KENYA MARINE AND FISHERIES RESEARCH INSTITUTE

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Seaweed Farming Policy Brief - 1

Seaweed farming industry in Kenya
"Tapping into the blue economy and mitigating climate change impacts"

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This policy brief is prepared by Kenya Marine and Fisheries Research Institute (KMFRI)

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Executive summary

The seaweed farming research program has developed and continues to refine suitable technologies for farming two species of seaweeds *Euchema denticulatum* (Spinosum) and *Kappaphycus alvarezii* (cottonii) in addition to providing guidance in establishment of suitable markets plus value addition technologies that are geared towards improving proceeds to farmers. The highly priced *Kappaphycus* is easily affected by environmental variations and thus Kenya Marine and Fisheries Institute (KMFRI) is developing technology to farm the species in relatively deep waters to evade the impacts of climate change that brings about temperature fluctuations.

Based in the innovations, seaweed farming has advanced more than any other mariculture species in Kenya due to a number of attributes that involve use of low capital requirements and material inputs, relatively simple farming techniques, short production cycles that can take place year round.

Consequently, the farming has become very prominent for smallholder farmers along the coast mainly women who can now make money to support their families. Currently the farming is directly supporting more than 150 house households i.e. more than 1000 people in the south coast of Kenya. Consequently, the interventions are providing employment opportunities at the village level and therefore assisting to improve the livelihoods of smallholder farmers or fishers thus generating substantial socio-economic benefits to coastal communities in Kenya. This can be witnessed through the number of families able to take their children to school in addition to meeting day-to-day needs.

However, a multiplicity of barriers and constraints have been documented to impact seaweed farming globally and in Kenya that are to be addressed through the seaweed research initiatives by KMFRI i.e. high temperature fluctuations, changing weather conditions due to climate change, seaweeds diseases, uncertain and fluctuating dry seaweed markets and limited value-added products. These factors lead to low incomes of seaweed farmers.

Therefore this seaweed policy document has been developed to highlight the research and innovation on the various aspects of seaweed farming and challenges the industry is facing. It's envisioned that the information will assist investors, potential farmers, policy makers and other stakeholders to make decisions on the way forward for the industry in order to tap into the potential of the expansive ocean space.

CONTENTS

List of Figures

Introduction

Seaweeds are farmed to extract the carrageenan gelling agent which is used as an emulsifier, binder, or for suspension and stabilization in a remarkably wide range of products in the food processing, pharmaceutical and cosmetic industries (FAO, 2013). Research has shown that the seaweed carrageenan can be a good substitute for agar that is popular colloid for food processing thus enhancing the demand for the product. However, currently several diverse products are being produced from seaweeds that are consumed and used locally in the coastal areas of East Africa (Msuya, 2013).

Seaweeds are one of the most highly farmed aquaculture plant species globally that rely on natural plant nutrients in the sea thus environmentally sustainable. Seaweeds have been farmed in more than 50 countries in the world and together with other aquatic species accounted for about 27.3 million tonnes in 2014 (FAO, 2016). The farming of seaweeds mainly (*E. denticulatum* and *K. alvarezii*) has been successfully practiced in the Philippines and in Indonesia. Outside the two countries, cultivation of these warm water seaweeds species (*K. alvarezii* and *E. denticulatum*) have been attempted in a number of tropical countries around the world. Although, significant production for export markets has been achieved only in Malaysia, the United Republic of Tanzania and currently in Kenya (Anyango *et al.,*2016, FAO, 2016)

Seaweed farming has been strongly promoted because it requires a low level of technology and investment and can be operated at the family level. The produce has relatively little environmental impact, does not require refrigeration or high-tech post harvest processing and is compatible with traditional fishing and subsistence shell collection in intertidal areas (Bryceson, 2002; Pickering, 2006; Msuya *et al.,* 2007). Consequently, it is a potential source of income and employment in rural areas with few alternative income-generating opportunities especially women (Wallevik and Jiddawi 2001; Bryceson, 2002; Wakibia *et al.,* 2006; Msuya, 2013).

Based on the significance of the seaweed industry globally, KMFRI has strategically placed itself to nurture the required technologies needed to enhance production along the coast of Kenya. This aims at utilizing the suitable areas within the 640km stretch of the Kenyan coastline. Initial site assessments identified suitable sites for seaweed farming to be in the south coast of Kenya such as Gazi, Funzi, NyumbaSita, Mkwiro, and Kibuyuni. However, further work is needed to identify other suitable sites to facilitate the utilization of the ocean space for blue economy development in

the country.

Therefore this strategic approach by KMFRI echoes well in addressing the vision 2030 and in the delivery of "Big Four" (Food security and nutrition, Health, Housing and Manufacturing) according to this year's Presidential directive.

History of seaweed farming in Kenya

KMFRI pioneered in the research towards farming of seaweeds from mid 1990's to early 2000's when experimental trials of seaweed farming were conducted in the south coast of Kenya. Since then different farming methodologies have been investigated to assess suitability for use by farmers. Currently, demonstration and commercial farms for the two species of seaweeds are established in suitable sites at the South Coast of Kenya and farmers are making income from the sale of the produce. Before 2010 the farming involved *E. denticulatum* (Figure 1) but later *K. alvarezii* (Figure 2) through technical support from KMFRI was introduced for farming in Kenya. Based on research, KMFRI up scaled seaweed farming mainly focusing on *Kappaphycus alvarezii* commercially known as *"cottonii"* which commands a higher farm gate price than *E. denticulatum*, commercially known as "*spinosum*". The seaweed farming intervention has increased the economic purchasing power as well as created more social empowerment for women of south coast of Kenya.

The two varieties of seaweeds were imported from Zanzibar and introduced in Kenya in the early 2001. In Zanzibar the species were originally sourced from the Philippines (Wakibia *et* al., 2006). The growth rates of the two species have been investigated through controlled field experiments and it has been established that they grow differently i.e. *Eucheuma* and *Kappaphycus* growing at 5.6 and 3.5 % d^{-1} respectively (Kimathi *et* al 2018)

Figure 1:Eucheuma denticulatum seaweed

Figure 2: Kappaphycus alvarezii seaweed

Seaweed production in Kenya

In partnership with KMFRI, the World Bank project, Kenya Coastal Development Project (KCDP), the coastal villages of Gazi, Funzi, NyumbaSita, Mkwiro, and Kibuyuni have received substantial financial and technical support to upscale farming of *E. denticulatum* and *K. alvarezii*. The initiatives put in place have resulted to farmers experiencing significant increase in seaweed biomass with time and earning meaningful income to meet their basic social needs. In 2015, Kibuyuni farmers and

others produced over 44 tonnes of dried seaweeds and sold at approximately Ksh 1,345,810. (Anyango *et* al., 2016). Dry seaweed is exported to China, Ireland and Malaysia by Seaweed East Africa Company.

Seaweed culture techniques in Kenya

The farming of *Eucheuma* and *Kappaphycus* involves the appropriate selection of site and cultivation methodology. In Kenya, commercial cultivation of *E. denticulatum* and *K. alvarezii* is carried out using the fixed off bottom line technique because the method is easy to apply (Figure 3). However the method is laborious because of the 'tie-tie' system (Ask and Azanza, 2002).

Figure 3: Fixed off-bottom line technique

Seaweed mariculture research interventions

K. alvarezii and *E. denticulatum* cultivation research interventions have used same methodologies including the tubular net, floating lines, cages, floating rafts, modified off bottom e.t.c. While most of the methodologies have been observed to be more successful for *E. denticulatum* species in all sites of cultivation, *K. alvarezii* production has been significantly low and the plant affected by "ice ice" disease and infexted with epiphytes.

With a view of enhancing the growth and production of *K. alvarezii* in the Kenyan coast, scientists from KMFRI seaweed mariculture team are currently conducting experiments to investigate whether the deep water culture techniques such as the tubular nets (TN), floating raft (FR) and the modified off-bottom MB) line are feasible in Kenya (Figure 4, 5, 6)

Figure 4: Tubular net culture technique

Figure 5: Floating raft technique

Figure 6: Modified off bottom culture technique

Comparative analysis of seaweed growth rates and net yields between the cultures in fixed off-bottom (FB), floating raft (FR) and the modified off-bottom (MB) technique has shown that the floating raft generated seaweeds with significantly higher values than in the other two culture techniques (Figure 7& 8).

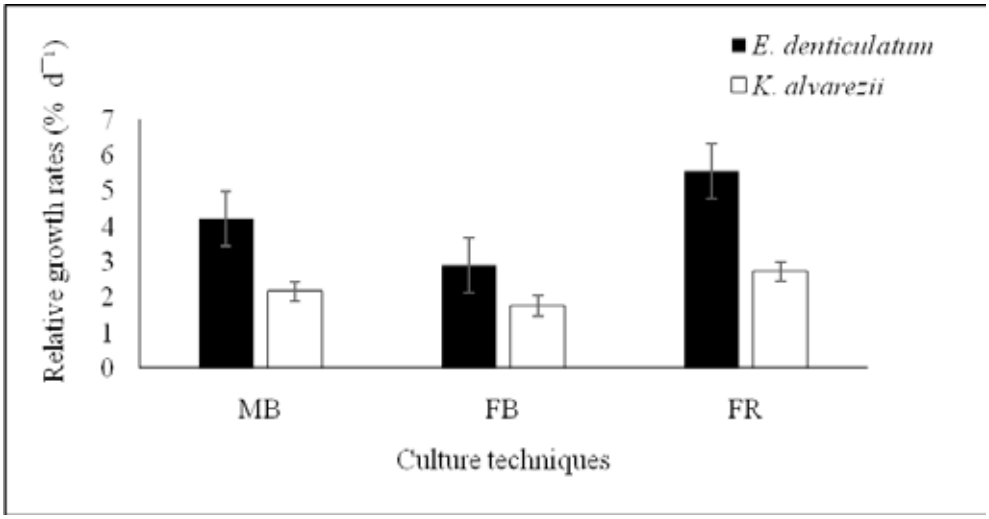

Figure 7: Relative growth rates of seaweeds based on culture techniques in the southern coast of Kenya (Modified off-bottom- MB; fixed off-bottom – FB; Floating raft – FR)- adapted from Kimathi et.,al. 2018

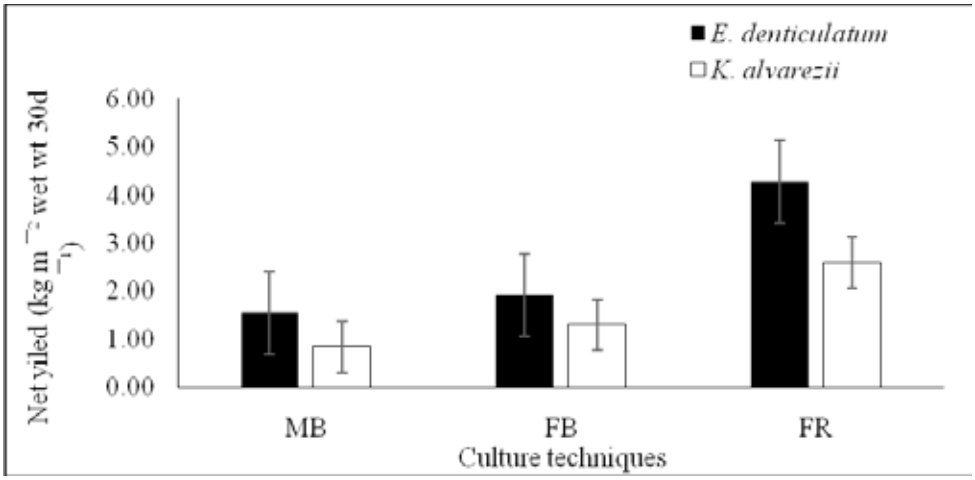

Figure 8: Net yields of seaweeds based on species and culture technique in the south coast of Kenya (Modified off-bottom- MB; fixed off-bottom – FB; Floating raft – FR)- adapted from Kimathi et.,al. 2018

Number of seaweed farmers (beneficiaries)

Seaweed farming currently undertaken only in the south coast of Kenya and is mainly practiced by women. A total of 144 farmers were estimated in 2015 out of which 84% were females and 16% males. Highest number of farmers was found distributed in Kibuyuni followed by Mkwiro, Funzi and Nyumbasita. (Figure 9 & 10).

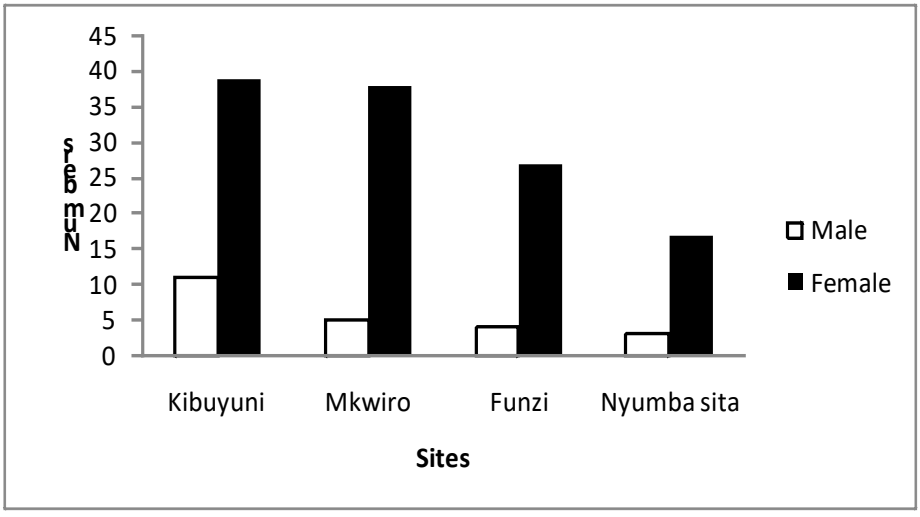

Figure 9: Number of seaweed beneficiaries in the south coast of Kenya

Figure 10: Farmers in NyumbaSita receiving farming materials

Production trends and Income generated

Seaweed farming has increased significantly from about 3 MT/yr in 2009 to a peak of 44 MT/yr worth Ksh. 1,345,810 in 2015 (Figure 11). This increase was due by the intervention of Kenya Coastal Development Project (2012-2016) implemented by KMFRI which supported farmers in upscaling production through provision of farm implements, establishment of model farms, provision of seaweed seeds, construction of the seaweed drying racks, establishment of seaweed nurseries and capacity building. A total of 144 model farms were established between June 2014 to January 2016 by KCDP. Seaweed production in Kenya still remains under exploited due to several challenges. For commercial exploitation and to interest any buyer, production is expected to be at least 30 MT per month on the minimum, which comes to about 360 MT/year or 36,000 kg/year.

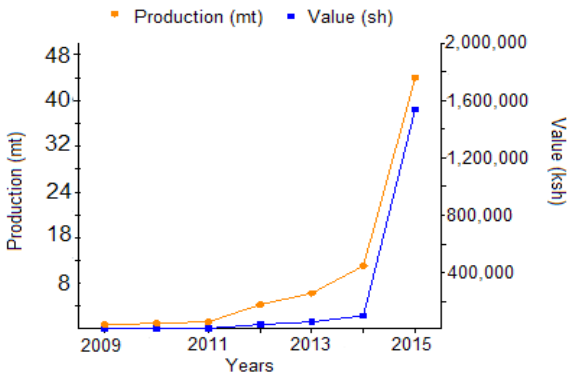

Figure 11:Seaweed production and value between 2009 and 2015

Market and value addition of seaweeds

Under the leadership of the Blue Economy Implementation Committee (BEIC) various stakeholders in seaweed industry which include KMFRI, Kenya Industrial Research and Development Institute (KIRDI), The State Department of Fisheries and Aquaculture, Kenya Bureau of Standards (KEBs), Brand Kenya, Kenya Intellectual Property Institute (KIPI) and the County government of Kwale are partnering to steer and fast-track seaweed value addition initiatives. The initiatives are geared towards enhancing product development and market mobilization for local and national development. Within the existing infrastructure at Kibuyuni, seaweed soap is being manufactured at small scale and sold to local consumers (Figure 12). However, the product is yet to be certified by the Kenya Bureau of Statistics before it is officially released to the market for mass consumption. Other products listed for manufacturing include seaweed cakes, juices, salads and sauces.

Figure 12: Production of seaweed soap in Kibuyuni supported by the Blue Economy Initiatives on Value addition

Challenges experienced in seaweed industry

The rapid expansion of any industry is bound to be affected by unforeseen ecological and societal consequences. For the case of the seaweed industry, three main challenges have been noted to impact its performance in Kenya.

1. High vulnerability of some seaweed to disease outbreaks. The most common reported disease is the "ice-ice". The disease bleaches the seaweed leading to development of white like segments on the seaweed thalli that induces breakage of the seaweed thalli thus bringing biomass loss. More research is needed to identify the disease causative for its currently unknown and is only suspected to be as a result of bacterial or viral infection infections and physical stresses mainly

due to sea temperature rise.

2. Pest infestation commonly referred to epiphyte infestations that develop a 'goose-bumps' like appearances. Whereas no appropriate control measure has been established, farmers react to it by removing the epiphytes 2 to 3 times every week although it requires intensive labor.

3. One other challenge that is mainly tied to site selection is herbivory from grazers with include Siganids (rabbitfish) and puffer fishes that nibble the seaweeds thalli. The long-spined sea urchins are also a pest and do cause injuries to the farmers.

4. Seaweed farmers in Kenya have had challenges in marketing dried seaweed. In the last years, farmers have relied on sale of the seaweeds to traders who export outside the country. However, the frequency of purchase and prices offered to farmers has been a thorny issue. In the last decade, KMFRI and the Government of Kenya together with other stakeholders like FAO have innovatively developed value added products that are helping to increase the income obtained by farmers from the seaweed industry.

Policy Recommendations

- For the industry to attain economical sustainability large quantities of seaweeds are to be produced to support the different investment options. To achieve this, more sites are to be brought under seaweed farming and current ones up scaled to commercial levels. Thus there is need for policy direction to develop inventory of all suitable sites along the coast to guide farming of the seaweed.

- Currently there is no clear policy guide on seaweed farming investments. Thus a national seaweed farming guideline with possible one stop shop for investors is required to minimize time spent to seek clearance and establish suitable farming sites. This will also enhance best practices in seaweed farming.

- As the industry develops conflicts are eminent due to the diversity of stakeholders utilizing the seaweed farming areas for other activities like fishing, fishing access routes etc. Thus development of a national marine spatial plan will help to minimize the conflicts and advance exploitation of the sea for the blue economy agenda.

- More advanced innovative research is required in the seaweed industry to enhance production of the high valued seaweed species (*Kappaphycus alvarezii*). This may involve but not limited to developing innovative farming methods in the deep waters where temperature variations are minimal as opposed to intertidal zone. Further research could involve development of genetic strains that are fast growing and are resistant to diseases and environmental stresses that are associated to climate change.

- KMFRI has over the years played the role of developing seaweed research innovations and testing the innovations through participatory research. Through this, farmers have also been trained on the different farming methods based on the attained results. However, as the industry develops to meet the anticipated needs under the UN 2030 Agenda and the blue economy, more structured extension support the interventions. This may effectively require an extension policy that stipulates the requirements and roles of extension providers who could be either national or county governments, non-governmental organizations, private investors or any other qualified organization, as may be stipulated.

- To address the challenges of seaweed markets and low prices of dry seaweeds, KMFRI and other stakeholders have innovatively developed value added products like soap, juice and salads. This intervention has been picked by the State Department of Fisheries and Aquaculture in collaboration with Kenya Industrial Research Development Institute (KIRDI) and are supplying a soap making machine to boost the earning from seaweed production.

- Currently the seaweed marketing in Kenya lacks clear structure as its dependent on private buyers. The buyers have no binding agreements with farmers on the frequency of seaweed purchase thus may at times lead to accumulation of seaweeds for almost a year before sales can be made. As an income generating activity, such delay in purchase of dry seaweeds may negatively impact performance of the industry and thus the need for a policy direction of seaweed market structures that could be anchored either at the county or national governments or farmer's cooperatives.