Baby Care) and adding seaweed powder (Fig. 38). *A discussion was held on the importance of using petroleum jelly rather than the readymade Vaseline so as to have a product that can be patented or marketed as a trade mark.* Working with the women members of the cooperative in Kidoti the trainees used firewood to heat the Vaseline (Fig. 38). Some of the Vaseline made that day was taken by the trainees as samples to show to colleagues in Mauritius.

Fig. 38 Trainees making seaweed Vaseline: preparing the fire and cooking pot, adding the Vaseline, mixing, adding seaweed powder, a pot containing seaweed Vaseline, and pouring the Vaseline into containers

In addition to learning how to make the two seaweed value-added products, the trainees were taken to the seaweed farming site and a seaweed drying area that are used by farmers in Kidoti. The aim of this session was to give the trainees the idea of distances between the farmers' homes and the farming sites. Whereas seaweed farms in Paje on the East Coast and Bweleo on the West Coast were near to the homes (about 200-300m) it takes the farmers in Kidoti 15-20 minutes to walk from their homes to the farming site (Fig. 39). The area used for drying seaweed in Kidoti is also different from that used in Paje. In Paje the seaweed is dried on grass (or in elevated platforms at the Seaweed Centre) but in Kidoti the seaweed is dried on stones as is done in some areas in Pemba (Fig. 40). Seaweed dried in grass and on stones is clean enough although it needs further cleaning but that dried in elevated platforms in cleaner. The trainees were able to learn this fact by visiting Kidoti and comparing the drying facilities in the two villages.

Fig. 39 Trainees standing near the seaweed farming site in Kidoti village, NW Coast of Zanzibar.

Fig. 40 Drying seaweed on stones in Pemba, Zanzibar

2.12 Discussion on the field works and literature acquisition

Discussion on what has been done in the field in setting seaweed farms using the three techniques (floating lines systems, bamboo rafts, and off-bottom) was held on day 13, 22 October 2011. This was done in Bweleo village. The summary included discussing criteria on selecting farming sites, types of farming materials needed depending on the technique, and costing for starting a farm. The trainees were given exercises that were discussed afterwards. Flip charts were used for the purpose (Fig. 41).

After the discussions the trainees returned to Zanzibar town where relevant literature was acquired at the Institute of Marine Sciences. Reports, journal papers, conference proceedings papers, and other literature were acquired through photocopying and printing. The trainees were given a list of literature citations from which they could choose additional literature-these were also made available to them either as soft or hard copies depending on the literature.

Fig. 41 Trainees and trainer holding a discussion session in Bweleo village, Zanzibar

2.13 Summary, discussions, and wrap up

This training day was used to summarise the whole training encompassing theoretical and practical sessions and holding discussions on how useful the training was, how it can be improved and how to collaborate in starting the farming in Mauritius. This was done on day 14, 23rd October 2011 at the hotel as well as at IMS. More literature was also acquired on this day.

2.14 Exercises given to the trainees

During the conduction of the training, the trainees were given different exercises depending on the topic. Some of the exercises were questions that were asked and discussed during the sessions but some of them were done as home works. These were then discussed during the ensuing training day/session. The exercises given as home works are shown in annexes i-iii. The training time table is shown in Annex iv.

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I would like to thank the Mauritius Research Council for choosing me for the work. I acknowledge the full support of the MRC staff in Mauritius and Rodrigues during the correspondence and conduction of the trainings. The research trainees: Chitra Ramphul, Morris Ravina, and Koushul Narrain who visited Zanzibar are thanked for being "very good trainees" and for their hard working mood throughout the training period. Thanks also go to Mr. Muhidin Abdallah of the Institute of Marine Sciences for his help in field and technical issues during the training. Seaweed farmers in Paje, Bweleo, Kidoti, and Chwaka are thanked for their help during field work.

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5 ANNEXES

Exercises for the trainees and discussion topics and the training programme

Annex i Costing and budgeting in seaweed farming
Seaweed Farming in Mauritius and Rodrigue: Capacity Building in Seaweed Farming for Technical Personnel of Mauritius and Rodrigues, 10-24 October 2011

COSTING AND BUDGETING IN SEAWEED FARMING

To start a seaweed farm one needs to prepare a budget for costs of starting and running the seaweed farming activity. The following are costs (applicable to both the Off-Bottom and Floating Systems Methods) that need to be budgeted for:

Initial Investment Costs

- Nylon (plastic) ropes (e.g. 4mm for tying seaweed-these are **both initial and routine costs as they are repetitive)**
- Tie tie **(both initial and routine)**
- Wooden pegs **(both initial and routine)**
- Seed
- Knives and machetes for cutting and sharpening the stakes
- Rubber/plastic shoes to prevent legs from stings/scratches.
- Drying racks (e.g. made of wooden stakes and palm fronds) that elevate the drying surface off the ground
- Plastic (fertiliser) bags for both carrying wet seaweed from the farm to the drying area and for storage of dried seaweed.
- Snorkeling masks for inspecting seaweed farms during high tide (Optional)

Labour Costs (e.g. Family members and hired people)

- Tying Seed
- Planting
- Farm Management e.g. removing debris and entangling algae
- Harvesting
- Carrying to Dry e.g. hired cart
- Packaging –putting into sacks.
- Carrying to the Market
- Tie-tie and rope separation -Farmers routinely work in the farms to separate tie-ties and ropes that are entangled together

Exercise for 18th October
Prepare a budget for starting:

1. an off-bottom farm
2. a floating system farm and
3. a bamboo raft farm,

costing the items necessary for starting a farm. You can use your country's currency.

Annex ii. Exercise 2

What do you need to start a seaweed farm? Imagine that you have not done anything back home yet-no feasibility study report -you are starting afresh.

Annex iii. Exercise 3

List (and explain) the criteria for selecting a site to farm seaweed

Annex iv Matrix of criteria for comparison of off-bottom and floating lines methods for the farming of seaweeds

Comparing characteristic	Method	
	Off-bottom	**Floating lines**
Natural capital (land)	Free access Limited by nature of intertidal bottoms (for the attachment of pegs)	Free access Not limited by nature of intertidal bottoms
Labour	More labour intensive	Less labour intensive; very labour intensive only at the initial phase
Financial capital	Need continuous financing because of abrasion of ropes	More stable conditions, less abrasion, less financial capital. High financial requirements required only at the starting phase
Environmental impact	Significant (negative) impact on intertidal organisms – lower coverage of plants and fewer intertidal animals (Msuya *et al*., 1996; Eklof *et al.*, 2005; Lyimo *et al.*, 2006)	Very low negative impact on organisms and environment in general
	Impact on mangroves and other trees because of cutting for pegs (Msuya *et al.*, 1996; Eckloff *et al*., 2005)	No wooden pegs are used (Msuya *et al.*, 2007a; Msuya and Mmochi, 2008; Msuya, 2009c)
	Limited microenvironments created	Create microenvironments under the floating systems which act as feeding, growout, and hiding grounds for marine organisms (Msuya et al. 2007a, Msuya and Mmochi 2008)

	Limited hiding places for fish	Act as fish aggregating devices providing farmers with an additional product (Msuya *et al.*, 2007a; Msuya and Mmochi, 2008)
	Can cause total loss of seed during die-off	Creates a seed bank that minimizes the amount of time a farmer spends trying to produce seed after a die-off (Msuya *et al.*, 2007a)
Social impact (interaction with other users of the sea, *e.g.* fishermen)	Minor conflicts may occur, *e.g.* stealing of ropes, fishing activity in seaweed farms	May cause conflict between farmers and fishermen (beach seiners, fishers with nets) and farmers and transporters of goods. A potential solution is zoning of the tidal flat areas as was demonstrated by Msuya *et al.* (2007b).
Adaptability	Easily adaptable so long as the area is suitable and available	Needs transport to deep water; some knowledge of swimming is an advantage-limitation to women farmers
Adoption for other uses	Low probability	High probability, *e.g.* already adopted for shellfish and pearl farming in Zanzibar
Duration of use in a month	Applied during low tides when the tide is out at and water level is from few centimetres to about 0.5m.	Can be applied throughout the year
Productivity	Lower production per unit area (Msuya *et al.*, 2007a)	Higher production per unit area (Msuya *et al.*, 2007a)
Livelihood diversification	High because of ease of farming; however, the methods is less productive	Higher because of higher productivity and potential to obtain additional products, *e.g.* seaweed and fish (Msuya and Mmochi, 2008)
Intensification capacity	High	Higher (more crops per unit area – possibilities of integrated culture are higher)
Sustainability	Higher – once started farming can be conducted continuously	High – needs sheltered areas without strong winds to prevent seaweeds from breaking

Annex v. The training programme

TRAINING PROGRAMME			
9 October 2011	Arrival and hotel check in	Abuso Inn	Dr. Msuya/ Assistant /
DAY 1, 10 October 2011	Lectures: • Overview of seaweed farming in Tanzania- history, development, challenges • Farming methods for Eucheumatoids	IMS	Dr. Msuya
DAY 2, 11 October 2011	Lectures: • Other methods of farming e.g. Ulva, Hypnea • Seaweed innovation-innovative farming, value addition	IMS	Dr. Msuya
DAY 3, 12 October 2011	Field day: Visit to seaweed farms in Paje-first hand observations and practical training in farming • Visit to various stages of production cycle • Cultural practices involved in farming from planting to harvesting • Harvesting of Seaweeds • Drying of seaweed-at the beach, homes, and Seaweed Centre • An experience of "Seaweed Tourism"	Paje village	Dr. Msuya/ Assistant
DAY 4, 13 October 2011	Field day: Collection and identification of seaweed species of interest in Chwaka Bay (Seaweed Taxonomy)	Chwaka village/Bay	Dr. Msuya/ Assistant
DAY 5, 14 October 2011	Field day: • Preparation of farming materials • Construction of 2 floating systems • Preparation of bamboo poles • Construction of 3 bamboo rafts	Bweleo village	Dr. Msuya/ Assistant
DAY 6, 15 October 2011	Field day: • Continue construction of floating systems • Planting (tying) of seaweed and anchorage of floating systems • Measurements of water parameters and others e.g. weather conditions	Bweleo village	Dr. Msuya/ Assistant
DAY 7, 16 October 2011	Field day: • Continue construction of bamboo rafts • Planting (tying) of seaweed and	Bweleo village	Dr. Msuya/ Assistant

	anchorage of bamboo rafts • Measurements of water parameters and others e.g. weather conditions		
DAY 8, 17 October 2011	Field day: Visit to the Paje Seaweed Centre + practical training in value addition • Post-Harvest handling-drying/ preparation for storage • Quality Management of Produce • Value addition-use of soap production machines • Value addition-soap packaging and marketing • Value addition-making of seaweed salad	Paje village	Dr. Msuya/ Assistant
DAY 9, 18 October 2011	Field day: • Recap of theory/practicals/ discussions at hotel • Field day: purchase of materials-ropes, tie tie-demonstrations in retail and whole sale shops-comparison of prices	*Funguni hotel Znz town	Dr. Msuya/ Assistant
DAY 10, 19 October 2011	Field day: Morning hours: • Preparation of farming materials • On land demonstration of an off-bottom seaweed farm – distances between ropes, pegs, and tie ties demonstrated and measured Afternoon (tide is 1.6) • Measurement of water and weather parameters and how to keep a log book of data	Bweleo village	Dr. Msuya/ Assistant
DAY 11, 20 October 2011	Field day: Morning: • Purchase of wooden pegs • Preparation of farming materials Afternoon (tide is 1.8): • Set up of an off-bottom farm • Measurement of water and weather parameters-use of log book • Group discussion with farmers-problems faced in farming and possible solutions	Bweleo village	Dr. Msuya
DAY 12, 21 October 2011	Field day: • Visit to Kidoti women group • A different environment of post-harvest handling-drying • Value addition-manual making of	Kidoti village	Dr. Msuya/ Assistant

	seaweed soap • Value addition-making of body Vaseline		
DAY 13, 22 October 2011	• Discussion on the field works and visits • Literature acquisition	Bweleo village /IMS	Dr. Msuya/ Assistant
DAY 14, 23 October 2011	Summary, discussions, and wrap up	Funguni hotel /IMS	Trainees/ Dr. Msuya/ Assistant
24 October 2011	Departure		

***The trainees were transferred to Funguni Hotel because the Abuso Inn had some problems with the accommodation**