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Abstract

Since its start in 1989, seaweed farming has contributed significantly to the economy of the country, through both revenue paid to the government and improvement in peoples' economy. The current production from *Eucheuma* and *Kappaphycus* species ranges from 6,000 – 10,000 tonnes per year. However, seaweed has been farmed and exported in bulk thus reducing the price paid to the farmers and increasing the country's dependence on international markets. To improve the economy of the farmers, it is time to add value to the seaweed and thus improve the farmers' gains from the industry and hence improve their economics. These innovation opportunities include semi processing of the seaweed i.e. to extract the gel, *carrageenan*, in the country and export it, and to make value added products such as soap, food snacks, and fabric. In addition, the farming of a new seaweed species such as *Gracilaria* will enable the production of a different gel, *agar* that has been shown to be suitable in laboratory cultures. The innovation opportunities will not only raise the prices paid in the world market but will also open channels for domestic market and make the seaweed farming industry more competitive with value-added products that will benefit Zanzibar and the local community.

Introduction

Commercial Seaweed farming in Tanzania started in 1989 using ideas that were developed in the 1970's by Prof. Mshigeni of Botany Department, University of Dar es Salaam. His substantial work is documented in his publications and reports such as Mshigeni (1973, 1976, and 1985). Two species of red seaweeds namely *Eucheuma denticulatum* (*E. spinosum*) and *Kappaphycus alvarezii* (*E. cottonii*) were imported from the Philippines for commercial farming when the local varieties of the same species failed to grow. Seaweed farming contributes significantly to the economy of Zanzibar where it contributed 15% and 27% respectively of Zanzibar exports in 1993 and 1994 (Msuya et al. 1996). Seaweed farming has also greatly improved the living standards of Tanzanian coastal people (Eklund and Pettersson 1992, Shechambo et al. 1996). About 90% of the farmers are women. Recently, *K. alvarezii* is preferred for its production of "kappa" carrageenan as compared to "iota" carrageenan from *E. denticulatum*. The preference is dictated by the world market. The price of *E. denticulatum* is currently half that of *K. alvarezii* (Tsh. 100 ~0.1 US$ vs. 220 per kg dw). Unfortunately, environmental conditions do not favour *K. alvarezii* in many parts of Tanzania. In Zanzibar, the main seaweed species farmed is *E. denticulatum* with seasonal farming of *K. alvarezii* in selected villages. In the mainland, the main species farmed is *K. alvarezii* but there are cases of seasonal and annual failures. This has discouraged farmers who cannot farm *K. alvarezii*, and there are complaints about the price of *E. denticulatum*. Even for *K. alvarezii*, farmers still feel that the price that they are getting is not equivalent to the work done in the farming.

Although seaweed farming started in Tanzania in 1989, farmers have been farming the seaweeds and selling to the developers/exporters. The seaweed prices are dictated by the world market through the exporters to the farmers. Farmers have no say in the marketing, do not know the market prices, and have no means of changing the value

of the product that they are selling. While the price has seemingly been increasing in local currency, in US dollar terms it has been decreasing. Although the world price of seaweed continues to rise, the price paid to the farmers continues to drop (I. Bryceson, personal communication). These factors coupled with the fact that the seaweeds are exported raw and bulky, thus fetching low prices in the world market needs to be addressed. The seaweeds can be semi-processed to add-value (extraction and selling of crude gel) and also fully processed to create new products such as soap, shampoo, seaweed food (snacks) etc for the local market. There has not been semi/full processing of the seaweeds for many years mainly due to limited knowledge, lack of funds, and low production of the seaweed. The seaweed processing technology is available in the country, but needs to be consolidated and disseminated to the stakeholders. Recently there have been attempts to semi-process the seaweeds such as laboratory extraction of the gel for medical purposes and full processing for making soap. These attempts are small scale and not in any way coordinated. To improve peoples' income, the aim is to increase the production of both *K. alvarezii*, and *E. denticulatum*, and to add value to the *E. denticulatum* that is produced in larger quantities than *K. alvarezii*. There is a need to consolidate the semi/full processing attempts, disseminate the knowledge to more people and thus make the attempts more productive. The quality of the seaweed can be improved through proper drying methods, i.e. the use of drying racks as opposed to palm fronds/clothes used in the villages. When seaweed comes into contact with rainwater, it gets bleached and rots thereby loosing its quality and can be rejected by the buyers. The current seaweed farming production ranges from 6,000 – 10,000 tonnes of dry weight per year with high fluctuations depending on market and environmental conditions. There is a potential to increase the production through increasing farming areas, modifying farming techniques (e.g. standardising the farms) and recruiting new farmers. There is also a possibility of farming other types of seaweeds such as *Gracilaria* and *Hypnea* that produce other gels, other than carrageenan, such as agar and alginates.

Stakeholders collaboration within the industry

The seaweed farming activity involves the farmers, developers (or buyers/exporters), research and training institutions, and extension agents. The developers provide farming materials to the farmers on agreement that the farmers will sell the product to the developer. The farmers are responsible for producing the seaweed and ensuring the quality of the seaweed i.e. it should be properly dried and with no quality reducing materials such as sand. The developer is required to buy the produced seaweed. Developers buy the product in a price that they set after considering the farming inputs that they give to the farmers. Reducing such dependence of farmers to the buyers by enabling them to buy their own inputs may increase the price of the seaweed in favour of the farmers.

Government institutions play a role between the farmers and the developers to ensure smooth running of the business e.g. intervening in case of problems and ensuring that the revenue is paid to the government by the developers. Research institutions are responsible for conducting research to support the activity such as environmental and socioeconomic impacts, improvement of production process, processing and quality control. In case of a problem, farmers report to the developers and/or the government and the two institutions together with the research institutions address the problem and give feedback to the farmers. For example, there were experiences of seaweed die-offs and stunting in Mlingotini, Bagamoyo District. The Institute of Marine

Sciences worked under the Sustainable Coastal Communities and Ecosystems (SUCCESS), a programme that is organised/funded and run by the Western Indian Ocean Marine Sciences Association (WIOMSA), and the Coastal Resources Centre of the University of Rhode Island to develop an alternative method of seaweed farming – the deep-water raft method. The new method is showing improvement in the growth of the seaweed. In another event, there were seaweed die-offs in several villages in Tanga and the stakeholders named SEEGAAD have looked at possible causes. The main causes are thought to be extremes of temperatures, rainfalls and fouling by wild seaweeds. The researchers have suggested seasonal farming in such villages.

Developers have buying stations that are located within the villages so that the farmers sell the seaweed in their villages. The head offices are located in Zanzibar town. There is continuous correspondence between the head office and the stations in the villages through mobile phones, and there is regular transport either by company cars or public transport. The longest distance between Zanzibar town where the head offices are located and research institutions does not exceed 20 km.

Knowledge, information, and resource gaps

Knowledge on processing technology and production of new products

The knowledge is available in the country but it is limited and needs to be consolidated and disseminated. There were studies by a scientist from the University of Dar es Salaam in Tanzania (the late Prof. Semesi) in the mid 1990's who showed that to install and run a semi-processing plant, seaweed production should be at least 15,000 tonnes per year. At the time the production was about 5,000 tonnes annually. Her study was based on importation of a semi-processing plant from South Africa. Now, it has been shown that semi-processing plants can be made within the country by the Tanzania Industrial Research Development Organisation (TIRDO) or by the Collage of Engineering and Technology (CoET) of the University of Dar es Salaam (Personal Communication), and at a specified scale.

Expert personnel on processing seaweeds

Small laboratory scale extractions have been done by CoET, Microbiology Unit of the University of Dar es Salaam, Sokoine University of Agriculture (SUA), and by the Tanzania Industrial Development Organisation (TIRDO) and some individuals. This information needs to be sought, put together and be disseminated to different stakeholders who will use the knowledge to make the seaweed industry more competitive. Large scale processing needs to be consolidated to include environmental considerations.

Information on market for new products

There has not been export of crude gel from the country and marketing of products such as soap, shampoo, etc locally has been done in limited scales. The markets need to be surveyed and confirmed.

Knowledge on farming new species

The farming of a new species of seaweed, *Gracilaria*, will increase the chance of selling seaweed products from our country. The method of farming the seaweed can learnt by looking in the literature to get information from other countries on how the seaweed is farmed. Since seaweed is farmed in Tanzania, even though the species are different, it should be easier to start the farming of a new species than starting in a

country where seaweed is not farmed at all. The gel (agar) from the seaweed can be extracted and marketed within the country and overseas. Scientists from UDSM have extracted agar from two species of *Gracilaria* and showed that the agar can be used to culture microorganisms in the laboratories just like the currently used agar that is imported very expensively (Kivaisi and Buriyo 2005). The knowledge needs to be refined/consolidated and disseminated to other stakeholders.

Innovation ideas

1. The first innovation is to increase production of both species. This can be done by expanding farms for *E. denticulatum* and/or standardising the farming method. To avoid die-offs in *K. alvarezii* it will be good to use and device methods for farming in the deeper waters. To facilitate this, farmers need to be ready to expand and standardise the farms, which may not be difficult as long as the farming areas are available for expansion. To move in to deeper waters need to be organised especially for women since it will be necessary to use boats. The farming in deeper waters (anchoring the seaweed) can be carried out by younger members of the family whereas the older members may do the tying of the seaweed on shore. For the activity to proceed smoothly considering that there are other users of the sea such as fishermen, villagers and their local governments and the research institutions need to work together to develop integrated coastal management (ICM) plans to avoid - conflicts between users of the coastal and marine resources.

2. Value adding involves processing and semi processing of the seaweed to produce the gel locally and reduce the bulkiness of the sold product. This requires a semi-processing plant to be made within the country considering that the knowledge is available in the country. The institutions that will make the processing plant need to be contacted.

As mentioned above, there have been trials by CoET, SUA, Microbiology Unit, and TIRDO to extract the gel from the seaweed for medical purposes. The extraction of the gel is part of the processing of the seaweed. These institutions need to be contacted so that they can work with the other stakeholders. The processing technology need to be developed and expanded and then disseminated to other stakeholders. Acquisition of a processing plant (processing plants) will increase the income of the stakeholders and farmers though the selling of the crude gel.

Shrinking of the seaweed before exporting – cutting into smaller pieces is being tried by one developer (Birr Company) in Zanzibar. The seaweed is rinsed in freshwater and then pressed to make smaller volumes for export. This knowledge needs to taped, practiced and expanded to semi-process more seaweed and where possible disseminated to other stakeholders.

The seaweed can also be boiled and the gel used for food. The gel can be used to make snacks or seaweed “biscuits”. It can also be used to make soap, fabric, and decorations. These products can be sold in the local market or exported if in larger quantities. The people who have such knowledge need to be contacted and used to disseminate the knowledge to other stakeholders.

To be able to add value to the seaweed, there is a need to mobilise and create awareness on semi-processing technologies, marketing of the semi-processed

seaweed, and the use/marketing of new products. Awareness is very important especially in Tanzania where there is no tradition of eating seaweed. For other products such as soap, it could be easier as there are soaps made from other resources such as clove and neem tree.

3. Acquiring the farming materials by the farmers needs careful negotiation between the developers, farmers and other stakeholders. The developers may be given time to adjust i.e. buy the seaweed at their set price until the time when they can recover what they used to buy the inputs and then let the farmers buy their own materials. This way, the farmers can negotiate and sell the product at more competitive prices. The Zanzibar government has already initiated the process and this will be advantageous to the cluster initiative. The case of Mlingotini village in Bagamoyo gives an example of such a change. Using a small-scale loan agent (FINCA), the villagers have been acquiring their own farming materials and they now sell the seaweed at 250 Tsh. per kg.

4. The quality of the farmed seaweed can also be improved through construction of drying racks for drying the seaweed instead of the palm fronds and clothes used by most farmers at present. The racks will be useful especially when there is more production and during rainy seasons when farmers loose both the quality and seaweed itself. To effectively achieve this, there is need to create awareness among farmers on the construction and use of drying racks.

5. The farming of the other species need be initiated at a pilot stage to find out the growth rate and study the markets – this needs to involve collaboration with buyers abroad. Countries where these seaweeds are farmed need to be contacted to learn how effective and profitable the seaweed is in their countries. The agar can be extracted from these seaweeds to carter for local market and later for export. The laboratory extraction of agar from *Gracilaria* by the University of Dar es Salaam need to be studied and used to train the farmers and other stakeholders to do the extraction and export the gel. The information available in the academia will be acquired by contacting the microbiology unit to establish the species (specific name) that has been tried. The contact will also enable the collection of reports on trials carried out. Mobilising the villagers/farmers and creating awareness and conduct research on the farming of the new seaweed species are the main issues that will facilitate the farming of the new species.

6. There is a great need to develop extension materials and programmes on different aspects of seaweed farming including farming methods, farm standardisation, integrated coastal management, and the economics of seaweed farming. Resources to carry out extension activities (e.g. facilitate acquiring of motorbikes) will enhance the performance of the extension officers. Extension services need to be strengthened for improving the quality of the seaweed through construction and use of drying racks and training of new farmers.

New personnel need to be trained on farming techniques, construction of drying racks, and on value added products. Increasing the number of extension officers will improve the extension services in seaweed farming, services that are currently very limited.

Key actors in the triple helix

Developers. These are the companies and individuals who buy the seaweed from farmers and export to overseas markets. They also provide farming inputs including ropes, tie ties, and also provide extension services. Being the people who provide farming inputs to farmers, market the seaweed and provide technical assistance they need to be contacted through a series of meetings to introduce the idea of cluster initiative and to get their views no what they can do within the cluster.

Farmers are responsible for the production of seaweed, ensure the quality of the seaweed (by using proper drying methods) and sell to the developer who provided the inputs or any other buyer depending on the agreement between the farmers and the buyers. Being a crucial group, workshops will be conducted with farmers in some villages (in some cases more than one village will meet together) to create awareness on increasing the farming areas, farming techniques and on the use of drying racks. Discussions on the making and marketing of new products such as soap and snacks will also be held in these workshops. Making of value added products at small scale, products that can be consumed by the farmers themselves with their families and friends or be sold to neighbours for trial uses to test market availability are important issues for the workshops. To increase production of seaweed, farmers need to expand their farming areas as most of them have small plots and also standardise the farming method. With help, they may expand/standardise the farms and thus harvest more.

Universities. The Institute of Marine Sciences (IMS) of the University of Dar es Salaam is responsible for research and development. It also acts as a liaison between the different stakeholders and helps to solve problems through research for example if there are environmental problems that affect seaweed growth the IMS conducts research to address the issue. IMS will play a key role to this initiative. The Microbiology Unit and CoET of the University of Dar es Salaam; and Sokoine University of Agriculture (SUA) are some of the University institutions that have done some extraction of the gel from seaweeds for research and medicinal purposes. These institutions need to be contact to get information on the extraction of the gel from the new seaweed species and trials done on the cultivation of this new species

Government under its Department of Fisheries is responsible in giving licenses to the developers who want to market the seaweed and collects revenue from developers. It also acts as a liaison between the farmers and the developers to ensure smooth running of the industry. The Department of Fisheries needs to be contacted and discussions held on the initiative in order to have a backup and support from the government. This will give firm foundation for the initiative. The Tanzania Industrial Research Development Organisation (TIRDO), a government organisation, has extracted the gel from seaweeds for research and medicinal purposes, and has stated that they can make the processing machines.

What the cluster initiative expects to achieve

The system of farming the seaweed and selling in bulk and not having any way of improving the selling price for the farmers need to be changed so that the farmers can earn something more than what they have been getting for a long time. It is expected that the cluster initiative will change part of the system of farming and marketing seaweed in Tanzania that has been going on for almost seventeen years for the benefit of the farmers and other local Tanzanians at large. Instead of selling only bulk

seaweed, the cluster initiative expects to initiate (and later commission) the selling of crude gel and value added products. It is also anticipated that apart from the seaweed exporters, there will be sub-clusters within the main seaweed cluster mainly: carrageenan extractors, seaweed food kiosk(s), seaweed soap manufacturers/sellers, agar extractors, and seaweed producers. Associated with these sub-clusters are service businesses such as seaweed extraction chemical suppliers, farming material suppliers, transporters, food/beverage sellers, cosmetic sellers and so on. The cluster initiative activities will be based in the Zanzibar Islands now, but the cluster has a long term vision of including some parts of mainland Tanzania. To facilitate such activities, the cluster initiative is relying on the funding from Sida-SAREC, the current funding agent, and also on other funding sources that will be sought later, such as the SMEs Competitive Facility and channelling proposals through the poverty eradication programme of Tanzania, the MKUKUTA.

Conclusion

Time has come for the seaweed industry to be innovative for the benefit of the farmers, the government and other stakeholders. With collaboration and facilitation, different stakeholders can work on different innovation ideas to increase the production and make value added products and thus make the seaweed industry more competitive. If successful, these efforts will have positive effects on the economy of the local Tanzanians who work, or will work, on the seaweed farming industry.

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