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Seaweed Farmer Education: Is it Enough to Sustain the Industry? Analyzing the Status of Stakeholder Investment in Muungoni and Jambiani, Unguja

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Abstract. Since Filipino researchers arrived in Zanzibar to determine the potential for cultivation of seaweed more than 20 years ago, the islands’ coastal communities have relied on the resource as a main or alternative source of income. When the companies started investing at the industry’s onset, trained personnel offered farmers’ education on proper farming techniques for *Spinosum* (*Eucheuma denticulatum*) and *Cottonii* (*Kappaphycus* spp.) by establishing demonstrative (demo) farms and holding seminars. Today, informal training involves experienced farmers teaching the newcomers their techniques. While demo farms remain in some villages, companies offer no extension services based on the belief that the farmers have mastered the skills, so further training is not needed. However, it is unknown if the effectiveness of the diffusion of knowledge from companies to farmers, especially new ones, has been enough to prepare farmers to deal with emerging environmental challenges threatening to destabilize the seaweed industry. On November 8th-28th, 2011 a series of interviews were conducted to assess the farmers’ technical knowledge and perceptions of environmental challenges, and analyze the government’s and companies’ role and perspectives on farmer education in Muungoni and Jambiani, Unguja. Results suggest that extension services by stakeholders are needed in addition to the establishment of farmer cooperatives. Future research is required to assess the current situation and create site-specific solutions in other villages in Unguja and Pemba.

1. Introduction

1.1 History: Introducing Zanzibar to seaweed farming

Research and development of seaweed farming in Zanzibar started as early as 1983 when three pilot seaweed farms were initiated in Fumba, Unguja and Pemba by a professor from the University of Dar Es Salaam. Since planting native seaweed species failed, scientists brought promising strains to test from the Philippines such as *Spinosum* (*Eucheuma denticulatum*) and *Cottonii* (*Kappaphycus alvarezii*) (Eklund, 1992). In 1989-1990, research spread to Jambiani and Paje where Filipinos from the seaweed supplier Company A established farms (Company A, personal communication). During this time, Company B, an overseas market and technical support provider for supplier companies, gave the supplier company ZASCOL (branch of Agro-Seaweed Company in Dar Es Salaam, Tanzania) loans to purchase ropes, tie-ties, and the first

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1 Dr. Mshigeni from the Botany Department
2 *Spinosum* and *Cottonii*: industrial names for the cultivated seaweed
3 In order to maintain the confidentiality of the companies interviewed, terms “Company A, B, C” etc. will be used substitute the companies’ name.
4 Tie-tie: material used to secure the seaweed seedling to the rope. Material is usually made of plastic or nylon. Some farmers have been seen using strips of fishing net.
harvests in order to begin their investment in Paje and Muungoni. Success at these sites encouraged the industry to expand to other villages and became commercially viable by 1991 (Eklund, 1992).

1.2 Industry Challenges: The natural environment and business relations

Initially the companies attempted to establish both Cottonii and Spinosum in the villages. Despite efforts to grow Cottonii, many sites did not have the appropriate environmental conditions to support this more sensitive seaweed which died off mostly because of EFA (epiphytic and endophytic filamentous algae) during Kiangazi (local name for hot and humid season) from December to March. Scientists attribute the rise in water temperature\(^5\) and salinity to the cultivated seaweed's susceptibility to epiphytism (Hayashi et al., 2010). EFA is smaller algae with a delicate thallus\(^6\) that attaches to larger algae in order to receive a better source of light (Mtolera et al., 2005). Only certain types of EFA cause destruction of the seaweed with the most problematic in Zanzibar being a red filamentous algae Polysiphonia spp. which causes a parasitic relationship by invading the tissue of the host and damaging the host's cells (Mtolera et al., 2005, Hayashi et al., 2010). In 1994, Cottonii grown in Paje died off due to a Polysiphonia outbreak. Furthermore, Pemba's early success of growing Cottonii in the early 1990's, when the farmers would produce about 1,500 metric tons per year, was suddenly destroyed following the 1997 El Niño event\(^7\) (Company B, personal communication). Thus, the fragile nature of this strain has made it difficult for farmers to sustain. Fortunately, the hardier Spinosum continued to flourish and is the most commonly grown in Zanzibar today.

Even though Spinosum grows well due to its tolerance of environmental change, it is not

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5 Optimum temperature for cultivated seaweed growth is 25°-27° C during May- August (Msuya, Mtolera, personal communication)
6 Thallus: body of the seaweed
7 A change in the usual ocean and atmosphere patterns of the tropical pacific occurring roughly every 2-7 years and causing an increase in water temperature
as valued as *Cottonii* in the world market. Customers value the *kappa* carrageenan from the *Cottonii* more than the *iota* from *Spinosum* because it has a stronger gel (Hayashi et al., 2010, Msuya, 2011, Mtolera et al., 2005). Therefore, the price since the beginning of 2011 has been 400tsh/kg for *Spinosum* and 600tsh/kg\(^8\) for *Cottonii* (Company B, personal communication). Prior to this year, the price was significantly lower, rising from 100tsh/kg in 2006, up to 130tsh, 200tsh, and finally 250tsh/kg in 2010 for *Spinosum*. 2006 was a pivotal year for the industry as the Zanzibar government decided to change the economic system from a monopoly to a free trade market in an effort to increase the seaweed price. As a result, the number of companies investing in seaweed increased from four to twelve (Department of Fisheries, personal communication). While the subsequent competition caused the price to rise, challenges developed that are continuing to jeopardize the business relationship between the companies and farmers.

1.3 Investor to Farmer: The diffusion of knowledge

Hands-on training of the seaweed farmers took place in the beginning from the early 1980's to 1990's when Filipino researchers would test certain strains and distribute seedlings to the farmers. From there, they would teach the farmers who received the first distribution farming design, technique, and expansion by establishing demo farms and teaching seminars (Company A and C, personal communication). Local seaweed officers employed by the companies continued to educate the farmers and oversee seaweed quality (Eklund, 1992). The farming method employed was the off-bottom method, which continues to be used most extensively. The method consists of wooden sticks which are placed in the sand to make rows created by attaching two sticks with a rope. Seedlings are attached to the rope using tie-ties spaced at even intervals along

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\(^8\) Estimated conversion rate: $1=1700tsh
each rope. While other methods, such as the floating line method, have shown to be more favorable for seaweed growth, recent efforts to employ it have not succeeded because of cultural and financial hindrances (Company A and B, personal communication).

Once the initial farmers were established in their techniques, the companies stopped training and placed the responsibility on the farmers to educate each other. Today, there are no programs established to improve farmers output. Instead, a majority of new farmers learn through the more experienced farmers' guidance. Some companies retained their demo farms, which have now transformed into nurseries or experimental lines, and employ skilled farmers (seaweed technicians) to continue maintaining them. In addition, they are encouraged to show other farmers as an example of how to improve their farming practices. However, the efficiency and effectiveness of farmer education in sustaining the industry is generally ignored. Even though the general idea is that those farmers who have worked for 20 years will teach the younger farmers, the quality of teaching may not be sufficient. While farming is their way of life, a large percentage of the producers do not realize what happens beyond their point of involvement. They conceptualize their environment's characteristics and the role it plays in their work.

Environmental problems existing since the beginning continue to become more critical, especially for Cottonii. Furthermore, the current challenges faced by companies to meet the world market demands influence their involvement with the farmers. It is now more important than ever for farmers to have the best management practices, an understanding of the purpose behind what they do, and a sense of the larger picture in which they are involved. While companies support scientific research by trying to find more resistant strands, testing viscosity, and experimenting on other site-specific problems, farmers need more holistic education to retain
technical knowledge for future generations and to help them prepare for seasonal problems.

1.4 Study Aims

This study aims to evaluate the need for further farmer education by (1) assessing the technical knowledge and environmental perceptions of seaweed farmers, (2) obtaining company and government representatives' perspectives, and (3) analyzing yearly seaweed production statistics in Zanzibar.

2. Study Sites

The study was conducted in Muungoni and Jambiani villages, Unguja (refer to Appendix 1 for map) from November 8th -28th, 2011.

2.1 Muungoni

While Muungoni’s shore is located at S06˚19’12.7” E039˚24’43.3”, the people live about 1km inland (about a 45-minute walk) with a population of 2,320. Coastal activities such as fishing and seaweed farming serve as the village’s main source of income, which is followed by secondary sources like agriculture, farming crops, and chopping wood to sell in Zanzibar Town.

Muungoni’s shore is bordered by mangrove forest and a supratidal zone composed of coral rock. The closest seaweed farms begin in the sandy subtidal zone of Pete Inlet, which is followed by a rocky sub- and mesotidal zone that extends approximately 104 meters (m) during the spring tidal cycle. The length of the shore extends about 321.5 meters. Farms are bordered by Uzi Island (S06˚19’38.8” E039˚24’10.8”), across Pete Inlet about 1.5 kilometers (km) from Muungoni’s shore, and Pete. Since environmental conditions are not suitable for seaweed growth by Uzi’s shoreline, the community also utilizes Muungoni’s territory.

When the seaweed farming industry began 20 years ago in Muungoni, ZASCOL was
among the first to invest in the resource. Company B consulted with ZASCOL to support the
development of the industry and teach them proper farmer training techniques. Several strands of
Cottonii were grown at this site such as *Kappaphycus alvarezii, K. striatum, K. striatum* (variety
*sacol*), and others (Figure 1). Historically, Muungoni has been the best site to harvest *Cottonii*
and currently harbors the largest amount of this seaweed in comparison to the few other sites in
mainland Tanzania. The most prominent challenges experienced by farmers are drying during the
rainy months, strong winds during the South Monsoon, “ice-ice” (an infection which causes the
thallus to turn white and dissolve), and epiphytism during the hot and humid months.

![Figure 1. Zanzibar seaweed strains. From left to right: Kappaphycus alvarezii, K. striatum, K. striatum (variety sacol), and Eucheuma denticulatum. Photo credit: Recarte Cay-an.](image)

2.2 Jambiani

Jambiani’s shore, located at S06°19.263' E039°32.936', is bordered by local homes,
hotels, and tourist shops and extends 7-10 km along the shoreline. Since the area is very large,
the village is split under the management of two shehas (local leader). The side of the village
where the study was conducted has a population of 4,034. In addition to seaweed farming,
fishing and tourism serve as sources of income for the locals. The farms are situated in a large
lagoon that is susceptible to stronger currents than in Muungoni. Therefore, the sand in the
subtidal zone is finer at this location. The mesotidal zone is characterized by a sandy substrate
which extends approximately 192.5 m from the low tide mark during the spring tidal cycle. The
supratidal zone consists of coarser sandy substrate in some areas and coralline rock in others.

Company A was one of the pioneers of seaweed farming in Zanzibar, and started their pilot farm in Jambiani in 1989 (Company A, personal communication). They first attempted to grow *Cottonii*, but failed due to EFA break outs (Eklund, 1992). Later that year, they started successfully growing *Spinosum*, which they continue to invest in today (Figure 1). Jambiani was the most successful producer of *Spinosum* from 2002-2006, but started experiencing a decline in 2007 (Company C, personal communication). The most prominent challenges for farmers are “ice-ice” and epiphytism during the hot and humid months, strong winds during the South Monsoon, and sea urchins.

3. Materials and Methods

3.1 Farmer Interviews and Observations

Interviews were conducted from November 10\textsuperscript{th} -15\textsuperscript{th} in Muungoni and November 23\textsuperscript{rd} -28\textsuperscript{th} in Jambiani from 30 minutes to one hour before low tide until high tide arrived (Refer to Appendix 3 for list of all questions). Therefore, daily interview periods lasted from about 2.5-3 hours, with each interview lasting 10-20 minutes. In Muungoni, women and men were asked questions while working by the shore or at their farms. Farmers who were sitting on the shore tying seaweed 30 minutes to 1 hour before low tide, were observed and assessed on their skill by following the guidelines of the “Farmer Observational Data Sheet” (Appendix 2). Once low tide arrived, farmers were interviewed while working on their farms. Questions focused on farmer's site and seedling choice, maintenance routine, seasonal perceptions, and solutions to environmental challenges. In addition to asking questions to assess their technical knowledge and perceptions, the quality of their farm was observed and a rough location of their farm was drawn on a map to aid in further analysis. Farm quality was assessed on the orientation,
uniformity of rope length, cleanliness of rope and seaweed, and spacing between lines and neighboring farms. Finally, daily observations were made of post-harvest handling, which involves the drying and packing process. A young male translator from Jozani Forest assisted with the interviews from November 10th -11th and a young male translator from Zala Park assisted from November 12th -15th. An exception to the scheduled interview process occurred on November 14th -15th, when the farmers did not go to the shore because of excessive rain. Therefore, no interviews were able to be conducted on November 14th, but were resumed on November 15th at the host family's house. Lastly, a handful of informal interviews with the key respondent, the father of the host family, gave insight into the farmers' collective mentality and opinion of the current seaweed price.

In Jambiani, a young male translator living in the village assisted in farmer interviews. On November 22nd, the Secretary of the Committee of Seaweed in Jambiani, Zimam Yusuf, was interviewed with the assistance of the translator about her role and opinions on the situation of seaweed farming (Appendix 3)\(^9\). In addition to the usual schedule of farmer interviews, a worker at the Company A Buyer Stations was interviewed on November 23rd and 26th about his duties and regulations on the seaweed quality he purchases from farmers (Appendix 3)\(^10\). Since the intertidal zone was longer than in Muungoni, farmers were able to access their farms one to two hours before low tide and therefore did not sit by the shore to prepare their ropes at this time. Therefore, the “Farmer Observational Data Sheet” was not used and interviews were carried out as the farmers worked in the water. Questions and observations were carried out under the same criteria as in Muungoni.

\(^9\) Switched translators because the first translator had to return to work
\(^10\) A seaweed committee was not located in Muungoni village
\(^11\) Information about buying stations in Muungoni gained from interview with Company B field representative
3.2 Company Interviews

Buyer and seller company representatives working in Muungoni and Jambiani were interviewed either face-to-face or through email, depending on their availability during November 17th - 19th. Company representatives were asked about training programs that they have implemented or are currently implementing and their opinion of farmers' education. Additionally, they were asked about their company's history, challenges, and relationship with the farmers (Appendix 4).

3.3 Government Interview

A representative from the Department of Fisheries was interviewed to gain information on the government's perspective on the knowledge of seaweed farmers and plans to implement educational programs to help sustain the industry (Appendix 4). Additionally, the representative provided information compiled from all the companies on the productivity of *Spinosum* and *Cottonii* from 2001-2010.

4. Results

4.1 Production Statistics

As shown by production data gathered from all companies from 2001-2011 (Figure 2), the output of *Spinosum* is increasing and *Cottonii* is decreasing in Zanzibar. However, for both types of seaweed, the production is decreasing in Jambiani and Muungoni from 2008-2011 (Figure 3). Although Figure 2 indicates that *Spinosum* is rising, no trends can be determined because there is not any indication of the difference in number of farmers from year to year. While the production may be rising with all farmers combined, the production per farmer capita may be declining.
4.2 Site Summary

4.2.1 Muungoni

Out of the 29 farmers interviewed, 12 were trained by company representatives, 11 by family or friends, and 6 taught themselves. From the 13 farmers taught by friends or family, 4 had been farming between 15-20 years and 7 had started farming within the year. Half of the farmers who taught themselves had farmed between 2-6 years while the other half had farmed between 11-14 years. ZASCOL began in 1991 to provide training to farmers, who were then entrusted to teach others in the community. Initially, the companies provided the farmers with training (using demonstration farms) and inputs\textsuperscript{12}, but for some unknown reason, the farmers explained, they eventually stopped providing inputs and had to buy their own. Company representatives further clarified that they stopped as a result of the increased competition between buyers created by the government's decision to change the economic system from a monopoly to free trade in 2006. The resulting competition brought corruption because those

\textsuperscript{12} Inputs: farming materials, rope and tie-ties
companies who continued to provide farmer inputs lost a large amount of seaweed to buyers who were offering a higher price or accepting a lower quality of seaweed. Instead of selling most of their harvest to the companies who gave them materials, farmers preferred to sell to buyers with a higher price. Therefore, the companies truly investing in the farmers did not receive any return from them. For the large corporations, it was not in the business’ best interests to continue giving inputs.

Farmers manage between 40-600 rows, which are divided between different sections called “lines”. For example, the average line consists of 40-70 rows. From all the farmers interviewed, the average number of rows is 189 per farmer. A majority of the farms do not have uniform orientation because sticks are not placed in a straight line and ropes have unequal lengths, causing many farms to cross into the space of a neighboring farm. Overall, the farmers have a non-aggressive attitude, suggesting complacency with their farming techniques. The farmers who requested improved techniques, if they were available, were the less experienced farmers. One of the farmers who started this season was interested in having specialists come to teach them how to make straight lines and create a farming plan. Many farmers petition for more inputs and stress that they work very hard for little money. They insist that even though they earn 400tsh/kg for Spinosum or 600tsh/kg, they only make a profit of 150tsh-200tsh/kg after investing in materials and an ox-cart to transport their seaweed to the shop.

During Kiaganzi when the seaweed, especially Cottonii, does not grow well because of increased water temperature, collectively the farmers average 14 bags/day. Farmers who solely harvest Spinosum in deeper water average 16 bags/day, while those in more shallow water average 11 bags/day. Farmers who harvest both Spinosum and Cottonii usually only harvest
Cottonii during Vuli and Masika\textsuperscript{13}, and those who attempt during Kiangazi are either discouraged and stop planting it altogether or maintain it during rainy months in deeper water. Out of all the interviewees, seven farmers, 5 experienced (14-20 years) and 2 novices (2, 6 years), currently grow and harvest Cottonii. Two others, both with 20 years experiences, used to farm this strain but then stopped due to the difficulties encountered. While both types of seaweed grow better during rainy seasons, farmers are unable to successfully dry their harvest. Thirty-five percent decide to leave most of the seaweed in the water, and 65% continue to attempt to dry and sell, ending up with an average of 9 bags/day.

\textbf{4.2.2 Jambiani}

Out of the 43 farmers interviewed, 24 were trained by company representatives, 11 by family or friends, and 8 taught themselves. Unlike Muungoni, a Committee of Seaweed Farming in Jambiani has been active since 2006 with 22 members. The secretary of this committee was interviewed to gain insight on the committee's purpose and their thoughts on the current state of the business. As committee members, their role is to relay problems experienced by farmers to the companies. Ideally, the companies will come upon request to collaborate with the community. Committee members organize meetings with the farmers, companies, and government officials to discuss solutions to problems. Additionally, for the ongoing progress of the industry they are planning to learn how to make seaweed soap and snacks from Paje where the activity is developing. They will return to Jambiani to teach the other farmers. The innovation of creating this internal market was sparked by an IMS (Institute of Marine Sciences) project called the Cluster Initiative which suggests ways farmers can benefit more from seaweed (Msuya, 2006). Currently, in Paje, Bwelelo, and Kidoti small companies have been emerging to

\textsuperscript{13} Vuli: Short rains, Masika: long rains
invest in this relatively new business, showing promise for further implementation in other villages.

Quality checks are performed at Company A’s drying station before the seaweed is carried into town to the companies' offices. The seaweed is checked for sand presence so that if the seaweed contains sand, the farmers must beat it with a stick until the sand is removed. From all of the farmers interviewed, each farmer manages from a range of 50-700 rows/farmer and an average of 325 rows. The farmers at this site were more adamant about their criticisms of their quality of farming, asking if their way of planting and harvesting was correct. Overall, they expressed a desire to learn improved techniques.

5. Discussion

5.1 Production Statistics

A decline in seaweed output in Jambiani and Muungoni (Figure 3) is caused either by farmers losing interest or seaweed productivity decreasing. Scientists have noted that the water temperature has risen 2°C compared to 10 years ago when the water was 1°C above the optimal temperature range for seaweed (Mtolera, personal communication). The increased temperature is a significant change for seaweed, which supports the argument that climate change is negatively affecting Zanzibar's production. A changing natural environment combined with a replacement of farmers with 20 year experience with those who are less educated, both impact the success of productivity displayed in Figures 2 and 3.

5.2 Farmer Technical Knowledge and Perceptions

5.2.1 Preparation Efficiency

Farmers at each site have different methods of preparing their seedlings to plant. In Muungoni and Jambiani, they prepare the rope at home, placing tie-ties at even intervals, then
bring their inputs to their farms. However, in Muungoni, the farmers arrive at the shore 30 minutes to one hour before the tide is ready to attach their seedlings onto the rope so they are prepared by the time the water is low. In Jambiani, they do this activity at their farms, which wastes time that they could spend expanding. Since the intertidal zone is much larger here, the farmers have a greater potential to expand if they prepare their ropes efficiently as in Muungoni.

5.2.2 Farm Quality: Site selection, orientation, and maintenance

In Muungoni, farmers choose their plot site either passively, suggesting little knowledge of the environmental reasons for site choice and the decision is made out of convenience, or intentionally, suggesting recognition of beneficial or harmful environmental characteristics. Fifty-six percent of the farmers responded passively, explaining that it is a good place, their seaweed grows well, or that all other places were taken. Forty-three percent of farmers responded intentionally, explaining that they have farms near the shore because it is easily accessible, they have farms far from shore because it is more productive, they wanted to be far from other farms for an open and clean area, the soil is suitable, or the area is optimal for *Cottonii*. In regards to orientation, a majority of the farms were crooked and rope were of different lengths, either longer or shorter than the length suggested by company representatives (10m), which often entered into the space of a neighboring farm. Thus the proficiency of the farmers' plots is limited. For day-to-day maintenance, they attend their farm anywhere between 4-7 days during spring low tide. Their maintenance involves fixing rope that has broken from the stick, cleaning the rope by rubbing off the dirt with their fingers or bringing it to shore to beat with a stick or against a rock, removing nuisance algae or epiphytes, and cut off algal pieces that have ice-ice. Other ways they help the seaweed to grow is by using empty bottles as buoys, especially for *Cottonii*, during the seasons of Kipupwe and Kiangazi when the low tide is extremely low. They explained
that the empty plastic bottles help the seaweed to remain suspended in the water column and thus grow well.

In Jambiani, 36% of the farmers responded passively, explaining that the water is good, it is a area they got, or someone chose it for them and 64% of the farmers responded intentionally, explaining that the shallower farms are easily accessible, the deeper water is better, no sea urchins, or the seagrass helps it to grow. In general, the orientations of the farms were straighter and had more space between neighboring farms than in Muungoni. Since most of the farmers use ropes provided by the companies, who pre-cut the ropes before distributing, all rope lengths were relatively uniform. Farmers attend their farms anywhere from 3-7 days per spring low tide, and maintain its condition by killing sea urchins, cleaning the rope at home using water and a knife to rub off the dirt, straightening or replacing the ropes and sticks, and removing nuisance algae.

5.2.3 Seedling Selection

One of the most important aspects of farming is the proper selection of seedlings to continue using to plant. According to past research, the best way to avoid contamination of seedlings is to remove an infected section as soon as the farmer notices it (Mendonza et al., 2002). In Muungoni, they break apart a large seaweed in half or more, depending on the size, near the center of a seaweed individual. At both sites, when the farmers see “ice-ice”, they break off the infected part and dry it, while using the non-infected part as a seedling. In Jambiani, the farmers also mentioned that they would dry “fat” seaweed, and continue using the “thin” ones as seedlings. Therefore, both experienced and new farmers’ knowledge of seedling selection is sufficient at each site.

5.2.4 Quality Retention: Post-harvest handling

Jambiani farmers dry their seaweed on the sand, grass, or coconut leaves, while in
Muungoni they dry it solely on the grass. While companies in both villages insist the best way to dry the seaweed is on coconut leaves or off the ground completely, farmers either are not aware or do not put forth the effort to dry it properly. In Jambiani, 18 farmers were asked about the best way to dry seaweed. From the four who were self-taught, one said by using coconut leaves and another said something must be put on the ground. A third mentioned that the seaweed must be placed in the sun and the fourth explained that the drying process is faster placing the seaweed on the sand but yields a lower quality than drying on the coconut leaves, which takes a longer time for the seaweed to dry. Out of the four who were taught by family or friends, two said by placing on the sand, another on the grass, and the fourth emphasized that the seaweed individuals should not touch one another. Finally, out of those taught by the companies, eight responded on coconut leaves, another on grass or coconut leaves, and the last only on the grass. The buying station personnel, who is a village resident, has an understanding of the best qualities of dried seaweed: it should be a deep purple color without sand. If farmers bring dirty seaweed, they are required to clean it off before it is accepted. Additionally, if the farmers bring yellow seaweed, they are encouraged to dry their seaweed on palm leaves or mats and avoid allowing rain contact. Before the establishment of the free trade system (Figure 7), the company only accepted the highest quality seaweed and therefore refused those that were yellow\textsuperscript{14}. When Company A comes to disperse farming materials 3-5 times/yr, the local personnel give them out in exchange for seaweed. Before being delivered into Stone Town, the seaweed is stored in a pile on a concrete floor inside the station until 1 ton is accumulated.

In Muungoni, all the farmers placed their seaweed to dry on the supratidal zone, which is accessible by stairs against the coralline rock that borders the shore. According to Company B’s

\textsuperscript{14} When the seaweed turns yellow during the drying process, this indicates that it has been contacted by rain water, which causes the valued carrageenan to be washed out
representative, the farmers used to dry their seaweed on top of coconut leaves years ago but stopped because they were often taken by fishermen to burn for cleaning their boats. Therefore, farmers currently dry their seaweed on the ground, mostly in the grassy areas. Since the rainy season destroys all seaweed they attempt to dry, the farmers request that the company builds a shack to protect their harvest from the rain. The farmers did not recognize that quality retention of seaweed also declines by simply placing on the grass, which contains moisture that degrades seaweed quality.

Another problem that starts in the water, but continues through post-harvest handling, is the mixing of *Cottonii* and *Spinosum* on the rope and consequently in the bags sold to buyers. Companies request that the two strains remain separate when they receive them for processing purposes. However, during interviews with farmers also planting *Cottonii*, the strain was often seen mixed on the same row with the *Spinosum*.

At both sites, none of the farmers recognize that they must ensure the high quality of the seaweed for reasons other than earning more money. The farming communities do not know why they need to provide high quality raw material and therefore motivation to have the best post-harvesting practices is low.

5.2.5 Problem Solving

At each site, farmers have similar and different ways about dealing with seasonal problems. In Muungoni, the environmental challenges felt by most farmers are “ice-ice” and epiphytes during Kiangazi, strong currents during Kusi, and drying during Vuli and Masika (Figure 4). Since *Cottonii* is the most susceptible to epiphytism and “ice-ice”, the best seasons to grow this strain are during the rainy months when the water temperature and level are favorable. The common methods for solving problems are listed in Table 1.
Since Muungoni farmers have difficulty covering their seaweed during the rainy seasons, they have requested the companies to build them a drying shelter but have not made their own efforts to use their materials to build a drying table or cover. Additionally, in an attempt to remove epiphytes and other “rubbish”, as they describe it, most farmers take and throw it into the water. Since farmers face many problems during planting and harvesting during Kiangazi, they were asked if they change anything about their technique. Not surprisingly, many returned a confused look and explained that there is nothing they really can do. Some mentioned that they stop farming completely during this season because they are unsuccessful. Others continue farming Spinosum but do not grow Cottonii. None of them indicated if they came more often to clean their farms or any other adaptive measures other than stopping work or coming less often to tend to their farms. In Jambiani, the challenges felt the most are similar to Muungoni except that the occurrence of sea urchins is higher and a nuisance because they eat the seaweed (Figure 5).

![Figure 4](image-url)

Figure 4. Muungoni farmer perceptions of seasonal problems. A black box denotes the time farmers recognize the problem. (1) katika/nyeupe = ice-ice, (2) nyuzi/chafu = EFA and nuisance algae, (3) wimbi = waves
Table 1. Seasonal problems encountered and corresponding solutions as described by Muungoni's farmers. Three out of the four problems are named using the farmers' word choice. They are translated accordingly: (1) katika/nyeupe = ice-ice, (2) nyuzi/chafu = EFA and nuisance algae, (3) wimbi = waves. Solutions are listed in order from most frequent responses to least frequent.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Description</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Katika/nyeupe</td>
<td>Disease; seaweed turns white, decomposes, feels soft</td>
<td>• If sunny, dry seaweed; if not, throw away in water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Break off infected part and throw in water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Change from <em>Cottonii</em> to <em>Spinosum</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Stop farming until problem gone</td>
</tr>
<tr>
<td>Nyuzi/chafu</td>
<td>Dirty; covers and destroys seaweed</td>
<td>• Remove from seaweed and throw in water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Leave it on seaweed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Dry seaweed</td>
</tr>
<tr>
<td>Wimbi</td>
<td>Strong wind and waves uproot sticks, tangle ropes, and take seaweed away</td>
<td>• Untangle ropes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Push in sticks deeper or replace</td>
</tr>
<tr>
<td>Drying</td>
<td>Unable to dry seaweed due to rain, turns white</td>
<td>• Still attempt to dry on grass</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Leave in water</td>
</tr>
</tbody>
</table>

Some farmers attempt to kill all urchins in seagrass beds surrounding their farms, while others explain that if just one is killed then the others will smell it and stay away (Table 2). Also, contrary to the Muungoni farmers' most frequent solution, farmers at this site mostly avoided trying to remove epiphytes and nuisance algae (“mashava”) during Vuli and Kiangazi and wait until Masika washes it off the seaweed.

![Figure 5. Jambiani farmer perceptions of seasonal problems. A black box denotes the time farmers recognize the problem. (1) katika/nyeupe = ice-ice, (2) mashava = EFA and nuisance algae, (3) wimbi = waves (4) unumba = sea urchins](image-url)
Table 2. Seasonal problems encountered and corresponding solutions as described by Jambiani’s farmers. Four out of the five problems are named using the farmers’ word choice. They are translated accordingly: (1) katika/nyeupe = ice-ice, (2) mashava = EFA and nuisance algae, (3) wimbi = waves, (4) unumba = sea urchins. Solutions are listed in order from most frequent responses to least frequent.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Description</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Katika/nyeupe</td>
<td>Seaweed burns, turns white, weakens</td>
<td>• Break off infected branch and dry</td>
</tr>
<tr>
<td>Mashava</td>
<td>Attacks the seaweed, causes it to drop and smell bad, irritates the skin</td>
<td>• Leave it on seaweed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Remove from seaweed and throw on the shore</td>
</tr>
<tr>
<td>Wimbi</td>
<td>Strong wind and waves uproot sticks, tangle ropes, and take seaweed away</td>
<td>• Untangle ropes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Push in sticks deeper or replace</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Do not plant</td>
</tr>
<tr>
<td>Unumba</td>
<td>Eat seaweed</td>
<td>• Kill using sharpened stick</td>
</tr>
<tr>
<td>Drying</td>
<td>Unable to dry seaweed due to rain, turns white</td>
<td>• Cover with palm leaves and/or place inside house</td>
</tr>
</tbody>
</table>

Overall, the farmers' solutions to their problems are reasonable because they do not know what is happening. For example, while they recognize that the water becomes hotter during Kiangazi, they have no capacity to prepare themselves for the change.

5.2.6 Farmer Mentality

For companies, farmer mentality due to the lack of understanding of the business is the greatest challenge when working with the farmers. During a meeting with all the Muungoni farmers on November 16th, farmers asked questions about how seaweed is used in the United States and had no knowledge of the small-scale seaweed soap and snack making business in Paje (Msuya, 2006). In Jambiani, farmers at a meeting held on November 28th reasoned that it is best to dry seaweed on palm leaves rather than either the sand because it destroys the seaweed quality or grass because the seaweed will destroy it. Therefore, there is no conceptualization of reasons for cleanly post-harvesting methods other than satisfying the companies' request. The lack of
awareness affects farmer mentality because they have no reasoning behind why they must handle seaweed in a certain way to attain a high quality material.

Another aspect is the farmers' perception of the company and government's presence. At the end of an individual interview, some farmers would say that many people always ask them questions without the farmers ever seeing the results. When the companies come to their farms, the farmers see them walking around, looking at the plots, and writing things down. Since farmers do not receive feedback, they feel unsupported.

5.3 Company Perspective

Players involved in the industry's general structure are (1) the farmers who produce and sell the raw material to (2) the supplier companies which sell to (3) their buyer companies based in the United States, Denmark, France, and the Philippines who in turn process and sell it to their customers.

With this relationship, many challenges arise in order to satisfy the interests of those involved. Supplier and buyer companies are looking out for the interests of the business while trying to maintain a positive relationship with the farmers. The supplier companies are constrained by the market price set by the buyer companies, who also demand a certain seaweed quality from the suppliers to meet the requests of their customers.

5.3.1 Suppliers: Company A and C

The general manager of Company A expresses that the greatest challenge felt by the company is the effects of the free market. The increase of the number of smaller companies who do not invest in the farmers and only need to collect a small amount of seaweed containers per month in comparison to the large-scale companies jeopardizes Company A's business. While this company is providing inputs to the farmers, they are losing their return to these other companies.
and struggling financially due to the taxes they must pay for having a base in the country. In regards to inputs, he argues that if his company allowed farmers to solely buy their own materials, then the price would rise as more farmers continued to buy until a point will be reached where the farmers will stop or pressure the companies more about raising the seaweed price.

The production manager feels that further farmer education is not needed because they have all the necessary technical knowledge. Where farmers struggle the most is having materials to cover the seaweed when it rains, so they often request for a plastic cover. When asked about farmer organizations in Jambiani, he mentioned that there used to be one where they would relay farmers’ problems to the company but speculated that it dissolved due to the lack of communication between the organization and the company or loss of interest from the farmers.

The current technician and past general manager of Company C argues that some farmers are educated and know how to expand their farm, but there are others who struggle. Those who struggle are satisfied with what they have or they “like spoon feeding” from the companies to receive their limited supply of inputs, despite the rise in seaweed price which hypothetically allows them to purchase their own. For Company C, the problem is the farmers' mentality while the company is looking out for the interest of the business.

Jambiani’s production decline is created by the farmers themselves because they do not understand the business- that there are farmers all over the world doing exactly the same thing. In order to gain the farmers' support, leaders and politicians feed off of the farmers' mentality. Therefore, leaders must be educated on the status of seaweed business in other countries and the global competition of the seaweed market in order to bring awareness to the farmers themselves. The key is competition: the industry expands from a competitive farmer and a competitive
country. Another problem Company C perceives is their customers like Company B, CPKelco, and Cargill and the lack of support they offer to the farmers who live very difficult lives. The supplier company argues that they should take more initiative on learning why the farmers are complaining for a higher price.

Company C also supports the idea of farmers forming cooperatives, but stresses that it is the company’s role to first educate them about the benefits. Then, organized members within the village must be able to execute the projects in order to maintain sustainable funding for the community.

5.3.2 Buyers: Company B

According to Company B’s representative, he has been working with the supplier companies for years to help farmers with their problems. However, he observes that the main hindrance to implementing and sustaining any plans is the culture. Through the years, he has made an attempt to discourage the mixing of *Cottonii* and *Spinousum* on the lines in the water by advising the supplier companies to tell the shop keeper, who purchases the dried seaweed, to check and reject bags with the two strains mixed together. Additionally, he has tried to encourage farmers to build plots with straight lines, all facing the same direction, and to flatten the sticks since they are currently a hazard to the farmers. However, the lack of leadership among the community members prevents progress. Despite struggles to motivate farmers to improve their farming practices, he believes that the farmers are dedicated especially because of the 1 km walking distance to the shore from their homes.

While this representative takes a personal initiative to improve the quality of seaweed farming in the village, his main focus is to work with the supplier companies, offering advice and training to achieve the company’s desired yield and quality and introducing newly developed
5.3.3 Impacts of a Free Trade Market

Many of the problems felt by companies and farmers today are a result of the opening of the market in 2006 to increase competition and increase the price of seaweed. Since the system was implemented without proper planning, the change brought an increase in corruption (Figure 7).

With the opening of the market, new buyers decided to accept lower quality seaweed and offer higher prices to entice farmers to sell to them. Even though they do not provide inputs in exchange, farmers continue to sell most of their seaweed to them. Therefore, companies like Company A and C (the remaining companies to provide inputs) suffer because they are not getting 100% return from the farmers they are providing with inputs. Therefore, seaweed quality submitted to the companies has gone down because the companies lower their standards in order...
to maintain business with their farmers. A representative from Company C explained that his company experiences pressure from two sides: (1) from their customers, the buyer companies who will only accept a certain quality and (2) the farmers who want inputs and a higher price.

5.4 Government Perspective

The Department of Fisheries representative explained that the responsibility of offering education to the farmers falls on the government. They see the greatest need for improvement in quality maintenance, including farm site selection and seaweed collection, and methods of harvesting, cleaning, and drying. For post-harvest handling, the government is planning to sponsor the construction of a drying shelter in Pemba sometime in the future depending on their budget. Since many farmers complain about the lack of inputs, the government is working with cooperative officials from SaccoS (Savings and Credit Cooperatives) to initiate a program in December and early January in some villages as a way to teach farmers how they can raise money to buy their own inputs. SaccoS is a micro-credit scheme that works with the seaweed farming production schedule ("Tanzania; Smallholder Support", 2011) and has been suggested by IMS researchers in the past as a way to improve farmers' financial savings and management (Msuya et al., 2007). Government officials intend to hire experts from the cooperatives to organize and execute the implementation. In response to the declining output of Cottonii, they are brainstorming the establishment of deep water farms, which is hindered by the women's inexperience in operating boats.

5.5 Expansion of Farmer Education

After assessing the technical knowledge of the farmers and comparing information from old and new farmers, and those trained by companies, families and friends, or self-trained, it became apparent that there is a need for extension services and the establishment of
cooperatives. Currently, only one local farmer in Muungoni is trained by the company representative who has the nursery, but that is not enough to encourage the other farmers to straighten their farms or improve farm management. Jambiani’s Committee of Seaweed Farming has the potential to motivate the farmers in a greater way than is currently being carried out. For example, since a majority of the community is discouraged to build a drying table, as suggested by the companies, due to the amount of time and effort that is required the committee should collaborate more with the companies to empower the people and lead the project.

6. Conclusion

Through observations and interviews in the field, the current organization of education is not enough to breed innovation, maintain an informed farmer community, or improve farmers’ output. All stakeholders need to have responsibility in carrying out extension services, helping to establish cooperatives, and improving farmers’ understanding of the business to sustain the industry in Zanzibar.

6.1 Extension Services

6.1.1 Tracking the Conditions of the Farming Environment

With environmental challenges triggered by human development or nature itself, routine measurements of characteristics such as water temperature, salinity, and nutrient levels should be made by extension officers. Scientific researchers alone do not have the capacity to reach out to all villages, but with additional support from the government personnel this process is possible. If government extension officers make the effort, then the information gathered will allow all stakeholders to track environmental trends and be more aware of the impacts on seaweed farms.

Information gathered should be released to the farmers through periodic village meetings and more consistently through the media. By broadcasting programs through television or radio,
farmers can remain informed about the environment and how they can take necessary preemptive measures. For example, officers can inform farmers sooner when water temperatures are rising and advise them to move into deeper water. Additionally, providing feedback on the progress being done in farming would create an innovative way for farmers to understand why researchers are always asking them questions.

6.1.2 Improving Farmer Mentality: Understanding the business

Companies agree that the average farmer’s knowledge about the seaweed industry is limited, contributing to ignorance and a non-competitive attitude. Therefore, they desire to educate them about the development of the industry in other countries and how the raw material they handle turns into a product used by people. If farmers realize how seaweed is utilized, they will have more reason to use the best farming practices—especially during post-harvest handling. Once again, media programming sponsored by the stakeholders can be a convenient method of implementation.

6.2 Farmer Cooperatives

In order to feasibly implement extension services with attainable and realistic agendas, farmers need to be organized into cooperatives. The average farmer does not have the financial capability to invest on their own in moving farm location or buying helpful tools such as a boat to carry seedlings and tools from shore to farm. Their work is labor intensive and the size of their farms is simply not enough to give them incentive to tackle larger financial commitments. However, by joining together in a cooperative and minimizing the costs\(^\text{15}\) per capita, farmers can take ownership of the challenges they face. While the Committee of Seaweed Farming in Jambiani has started to give the farmers a voice, the members also can organize the farmers’

\(^{15}\) Costs to purchase all farming materials
finances in order to invest in larger projects such as the drying table which currently discourages them. For those villages which do not have organizations, like Muungoni, officers should work with the farmers to demonstrate the advantages of utilizing a cooperative while initially guiding them on the logistics. To reach out to farmers most effectively, these extension officers can collaborate further with company and SACCOs officials. In the future, establishing this teamwork mentality with strong local leadership will enable farmers to form small businesses and continue investing together without a heavy reliance on the seaweed companies.

6.3 External and Internal Market

The seaweed market has extended to customers worldwide who use the macroalgae for food, fertilizer, an energy source, gelling agent for foodstuffs and pharmaceuticals, and water-holding agent in paper and textile printing (Gellenbeck, 1983). While Zanzibar supplies the world market, there is very little use of the resource by the producers themselves. Only recently with the onset of the Cluster Initiative have the people made and used products such as seaweed green vegetables, snacks, juices, jams, and soap. To stabilize Zanzibar's industry, the growth of an internal market must continue. The small businesses in Paje and Kidoti have the responsibility to design a mechanized system of making these products, spread awareness to other villages, and initiate a semi-processing plant. If products are used locally, if they touch the lives of the seaweed farmers, then they are more likely to care about how they treat it.

7. Recommendations

Due to company representatives' time constraints, supplier companies from Muungoni (ZASCOL and Zanque) were not able to respond to questions. Therefore, future study should access their opinions on the topic of farmer education. While several recommendations have been made on how to improve stakeholder investment in the farmer, a deeper analysis of the
logistics involved is needed. Many questions remain on the design of media extension programs, the leadership role and organization of farmer cooperatives, and the expansion of the internal market. Since progress to make seaweed products has started in Paje and Kidoti, other researchers should evaluate the small business structure, its impact on the people (e.g. any changes in household finances and personal expenses), and its overall success.

For a biological approach, more research is necessary to study the extent of the emerging environmental problems in Zanzibar. Since EFA is destroying the industry, especially for *Cottonii*, companies are urging biologists to look for solutions. First, a survey of epiphyte species throughout the islands of Pemba and Unguja would provide valuable information on their diversity and intensity. Building on this research, realistic biological solutions can be tested to minimize epiphyte growth on cultivated seaweed. While it is unanimously accepted that an increase in water temperatures corresponds with an increase in “ice-ice” and epiphytism, it remains unclear what other factors are involved. Plausible outside influences to explore include, but are not limited to, fishing (e.g. destructive fishing practices, use of motor fuel) and tourism development (e.g. hotels, nutrient input) impact.

Whatever future research is conducted, taking care to inform the farmers, who serve such an integral role in the industry, about findings and progress is essential to maintaining a productive relationship between them and the stakeholders.
References


Msuya, F.E. et al. (2007). *A Comparative Economic Analysis of Two Seaweed Farming Methods in Tanzania.* The Sustainable Coastal Communities and Ecosystems Program. Coastal Resources Center, University of Rhode Island and the Western Indian Ocean Marine Science Association. 27.


Appendices

Appendix 1

Map of study sites Muungoni and Jambiani, Unguja. Sites are indicated with a black box. Source: Google Images
Appendix 2

Farmer Observational Data Sheet

Date:  Time:  Farmer:  Site:

*Activity Observing:

Farmer's Technique:

Means of acquiring technique: self-taught/company representative/family or friend

**Reasoning for technique:

Duration of farming:

Notes:

*activities observed: tying seaweed to the tie-tie, beating rope against rock or with a stick
**reasoning for technique: asked questions about how they choose the right seedling, where do they cut it and how it helps the seaweed to grow.

Appendix 3

Farmer Interview Questions

Questions were translated into Kiswahili prior to interviews with the assistance of the translator. During interviews, questions were asked by the student and clarified by the translator if necessary.

Date:  Start Time:  End Time:  Farmer:  Site:

1. What year did you begin to grow seaweed?
2. How many farms do you have? Where are your farms located?
3. Have you chosen this farm yourself? (If “yes”) Why have you chosen here? (If “no”) who and why have they chosen here?
4. How many ropes do you have?
5. Have you always had this farm? Or have you changed farm locations?
6. How many strings do you have?
7. *What kind of seaweed do you grow?
8. Every low tide, how many days do you check the condition of your farm? How do you take care of your farm? How does this help the seaweed grow?
9. What else do you do to help the seaweed grow well?
10. Every day, how many ropes do you work?
11. How do you choose which seedlings to use? How do you know which seedling is good?
12. Who has taught you how to grow and harvest seaweed?
13. What time of year does your seaweed not grow well? What happens to the seaweed? How much are you able to harvest a day during this season?
14. During this time of year, do you change anything about your technique?
15. When do you grow the most? How many bags every day during this season?
16. (If did not mention “ice” or epiphytes) What happens to the seaweed with the problem of “katika” or when the seaweed turns white? What time of year do you see this? What happens to the seaweed with the problem of epiphytes? What time of year do you see this? What do you do when you see these problems?
17. What is the best way to dry seaweed? If the seaweed has dried well, what does it look like?
18. Do you see any other problems with seaweed?

*Only asked in Muungoni where Cottonii and Spinosum are grown.

**Buyer Station (Jambiani) Interview Questions**

1. What is your job here? What does ZANEA tell you to do?
2. Do you check the quality of the seaweed? What do you look for?
3. What does good dried seaweed look like? Bad dried seaweed?
4. What else do you do at this buying station?
5. Do only certain farmers receive inputs?
6. How long do you store seaweed in a pile before packing and selling into town?
7. Do you ever refuse yellow seaweed?
8. Are farmers paid the same price for yellow and red colored seaweed?

**Committee of Seaweed Farming in Jambiani (Bi Zimam Yusuf) Interview Questions**

1. How long have you been farming? How long have you been working as the secretary of the committee?
2. What do you do as secretary?
3. How does the committee communicate with the government and companies?
4. What role do the companies have here?
5. How often do the companies give farmers inputs? What else do they give?
6. What problems happen to the seaweed here and during which seasons?
7. Do farmers change what they do during these problematic seasons to help the seaweed grow?
8. Is there any training or educational programs offered to the farmers?
9. Do you think that there is a need for further training or education to help farmers?
10. What do farmers call “epiphytes”/“algae”?
Appendix 4

Company Representatives Interview Questions

(a) Field Representative (Company B)
1. When did seaweed farming start in Muungoni? When did your company arrive?
2. When seaweed farming started in Muungoni, how were the seaweed farmers trained?
3. How long have you been working as a field representative in this area?
4. What is the role of a field representative?
5. How do you train supplier company technicians? How often do you train them?
6. Currently, there seems to be no training of farmers. Do you think there is a need to implement any kind of program?
7. What are your opinions on the current technical knowledge of the farmers? What are some ways that they could modify their techniques to increase production? Do you feel that the farmers are motivated enough?
8. Has there been or is there currently a farmer cooperative in Muungoni? How do you think they help the farmers?
9. During the die-off season, what are some possible ways that the farmers could modify their management or techniques to help seaweed grow better/ increase production?
10. What are the qualities of a successful seaweed farm plot? Why are these qualities important?
11. What are the reasons why companies have stopped providing inputs? When did they stop?

(b) General Manager (Company A)
1. When did seaweed farming start in Jambiani and when did your company arrive?
   What is the organizational structure of your company? Which representatives work in the field with the farmers?
2. What are the challenges your company faces?

(c) Production Manager (Company A)
1. How long have you been working as a production manager in Jambiani?
2. What is the role of a production manager?
3. Is there a training program in place for farmers?
4. Do you think that there is a need for more training of farmers? Why or why not?
5. What are the qualities of a successful farm plot? Why are these qualities important?
6. What seasonal challenges do the farmers face? What are some possible ways that farmers could modify their management or techniques to help the seaweed grow better?
7. Do you provide inputs to the farmers? What else do you provide?
8. Do you have nurseries established here?

(d) Technician/Past General Manager (Company C)
1. Can you explain how seaweed farmers in Jambiani have been trained? What was the process?
2. Do you feel that the education and training that the seaweed farmers in Jambiani have received is enough? How so?
3. What problems do seaweed farmers experience in Jambiani in regards to growing
seaweed? Are there particular seasons that are less productive? Are there some possible ways that farmers could modify their management or techniques to help the seaweed to grow better?
4. Has there been a history of farmer cooperatives in Jambiani? If so, has it helped the farmers? If not, do you think that it would be beneficial? How so? If they have existed and failed, what are the reasons for them falling apart?
5. What are the qualities of a successful seaweed farm plot in regards to placement, design, and overall management?
6. Do you have any other comments that you would like to make in regards to the education of seaweed farmers and the role companies like your should play in sustainable management of farms?

**Government Interview Questions**

1. When did the government change system to a free trade system? What was their reasoning behind it?
2. Are there any plans to implement further training or education for farmers? How should it be carried out? Who has the responsibility (companies or government)?
3. Do you have data of the general productivity of *Spinosaum* and *Cottonii* over the years?