



## The Seaweed Supply Chain in Jambiani Coastal Communities, Zanzibar: Challenges and Way Forward

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### **Abstract**

The study investigates activities in the supply chain of seaweed and their challenges among seaweed farmers in the coastal community of Jambiani-Zanzibar. The study is conducted in Zanzibar's Jambiani area with greater concentration in Kikadini and Kibigija. Employing qualitative approaches, the case study design is chosen to be the best fit in to this study considering the case, respondents and nature of the study. Researchers recruit 45 respondents through snowball and purposive techniques. To obtain the required data, researchers make use of In-Depth Interviews (IDI), focus group Discussions (FGD) and document review. Through tables created manually, researchers code and analyse data content wise. Findings show that the supply chain of seaweed just like other crops involve activities like farming and harvesting, storage and preservation, value and quality addition well as marketing. However, seaweed farmers were confronted by challenges include low price, lack of proper storage facilities, farming and harvesting facilities, climatic changes among others. Thus, based on the observed findings, researchers recommend the establishment of well facilitated drying and storage centres, sufficing farmers with adequate information regarding seaweed market and prices worldwide and establishment of seaweed processing industries which will help in minimizing the act of selling raw seaweed abroad.

**Keywords:** *Challenges; Supply Chain; Seaweeds; Coastal Community*

### **1. Introduction**

Blue economy is one of the current economy countries are capitalizing on throughout the world. It involves a series of water bodies-income generating activities. These include fishing, water body tourism, seashell extraction and seaweed farming among others. These activities are mainly done with an intention of exploiting waterbody resources but in a sustainable manner. Seaweed production is one of the

most important blue economic activity carried out that through the world. It has grown widely due to its economic potential (Larson Et al., 2020). Currently, there are more than fifty countries growing seaweeds across the world with the most prominent being Indonesia, Philippines, Malaysia, Fiji, China, Brazil, Tanzania among others (Food and Agricultural Organization [FAO], 2019).

Seaweed with its varieties have been associated with social, environmental and economic benefits. For instance, in the environmental aspects, a study by Zheng et al. (2019) reports that seaweed production has been used as a solution to sea pollution. It is reported that up to 2015, seaweeds removed thousand tonnes of Nitrogen and Phosphate in Chinese Coastal waters, arrested thousand tonnes of Carbon, absorbed million tonnes of CO<sub>2</sub>, released million tonnes of O<sub>2</sub> and produced thousand tonnes of Iodine in sea waters. Moreover, seaweed farming has been reported to minimize the use of thousand tonnes of chemical fertilizers and pesticides. In social lines, a study by Brownlee et al (2012) reports that, apart from other uses, seaweeds are used by coastal communities as food and the habit is growing across the world. On the same note, Putra et al. (2013) reports that seaweed is used as food and is associated with several health benefits in the human body. A study by Rajapakse and Kim (2011) report that seaweeds are rich in dietary fibres, fatty acids, essential amino acids and Vitamins A, B, C, and E. Moreover, a study by Brown et al. (2014) reports that, economically, seaweeds have been a catalyst to industrial development. They have been used as industrial raw materials in the manufacture of hydrocolloids most of which are industrial food agents. Samuels, Setati & Blancquaert (2022) report that while for many years, seaweeds have been used as industrial raw materials for producing animal feeds, of recent, they have not only been discovered to be great sources of fertilizers with bio-stimulants, they also form raw materials for industrial human medicine and bio-pesticides (Pharmaceuticals) (Nor, 2016). It is revealed that, seaweed extracts are rich in important nutrients including amino acids, carbohydrates, proteins, osmo-protectants and phytohormones which form important elements required in the production of both human medicine and pesticides (Khan et al., 2009).

Seaweed production is an important source of revenue and enhances the lives of people around the coast (Kalumanga, 2018). The activity has been a source of income that has enabled people obtain food, improve their houses and promoted savings among women in families (Krishnan & Narayanakumar, 2010). A study by Larson et al. (2020) reports that, in Indonesia, seaweed production has been associated with positive economic status of women. Studies by Van den Burg et al. (2018) and Msuya, (2012) report that, apart from being a source of employment to mostly idle women and the youth in the coastal families, seaweed production has been a weapon for fighting against poverty among rural communities situated around the coast. Moreover, it has been reported that the benefits of seaweeds are wide spread. To investors, seaweeds are considered potential catalysts for business growth and industrial development as they form rare raw material to a series of finished goods used all over the world. To the government, because a great percentage of the raw seaweed and associated products are supplied across the world, it has been a major source of government revenues through exports. Veldarrama et al (2015) report that seaweed farming and its associated activities have developed into a lucrative export business in some countries and thus contributing to foreign currency inflows.

Following potential social and economic benefits realized from seaweed production, the entire supply chain of seaweed has attracted a reasonable number of actors both in the up and downstream. They are involved in different activities of the supply chain. While studies report that some people are involved farming, others are involved in harvesting, processing, storing and transportation (Engle et al., 2018). Moreover, at a certain stage, local vendors (intermediaries) buying from local farmers are involved. These sell bulky of collected seaweed to industries or large companies that export the raw seaweed or semi processed seaweed to exporters. Thus, the entire production line involves farmers, processors, transporters, intermediaries, industry owners/exporters (Msuya, 2014). Because of the potential benefits associated to seaweed in financial lines, every actor tries to ensure that its supply chain is properly guarded as it forms a potential livelihood strategy of all actors involved.

Local traders support the farmers financially and give them access to vital technical and market information while farmers take care of the weeds, harvest, process it. Transporters carry the processed weed to stores for storage. Large traders or exporters, on the other hand, gather and purchase seaweed from farmers and offer tools for seaweed cultivation as well as knowledge and expertise regarding the dynamics of the product market. In most cases, exporters sell the seaweed to large manufacturers all over the world (Mulyati & Geldermann, 2017). Everyone involved makes sure the seaweed is provided to the customer in the desired quality (Republic, 2013).

Despite all these efforts, it has been reported that the entire seaweed supply chain has been facing a number of challenges. Through various studies from different scholars around the world, challenges facing the supply chain of seaweed have been portrayed including limited funding to the farmers (Duijn, 2017; Zamroni, 2018). Inadequate and inappropriate collection centre and poor modes of transportation (Mulyati & Geldermann, 2017), inadequacy of, handling, processing techniques and storing materials (Nor et al., 2020). Moreover, experiences from India, US and Australia show that low income among farmers, increased vulnerability of farm sites to natural disasters and limited market for the seaweed pose great and serious challenge to seaweed supply chain (Krishnan & Narayanakumar, 2010; Rosentrater, 2017).

In Tanzania, and particularly Zanzibar, the revolutionary government of Zanzibar is one of the key players in the seaweed production. It has, through a number of different intermediaries, been buying the produce from farmers across the islands. Because the product holds great potentials to the government economy and the livelihood of the people it has enacted a number of regulations to govern the entire seaweed production. For instance, the creation of Seaweeds Development Strategic Plan (SDSP), Agricultural Transformation for Sustainable Development in Zanzibar, 2010-2020, The National Strategy for Growth and Poverty Reduction I and II were aimed at enhancing smooth seaweed production and trade. Despite all these strategies, the seaweed production sector and its entire supply chain, which has great potentials for catalyzing the economic development of the country, have been reported to be inefficient. Although a number of studies conducted in Tanzania have reported several challenges facing the sector and its supply chain, most of these facts are archaic (for instance Msuya, 2012; 2014). Moreover, a more recent study by Msuya (2020) centred on the effect of climate change, unclear policy and research on seaweed farming leaving other activities involved in the entire supply chain unattended. Although previous studies could provide insights on the challenges facing the sector, their findings might not hold truth and might not reflect the current situation as the sector has had several changes in the last five years. This necessitates a more current study to investigate challenges facing the seaweed farming and the entire supply chain in Tanzania. The study is motivated to analyse the current supply chain activities among seaweed farmers at Jambiani Zanzibar and explore the perceived challenges facing supply chain of seaweed among seaweed farmers at Jambiani Zanzibar.

## **2. Literature**

### **2.1 Theoretical Review**

The theory of constraints (TOC) created by Eliyahu M. Goldratt in 1984 guided this study. TOC is a management strategy used to deal with limitations (Goldratt, 1980). The main objective of the of TOC is to maximize the business practice, process or activity's efficiency while also maximizing profitability, quality, and accomplishing the main goals (Williams, 2010). The theory shows that every company's primary goal is to boost profits. However, limitations end up being the biggest barriers to making profitability for businesses. On the other side, businesses would have a continuous improvement management system and higher profitability if they were able to control restrictions in their systems (Imşit et al., 2014). The Seaweed production and supply chain is, in this study an organization that seeks

to maximize profits through the entire process of producing seaweed. However, the organization is facing different limitations and challenges that constrain it from maximizing its profits in general. In line with this study, the theory facilitated the process of revealing and discussing findings with regard to challenges facing the entire supply chain of seaweed production in coastal Communities in Zanzibar. It is hypothesized that, once contemporary challenges are identified in the sector, relevant solutions will be sought and the organization will maximize its profits.

## 2.2 Supply Chain Activities among Seaweed Farmers

Ideally, seaweed production is one of the common activities in the World. However, The Asian continent contribute widely in the amount of the world seaweed production volume. While there exists different literature regarding what constitute the supply chain of other produce in Tanzania, facts regarding what takes place in the seaweed production supply chain remains folded. However, elsewhere in the world, literature provide series of activities the entire supply chain of seaweed includes. For instance, a study by Krishnan and Narayanakumar (2010) provide that the supply chain starts with farming and harvesting operations. In India, the farming of seaweed is basically a contract farming between farmers and self-help organizations. A study by Rosentrater (2017a) reports that there is no seaweed supply chain if it does not start from planting of seaweed seedlings by tying them on the ropes. The entire process of farming goes hand in hand with preparing farms, cleaning farms after planting to remove all unwanted materials and finally harvesting (Nor *et al.*, 2020).

Literature emphasize that the harvested seaweed needs to be processed before being stored (Rosentrater, 2017b). While most of the harvested seaweed is processed by individual farmers, very few other players participate in the process. Currently, seaweed processing involves sun drying. Properly dried seaweed is stored in the available stores and supplied with the required temperature to prevent it from spoilage (Rosentrater, 2017b). While some of the dried seaweed is stored at home, some of it is transported to sales points. According to Mahmud and Kamarulzaman (2020), while some farmers transport their dried seaweed to stores and sales points, there are special transporters who specifically gather seaweed from farmers and transport it to storing and sales points.

Marketing is the subsequent activity reported in the supply chain. Studies report that in some countries, the activity is managed by the farmers, who create their own pricing incentive systems and work with businesses to sell seaweed (Krishnan & Narayanakumar, 2010). It is further reported that, the export of seaweed facilitates the marketing function and determines the actual price of seaweed (Soethoudt *et al.*, 2022). The company to which farmers sell their seaweed, determines the real amount of price for each kilo of seaweed produced. Although the supply chain activities in other crops include value addition, apart from harvesting mature seaweed and packing it in polythene bags as reported by (Nor *et al.*, 2020), there is limited literature on the activity, thus suggesting that seaweed is sold raw as it is and no value is added apart from sun drying it.

## 2.3 Challenges Facing Supply Chain of Seaweed among Seaweed Farmers

Researchers reviewed several scholarly works all over the world to identify challenges facing the supply chain of seaweed production. While most literatures are far from the Tanzanian context, they shed light on the subjects. In general, challenges and limitations are centred on activities involved in the supply chain of seaweed. Studies by Msuya (2012) and Moh'd (2015) report that in the entire farming activity has various limitations. It is reported that it has been difficult to grow and gather seaweed due to limited government support in the activity. Zamori (2018) and Duijn (2017) report that farmers use poor implements and have limited access to modern farming equipment that might facilitate their efficiency and increased high quality output. Further studies by Cottier-Cook *et al.* (2016) and Msuya (2020) report

that climatic challenges affect the growth of seaweed. Climatic components of excessive heat and storms hamper the smooth growth of seaweed. Moreover, diseases and destructive algae attack weeds and lead to low produce with poor quality. Like any other crop, the entire farming of seaweed is challenged with limited technical knowhow regarding farm management, outdated technology as well as excessive post-harvest losses (Ward, 2015; Zamroni, 2018; Nations, 2016; Msuya, 2012; Nations, 2016; Cuaton, 2019).

Because the already processed seaweeds has to be transported to stores and sales points, transporting seaweed has not been smooth. While literature report the existence of long distances from farms to stores, low quality roads have also been reported (Mulyati & Geldermann, 2017). Apart from transportation, storage, preservation and value addition have been challenged by the absence of facilities for managing seaweed harvested from farms (Berger et al., 2016). A study by Msuya (2012, 2014) reports that because of inadequacy of packaging materials, most of the harvested seaweed has been wasted and sold as low-quality product. Moreover, limited skills among farmers on quality control renders their weeds vulnerable to quality shocks (Zamroni, 2018 Ward, 2015). A study by (Nor, et al., 2020) reports that because of limited and appropriate storage centres, most of the seaweed is stored at home which renders them low quality. While all these challenges are cited, the major serious challenge emanates from limited funds and low capital invested in the entire industry (URT, 2013).

Similar to other activities, scholars report that the marketing activity faces serious challenges. A study by Duijn (2017) reveals that farmers have limited access to market information and most especially the export markets. This is purposely concealed by intermediaries and exporting companies so that they can benefit more at the expense of farmers (Nor et al., 2020). As a result, there have been serious price variations from time to time. Surprisingly, while the demand for seaweed seems to shoot in the global market, the local prices keeps dwindling (Larson et al., 2020). Moreover, price variations associated with raw material purchases make it challenging for farmers to ensure appropriate seaweed farming and harvesting (CBI, 2019). In the same vein, stiff competition from among producers in the world hinder the stability of the price leading to demoralizing other growers (Moh'd, 2015). Furthermore, it appears that a major problem with the supply chain for the development of seaweed is the lack of coordination and collaborative planning among farmers, institutions, and the government (Mulyati & Geldermann, 2017).

The review of literature has revealed activities constituting the entire supply chain of seaweed production across the world. Borrowing activities from other crops, literature from various parts of the world have identified what the supply chain of seaweed entails. In the same vein, studies have identified challenges limiting the entire supply chain of seaweed. Despite having all these realities, it is difficult to draw a conclusion regarding what is happening in the supply chain of seaweed in the Tanzanian context due to the fact that there are differences in contexts and regulatory framework, as well as social arrangement of growers. In the same vein, studies conducted by Msuya (2012, 2014) presented some challenges facing seaweed farming, however, her studies were mainly focused on seaweed farming and not the entire supply chain of seaweed. Moreover, findings presented are old and may not reflect the current state of affairs. Thus, it is very clear that, apart from weather and climatic challenges highlighted by Msuya (2020), it is unclear as to what is limiting the supply chain of seaweed production in Tanzania.

### **3. Methods**

#### **3.1 The Study Approach**

In this study, the researchers used a qualitative approach, which typically entails a direct communication with participants through interviews, Focus Group Discussion (FGD) and document analysis and subjecting the data to an analytical induction process rather than deduction process. According to Wisdom & Creswell (2013), a qualitative research approach facilitates researchers to understand, explain, explore, discover, and clarify situations, feelings, perceptions, attitudes, values,



beliefs, and experiences of a person or group of people. Because the methodology is adaptable and emergent in nature, it is normally used to record people's life experiences, behaviors, emotions, and feelings as well as how they act in their setting and the difficulties they encounter while working (Astalin, 2013). In this study, researchers used the methodology to interact with seaweed farmers and other potential participants, understand their life, operations and thereafter determining what challenge their operations. Together with this methodology, researchers used a case study design. This facilitated them to understand deeply the operations and the entire supply chain of seaweed (Rose et al., 2015). Seaweed supply chain in Jambiani, Zanzibar was the case researchers studied.

### 3.2 Description of the Study Area

Jambiani located 53 Kilometres away from Zanzibar town (stone town) is situated along the southern coast of Unguja. It has an elevation of 1m above the sea level. The place is estimated to have around 7000 inhabitants (Abdullah et al., 2022). It is located between Paje and Makunduchi. Like other areas in Unguja, Jambiani's climate is tropical in nature experiencing both short and long rainy seasons influenced by the presence of the Inter-tropical Convergence Zone (ITCZ) (Kai, Ng'wali & Faki, 2021; Kai, Kijazi & Osima, 2019). Economically, the social economic activities are carried based on gender. For instance, while seaweed cultivation, octopus hunting, palm collection and coconut husking are female based activities, fishing is the main activity for most men along Jambiani coast (Abdullah, 2022).

This work was carried out in Jambiani village in the areas of Kibigija and Kikadini. The area was cited due to having a significant number of seaweed farmers in comparison to other areas of Unguja. In comparison to other areas, seaweed farming and the entire supply chain is considered to be advanced than in other areas. It is further explained that, since the 1980s people in Jambiani were involved in seaweed farming and thus are considered more knowledgeable in the subject because they have lived the topic.

### 3.3 Participants and Sampling Procedures

The study mainly focused on the social arrangements of area. This being the case as described by Abdullah et al (2022) seaweed farming is mainly a female based activity with men being involved in other activities of the supply chain. Therefore, the study mainly obtained from women and a few men participating in the storage, transporting, and buying seaweed from famers. Through snowball and purposive sampling approaches seaweed farmers, transporters, store owners, intermediaries and exporters were obtained. Through snow ball sampling, following recommendations from Taherdoost (2016), researchers obtained the first sample from one researchers' connection. Through the first participant, researchers obtained the second and the process of recommending more participant proceeded until the required data was obtained (after data saturation). According to Taherdoost (2016) authors normally use a few cases as a motivator to get more cases to participate in the study and so expand the sample size. This strategy works best in tiny groups that are challenging to reach because they are closed-off. Regarding other participant in the study, the purposive sampling technique was used. The participants were purposively pointed and recruited in the study because of their knowledge and role they play in the entire supply chain of seaweed. According to Saunders et al., (2009), special and desired characteristics prompt the researcher to recruit a person to participate in the study. The technique was used to sample transporters, store owners, intermediaries, and exporters.

The study included 45 participants as a sample size among whom 35 were seaweed farmers; 15 from Kibigija and 20 from Kikadini areas. Moreover, transporters, store owners, intermediaries and exporting companies were each represented by 2 participants. Moreover, for more clarity, the study recruited 1 village council member from each of the surveyed areas; 1 from Kibigija and another from Kikadini.

### 3.4 Methods of Data Collection

In this study, data was obtained through the use of three main techniques, In-depth Interview (IDI), Focus Group Discussion and document review. Researchers held IDI with seaweed farmers from Kikadini and Kibigija, Transporters, Store owners as well as intermediaries and exporters. Regarding seaweed farmers, most of the interviews were conducted with participants in their farms. These interviews lasted around 20-30 minutes. Each group of participants had special set of questions. Interviews enabled researchers to obtain data regarding activities involved in the entire supply chain of seaweed and challenges facing each activity and potential actors particularly in Jambiani, Zanzibar. Additionally, the interview method allowed the researchers to adjust the respondents' repeated responses and answers as well as reform and redesign the interview guide (Saunders et al., 2009). The interview also used to gather additional data about the respondent's personal characteristics and environment, which is frequently very helpful in interpreting results but also Samples can be controlled more effectively as there is no issue with the missing returns; overcome resistant, greater flexibility, and non-response generally remains very low (Kothari, 2004).

Five groups were selected for the Focus Group Discussions (FGDs), which was facilitated by a moderator and note-taker. The FGD took place in a welcoming, tranquil, and convenient environment (Kothari, 2004). The primary justifications for using this method in this study are that FGD swiftly produces wealth information and aids in the testing of new concepts and enhancement of pre-existing ones. FGD helped in reviving memories, thoughts, and experience of seaweed farmers, and intermediaries' businesses regarding the supply chain activities and perceived problems for seaweed farmers at Jambiani Zanzibar. To enrich themselves with adequate data and to arrest interview related biases, researchers conducted FGDs. Two discussions were conducted with seaweed farmers. One discussion was conducted in Kibigija and another one in Kikadini. In each discussion, six participants were recruited. While one researcher acted as a moderator, two others recorded the discussion manually and the forth research recorded to entire discussion with a voice recorded after obtaining consent from participant. The discussions centred on challenges facing the supply chain of seaweed production in general and enabled the researchers to perform checks and balances on the numerous responses made regarding the topic during individual IDI.

To supplement data from IDI and FGD, researcher conducted a document review process. Though this, researchers were interested to find out what is spelled in documents regarding the seaweed supply chain as well as cited challenges facing the entire supply chain of seaweed in Zanzibar and Tanzania in general. Researchers reviewed the seaweeds development strategic plan (SDSP), The Zanzibar Agricultural Transformation for Sustainable Development, 2010–2020 (Forum & November, 2005), The Seaweed Cultivation and Utilization for Agricultural Productivity, Food Security, and Sustainable Livelihoods (Revolutionary Government of Zanzibar, 2020) and The National Strategy for Growth and Poverty Reduction II (URT, 2010). In order to ensure that tools enabled researchers to collect the required data, the prepared tools were shared among colleagues and supply chain experts for review and corrections. Moreover, because tools were prepared in English and were supposed to be administered in Kiswahili, researchers provided tools to a qualified translator to translate them. For the purposes of minimizing ambiguities, the Swahili translated version of tools were given to another translator to back translate them in English. The second English version was matched with the original tool to see if there are variations and areas for improvement.

### 3.5 Data Analysis

Since this study uses a qualitative method, the researchers used qualitative analytical techniques to summarize, arrange, organize, interpret, analyse, and present the data in light of the accepted general and specific study objectives. Data analysis began at the study area after conducting the first interviews of day one. These gave a clear picture of the nature of the study findings. Collected data were after a

thorough arrangements, transcribed and typed in MS word. Because interviews and FGDs were conducted in Kiswahili, transcribed data were translated in English before being cleaned. This was done to avoid omitting important data before it is captured in the English version of data. Researchers used an independent translator who was new to the topic. This was made to ensure that the translator is not swayed with individual views but rather findings from the study. Following a thorough reading of the typed data, two researchers coded the first three transcriptions independently. Then, transcriptions were matched to measure variations and similarities. After a joint consent of the contents, coding was done through all collected data. Important codes were identified and sub codes matched to those they relate to. This method was used to both objectives of the study.

Researcher ensured that all data was collected after acquiring a formal research clearance permit from College of Business education the Zanzibar revolutionary government. Moreover, participants were only recruited after their formal consent to participate in the study. Researchers restrained themselves from using any monetary tokens to participants as this would lead them to provide even false information. Findings collected by researcher in this study were made confidential and are kept safe and cannot be accessed by anyone apart from researchers themselves.

#### **4. Finding and Discussion**

##### **4.1 The Supply Chain Activities of the Seaweed along Jambiani Coast in Zanzibar**

The study following the dearth in literature regarding activities in the supply chain of seaweed south to determine if activities in other crops are similar to those in the seaweed production. According to the findings, there are many supply chain operations, which are related to seaweed cultivation and harvesting operations, storage and preservation, seaweed handling and transportation, assuring seaweed quality and value addition, and seaweed marketing. Findings are presented in the subsequent section of this study.

##### **Farming and Harvesting Operations of the Seaweeds**

This is the first activity in the entire supply chain of seaweed in Jambiani, Zanzibar. It is marked with obtaining the appropriate field, durable pegs and synthetic ropes. Seedlings are normally attached on the ropes tied on lined pegs hammered deep in the ground. The first step was to plant the seaweed. While pegs act as attachments, ropes act as catchments on which seedlings are attached. They protect seaweed from being swayed with sea tides and moving waves. Respondents reported that pegs are put in an adjacent fashion to allow the farmers to stretch the ropes on which seaweed is attached. One respondent stated: *"We attach ropes on pegs and on it we tie seaweed seedlings and wait for harvesting after two months"*. In a more elaborate manner, another participant reported that:

This is the initial activity. We first get pegs which we normally buy at 2500= (Approximately 1\$) for 30 pieces. The number of pegs you need are determined by the size of your farm. Although badly needed for seaweed farming, pegs are hardly available. This is followed by preparing seedlings, and then ropes most of which are provided by intermediaries or companies buying seaweed. (Farmer, Mwendawima, Kikadini Ward, Jambiani).



## Standing pegs during the Seaweeds Farming



Findings further indicate that it is difficult to farm seaweed without ropes. Noting the importance of such ropes, it is currently a common practice for seaweed buying companies to supply their farmers registered with them with a number of ropes of their interest (as much as the size of one's farm). However, it was reported that, this was done on a restriction that a farmer belongs to a known farming group and must sell her produce to the same company from where she obtained ropes. Confirming this, a participant said that;

Normally, nylon rope and sacs are supplied and delivered through an agency company that acquires seaweed from farmers. However, they (farmers) must be registered as members of that firm in order to earn or enjoy the company's services. (*Farmer, Dimbuni, Kibigija ward, Jambiani*)

Farming is never complete is there is no harvesting. As for seaweed, farmers normally have to wait for around two to three months before picking matured seaweed (waiting for two successive tides waves). Farmers then sort their produce to remove dirt and sand before further processing is done. From responses it can be noted that seaweed requires special care before being placed in storage facilities. For instance, on the same issue one participant testified: *"The removal of dirt and sand begins during harvesting. Farmers, remove sea grasses and other dirt materials before drying their produce"*.

Findings as reported by participants indicate that the entire supply chain begins with seaweed farming. This is one of the critical activities from which all other activities stem. The activity has been observed to contain sub activities that in general make up farming. It has however been noted that, farming is a tedious activity, it involves several requirements. At times, because of the difficulty in acquiring implements some seaweed buying companies supply some of the material to farmers inviting an aspect of contract farming. In this the farmer is only required to sell the produce to the one from whom implements were obtained irrespective of the price offer. in which a number of activities are engulfed in it.

## Processing, Storage and Preservation of Seaweed

Upon successful harvesting of seaweed, farmers normally start processing it. It is normally done by drying. Here farmers only depend on direct sunlight. Farmers reported that, following harvesting, farmers spread their harvest on canvas or grass. This is done to ensure that the weed dries up. Moreover, they reiterated that, in drying they have to ensure safety of the place so that the weeds do not come in contact with sand. Throughout the process of drying, farmers make sure that nothing wet come in contact with the weeds as they cause deterioration and decomposition. A participant on this said:

...after removing all wastes, farmers use special materials such as coconut tree leaves, sacks and tarpaulin and nowadays they (farmers) seaweed is dried on special stands built of trees to avoid contact with sands. (*Farmer, Kibigija, Jambiani*)

### Canvas sheets used to used to dry on the floor



Furthermore, findings showed that spraying insecticides was another method of storing seaweeds, but results show that farmers were unable to do so owing to a lack of funds to purchase insecticides, but secondly would degrade the quality of the weeds thereby causing dwindling of weed prices. While some farmers showed that there are species insecticides that are friendly, they were not sure of which ones. One of them said:

There are special sprays that can be used to kill harmful fungus and bacteria, however, because we don't know them our partners would have identified and supplied them (insecticides) to us. It would be a step ahead. (*Farmer, Mfumbwi, Kikadini ward, Jambiani*).

Processing of seaweed is proceeded by storing it in special materials and places. However, findings indicate that, dried seaweed is only packed in a traditional packaging materials and nylon sacks. At times, this affects how seaweed is transported from Jambiani to marketing places (Stone Town). Confirming this, a farmer said: "*Seaweeds are not packed in better packages, they disturb during transportation especially during rainy seasons*". This clarifies that, the way seaweed is packed raises more questions and chances of incurring losses.

Although dried weeds are normally taken for selling, in most cases farmers prefer storing them until they have a reasonable and bulky produce to sell at once. In the process, it would be ideal having a dedicated store. However, findings indicate that, although storage is one of the key activities in the supply chain, in the seaweed farming, there are no stores dedicated for the activity. This forces farmers to store their produce in their own houses. This open chances for weeds to be contaminated with water hence being degraded.

### Handling and Transportation of the Seaweeds

Transportation is another important activity in the seaweed supply chain. Transportation of seaweed begins immediately after harvesting. At this stage, depending on the number of sacks available, farmers use three common transporting methods. In the first method, farmers are forced to carry their harvest on the heads while taking it to drying points. Secondly, they tie their sacks on ropes and pull them. Because they are in water, they are light and can easily be pulled to shores where they are then carried to drying points. Sometimes, farmers use canoes when seaweed farms are located far away from the coast. In this way, sacks might be carried in the canoes or tied and pulled by the canoe. This was confirmed by an intermediary who said, "*...some farmers transport seaweed using canoes. They do it when taking seedlings and when harvesting...*".

In the case of dried seaweed, farmers pack their produce which is transported to seaweed purchasing companies. In this case, the activity involves different transportation means beginning with bicycles, motorbikes, pickups and trucks. It is reported that while farmers use bicycles and motorbikes in transporting of the weeds to buying company (in this case ZANEA), intermediaries use trucks. The nature of transport mode depends solely on the distance between a farmer and the sales point, the amount of the luggage and the financial capacity the farmer. However, findings reveal that, handling materials used by farmers and transportation lines were prone to financial losses especially during the rainy seasons.

While transportation is done by farmers using rudimental methods, packing as well as unpacking are manually done making it difficult for the farmer and intermediaries themselves. During an interview, an intermediary revealed that:

We have no facilities for handling the weeds (unloading it from farmers' sacks and putting it in the company sack), we do it manually due to limited technology. Sometimes we ask farmers who come to sell their produce to help us doing it (**Male worker, ZANEA co.ltd, Kibigija, Jambiani**)

Although transportation is of paramount importance in the supply chain and in this regard seaweed farming, it still raises challenges especially when taking harvest from the farm to drying place and when transporting dried produce to sales point. Findings generated indicate that it is only safe during sunny seasons and risky otherwise. Findings suggest the establishment of communal drying place that is near sales point. In the same manner, findings suggest the use of technological means in drying and handling of produce.

### **Ensuring Quality and Value Addition of the Seaweeds**

Quality addition begins with the choice of seaweed to grow, how long one has to wait for it before it matures, how it is harvested and what happens after that. The findings indicated a number of activities for assuring the quality and value addition of the seaweed supply. These involve harvesting matured seaweeds, selecting the appropriate packing facilities, removing waste elements prior to sale, and drying the seaweeds in specified sheets. Regarding harvested matured seaweeds, it was revealed that it facilitated farmers to easily sell high quality produce. They also indicated that two tide periods were sufficient for the farmer to pick and select the matured seaweed.

Farmers in order to ensure quality, they normally sort their produce from unwanted materials. This is done both immediately after harvesting and a day before selling the produce. They remove seagrasses, shells, sticks, and other unwanted algae. Normally the dried seaweed is normally cleaned from sand and any other unwanted materials. This facilitates farmers to sell high quality produce. In an interview, one participant said:

At every stage of seaweed farming, harvesting processing and selling, quality is of utmost importance. For instance, farmers normally make use of tarpaulin, coconut leaves, sacks and grasses in drying seaweed to prevent it from getting in contact with sand. This maintains quality. (**Intermediary, Kibigija, Jambiani**).

Moreover, because the nature of packing determines the quality of the produce, farmers normally, on that aspect, sell their produce as a poor quality one because it is poorly packed. For instance, farmers only use nylon sacks, most of which were used to pack other produce like floor or rice. The practice jeopardizes farmers of the right of enjoying full payments for high quality produces, One participant during an FGD said:

Because of the lack of proper packaging materials at the time of harvesting and storage, we tend to adopt nylon sacks to pack the produce and store it home until the time of selling it (**Female participant, Baghani, Jambiani**).

Activities of quality checking and value addition are very important in the supply chain of any crop. However, based on the findings, in seaweed farming, farmers and intermediaries have little to do regarding the value addition. Apart from drying, sorting and packing in low quality sacks, farmers have less to do on the issue. On the side of intermediaries and exporters, findings indicate that they do not process the weeds apart from packaging them to meet export standards. This suggests that Tanzania sells raw seaweed to external world which earns little than if there was more processing done. Moreover, due to the fact that the only processing done depends on direct sunshine, the question remains what happens to matured seaweed harvested during the rainy season?

### Marketing of the Seaweeds

This is another important activity in the seaweed supply chain. Findings obtained in this study reveal that, although farmers do all what is needed in the supply chain of seaweed farming, prices are normally determined by the intermediaries. And because farmers normally receive implements (though at low scale) from buying companies, they are compelled to sell their produce at any price determined by the buying company. Further findings indicated that price is determined by intermediaries' company without any consultation with farmers. This leads to offering low prices to farmers who toil hard to farm the crop with no clear basis for that yet the demand for the seaweed is high worldwide. A participant reported:

*We used to sell seaweed to intermediaries or companies for 800/- (0.35 \$) per kg, but now we sell 1kg for 1000/- (0.4 \$) As a result, this approach has occasionally caused other farmers, particularly male farmers, to abandon farming. (Female farmers, Mfumbwi, Kikadini ward, Jambiani)*

Findings reveal that intermediaries normally set lower prices in comparison to the world market price. On the same vein, findings suggest that lower prices demotivate more farmers to quit seaweed farming due to low income associated in it. Further findings suggest that, contract farming that companies end up with farmers deprive them (farmers) of their independence to choose a buyer with attractive prices.

In general, the supply chain of seaweed is to some instances similar to other crops. It has been revealed that the chain begins with farming. Just like other scholars (Krishnan & Narayanakumar, 2010; Rosentrater, 2017a), the entire supply chain of seaweed begins with farming. Although reported to be on a lower scale, procedures like tying seedlings to nylon ropes (Msuya, 2014d), collect mature seaweed (URT, 2013), and transporting seaweed to drying fields (Nor et al., 2020) are similar. Findings entail the importance of storing facilities, but they have been revealed to be unavailable. A study by Rosentrater (2017a) reveal that storage is of utmost importance and leads to quality shocks in produce if not well stored. The absence of storage materials and dedicated stores raise chances of incurring losses among farmers. This suggests the establishment of communal stores that have the required storing conditions. Drying of seaweed is an important process that involves several people. However, it depends solely on sunlight. This explains what farmers go through and losses they incur during rainy seasons as explained by Msuya (2020). The situation suggests the establishment of more advanced means of drying seaweed in bulks, in a short period of time and at any season of the year.

Although seaweed supply chain involves transportation, quality addition and marketing, the two activities are done on a lower scale and have been reported to be unsatisfactory. For instance, A study by Mansor and Kamarulzaman (2020) that the nature of seaweed determine how it is transported, however, transport means are limited and non-friendly. In the same vein findings reported the presence of manual loading and offloading of produce from seaweed farmers' sacks, which at times leads to disturbances. Similar findings are reported by (Rosentrater, 2017b). This situation suggests mechanization of seaweed collection points to avoid disturbances.



Despite all stages and activities farmers are involved in, prices at which they sell their produce is only determined by buying companies and intermediaries. Findings reveal that farmers are paid low prices for their seaweed produce. This does not only lead to dwindling the number of people involved in the activity, it causes more poverty than prosperity the activity was expected bring. Such findings are cementing those given by various scholars (Krishnan & Narayanakumar, 2010; Soethoudt et al., 2022; Msuya, 2014d; Van den Burg et al., 2018; Nor et al., 2020). It moreover suggests that, if such exploitative habits are not checked the activity will remain with no farmers at all.

#### 4.2 Challenges Facing Supply Chain of Seaweed among Seaweed Farmers

The study looked into the difficulties that seaweed farmers face in their daily operations along the coast. The findings suggest that there are various causes, as shown in the following paragraphs. These include farming and harvesting obstacles, handling and transportation issues, storage and preservation challenges for seaweed producers, quality and value of seaweeds challenges, and marketing challenges.

##### Challenges to Farming and Harvesting of the Seaweeds

The findings revealed that various seaweed farmers face a variety of challenges while farming seaweed. Poor government assistance in provision of farming equipment, price fluctuations when purchasing raw materials and selling seaweed produce, climate change with high temperatures and a lack of post-harvest facilities. Others include lack of farm management experience, obsolete technology, and lack of harvesting equipment/tools were among these challenges. a thorough description of these challenges is given in the subsequent paragraphs.

Poor government support hurt seaweed farmers according to the findings. Participants confirmed that despite that seaweed farming is one of the key crops that the government is emphasizing farmers to grow, it hardly provides any technical, financial or technological support for its farming. Farmers have to depend on their own sources, implements, equipment and knowhow. This jeopardizes their entire production and harvest in general and sends them in the hands of big sharks who act as intermediaries for equipment like ropes and other necessary implements. A participant mentioned that: “...because there is a dearth of government support for the provision of farming equipment, substantial assistance was provided by private purchasing companies which subject farmers to low prices at the end. (**Farmer, Kibigija, Jambiani**)

Climate change was yet another big challenge facing seaweed farmers during farming and harvesting. As a result, respondents testified that climate change, particularly the increase in high temperatures and the unexpected occurrence of rain or rainy season, makes the activity more difficult since farms and crops are more vulnerable to spoilage. Moreover, high temperatures trigger the eruption of poisonous seagrasses, which kill the seaweeds. One informer provided testimony on the effect of climatic changes. She uttered: -

Normally, heavy rainfall causes seaweeds to grow faster in the sea, but harvesting and drying them, especially during the rainy season, kills the farmers' efforts. It is until the government intervenes by giving us drying materials or building a common drying centre that will run at whatever season of the year (**Farmer, Kibigija ward, Jambiani**)

Farming is never successful if inadequate skills are used and the farm is not properly managed. Findings in this study reveal that most farmers have limited knowledge regarding farm management and use rudimentary skills. In the same vein, findings indicate that farmers use traditional technology that does not go hand in hand with what farming requires currently. For example, the use of wooden pegs and ropes signify backwardness in the activity and hamper productivity.



Another challenge is limited investment in the farming of seaweeds. It is mentioned that, farming only depends on traditional means with traditional sizes of farms. No big investment is observed in seaweed farming. An intermediary when interviewed said:

There is great potential in seaweed farming and business in general. However, there is no investment in it. Even if we deal in the crop, we have not invested heavily in the farming of the crop, as a result, most farmers have smaller farms and are subsistence in nature. **(Intermediary, Kibigija, Jambiani).**

Such a quotation indicates that had there been sound investment in the sector, both farmers and buying companies would benefit a lot from seaweed farming than they currently do.

Another challenge facing seaweed producers is shortage of harvesting equipment, which was described by farmers themselves. They reported harvesting seaweed manually and get in contact with salty waters for a great period of time which sometimes may lead to some diseases. They further report that, even after harvesting they lack special materials to put their harvests and limited equipment to carry the harvested seaweed to the shores and drying places. A farmer said: *"We do everything manually, this affects us considering the fact that most of us are women"*. She added: *"...if there was reasonable capital and investment, we would have bought the required equipment"*. The finding suggests that, limited investment forces farmers not only to suffer while farming but also use backward technological equipment in farming which among others affect their yields.

### **Handling and Transportation Challenges for the Seaweeds Supply Chain**

In this stage, findings depict a number of challenges including limited transport means. In this regard, it is only the better off families in possession of bicycles and motorbikes that are in the position of transporting their produce easily, otherwise, farmers carry their produce on the head. A farmer said: *"I normally carry my produce on my head after harvesting and when taking it to the intermediary for selling"*. In this same stage, transport costs are exploitative. Farmers in most cases have limited income. In moments when they want to take their produce for selling they are charged highly yet, they only have limited income out of what they produce. They are thus forced to sell the weeds to intermediaries who offer them limited prices. Moreover, farmers mentioned that, seaweed requires appropriate handling materials for it to be transported from the farm to the drying ground and from there to sales point. These materials are currently not available and farmers end up re-using nylon sacks initially used for flour, rice, soap and other products. Insisting on how difficult it is in handling and transporting the produce, a farmer said:

Had you visited during the high you would have seen how we struggle pulling sacks from the sea to the shore after harvesting. We sometimes ask fishermen to help us with their canoes and boats. **(Farmers, Kikadini ward, Jambiani)**

### **Storage and Preservation Challenges Facing Seaweeds Farmers**

In this activity, farmers normally face two major challenges which are lack of dedicated stores, and appropriate storage materials. In the first instance, findings revealed that there are no dedicated stores in which dried seaweed is stored. Because farmers normally pile their produce for at least two consecutive harvests and sell it at once, they are forced to store their produce in their houses most of which are grass thatched, with muddy floors. Such houses do not have the required conditions for storing dried seaweed. It is likely for them to be moisture, lose their initial quality and thus yielding low prices.

Further findings reveal that limited storage facilities are a challenge. As a result of the findings, the participants revealed that limited storage facilities were a concern for seaweed farmers. They argued, however, that nylon packages were their primary storage container; a quick but inappropriate solution. During an interview, one participant revealed that:

*Look! We have no storage equipment. We only use nylon sacks. They have become our only means. Although useful during dry seasons, in rainy seasons they contribute widely to the decay of seaweed. This damage the weeds' worth and quality. (Female respondents, Mfumbwi, Kikadini ward, Jambiani)*

### Challenges Related to Quality and Value of the Seaweeds

A number of issues were related with the quality and worth of the seaweeds. Findings revealed that farmers' lack of knowledge and skill in guaranteeing seaweed quality was a serious challenge. For instance, farmers receive limited trainings, they do not visit other places to see how they are growing their weeds as well as other varieties and neither do they receive aquaculture extension services. As a result, their weeds have in most cases been attacked by chronic seaweed diseases which lower the quality of these weeds. In such a situation, it is more likely that the quality of produces will be low and will not attract reasonable income at all.

Packaging and packing add on the quality of a produce. However, in Zanzibar, most farmers sell seaweed raw as it is just because they have no funds to buy packing and packaging materials. Findings mentioned that traditional packaging materials such as sacks and nylon were merely their means of preserving the seaweed and packaging it. In a similar scenario, seaweed farmers stated that their lack of expertise of employing packaging materials jeopardizes their attempts to deliver high quality products. Connected to this, traditional seaweed drying technology reduces the amount of nutrients in the produce and accelerate low quality and income thereafter.

Another problem was excessive rain. Findings reveal that excessive rainfall damages the quality of seaweed. It is reported that, because farmers have limited materials including tarpaulins and appropriate stores, rainfall normally destroys most of the weeds harvested in that period. For instance, farmers stressed that during the wet season, gathering and storing seaweeds becomes extremely challenging when it comes to stores and drying. As a result, the seaweeds eventually become rotten. A farmer said:

*During the rainy season, specifically between March and May, seaweed farmers face storage problems. We stop harvesting weeds or harvest in little quantities owing to the fear of drying and losing it. (Farmer, Baghani-Kibigija, Jambiani).*

In a nutshell, while farmers strive their level best to harvest, process and sell high quality seaweed produce, their surrounding environment deter their efforts. Findings suggest that little is done with regards to quality and value addition. It indicates that farmers end up selling low quality produce, raw in nature which attract low prices at the end.

### Marketing Challenges of Seaweeds

This study identified a variety of issues connected to the marketing of seaweed based on low prices, and poor communication and information between farmers and purchasing/intermediary businesses, Findings in this aspect reveal that intermediaries do not provide clear information regarding the actual price of seaweed in the world market. Moreover, they do not provide concrete reasons as to why prices are low. To most farmers, they ask themselves why is a highly demanded crop in the world market bought at such low prices like it is to seaweed in Zanzibar? They also ask themselves, why are intermediaries not giving concrete reasons as to why there is low price of seaweed in Zanzibar. This suggests that farmers know little of what is taking place in the world market regarding seaweed prices. Moreover, findings suggest that secrecy and concealment of seaweed prices and major buying companies overseas.

It was moreover revealed that seaweed prices are normally low and determined by intermediaries. This discourages many farmers who desert their farms and go for other activities. Findings from farmers

show that prices are low. One of them testified: *"Seaweed prices are too low. A reasonable number of farmers (mostly men) have abandoned seaweed farming. They say profits are lower in comparison to the efforts they invest."*

Findings in general reveal that, although seaweed farming is of paramount importance to the economy of the country, the entire supply chain of the crop is challenged by serious problems which hinder its utmost benefits. It is revealed that low investment and rudimental technology hinder the farming process. In the same way, weather and climate in general challenge the drying and processing, low capita and limited dedicated stores hamper handling, and storage and high transport costs hamper transportation of seaweed to the required buyers offering relatively higher prices. Just like it is in other crops, there is limited flow of information from intermediaries to farmers. This indicates that farmers do not know the actual price of seaweed in the world market. This leads g=farmers to accepting the low price dictated by intermediaries. These findings are in line with several scholars who reported similar trends. For instance, studies by Msuya (2012) and Moh'd (2015) reveal the presence of inadequate skills and limited investment in seaweed farming coupled with outdated technology seriously lower the produce farmers obtain. On the same grounds, Ward (2015) and Zamroni (2018) stress that while high temperature affects the growth of seaweed growth, lack of post-harvest handling equipment seriously affect how weeds are handled and transported. On a serious note, Msuya (2020) had earlier reported that climate change comes along with serious and adverse challenges to seaweed farming including uncertainties in rainy and sunny seasons. As a result of climate change, farmers obtain rainfall even in periods that rainfall was not called for. In most cases it destroys their harvested seaweed.

Inadequacy of dedicated stores, and handling materials were earlier reported in the works of Nor et al. (2020) and Mulyati and Geldermann (2017). In these studies, it was categorically mentioned that because farmers have no dedicated stores, and neither do they have handling materials and storage facilities, it is more vivid that they store their produce in seaweed storage unfriendly conditions which lead to their poor quality. A more serious challenge regarding prices and information was reported by several scholars (Aleman et al., 2019; Zamroni, 2018; Nor et al., 2020; Mulyati & Geldermann, 2017; Moh'd, 2015; Duijn, 2017). Through these scholars it was reported that because of concealed information about the entire seaweed market and lower prices, a number of serious farmers have deserted seaweed farming and resorted to other crops. This partly explains why the overall production of seaweed is dwindling year after the other.

## **5. Conclusion and Recommendations**

### **5.1 Conclusion**

The study explored activities and challenges facing the supply chain of Seaweed along Jambiani coast in Zanzibar. The study comes after realizing dearth in literature regarding activities and challenges in the supply chain of seaweed production in Tanzania. Though qualitative means in which interviews and extensive discussion with participants were carried. It was revealed that several activities are involved in the entire supply chain of seaweed production. These include the planting, harvesting, transporting, processing and much more. However, it was revealed further that inadequacy of funds, skills, stores, handling materials, high transportation costs and low prices on the seaweed generally hamper the seaweed supply chain. The entire study suggests inefficiencies in the entire supply chain of seaweed right from the down to the upstream. While most challenges call for government intervention, others need the presence of active public private partnership. It is until the identified challenges are solved, otherwise, the government will continue to lose more farmers and register low income in this important commercial crop. Income from this crop will keep dwindling unless serious steps are taken.

## 5.2 Recommendations

Based on the obtained findings and major conclusions the study recommends the following;

The government needs to entice foreign and local investors to invest in seaweed production just like they do it in other crops. This will facilitate the introduction of new technology and establishment of modern farming equipment such as plastics pegs to sweep away wooden pegs that are a threat to environmental degradation. The presence of serious investment will make even other growers serious there by attracting quality produce and increased income among growers and the country in general.

The government through its responsible ministry is urged to establish seaweeds processing plants. These will add value to the produce and will boost the price instead of selling it as a raw seaweed. Further, farmers should be given a chance to sell the seaweed outside of country rather than depending on intermediaries' companies.

In order to alleviate the challenge related to storage and preservation as well as reducing post-harvest losses, the study recommends to the establishment of solar power-driven driers which can be used during the rainy season so as to reduce post-harvest loss. These may be acquired in form of soft loans or maybe owned communally by a village. On the same note, the government may construct community drying and storage centres in all seaweed producing localities. This will ensure that weeds are dried at any season of the year and in a shorter period of time.

The study suggests to initiate seaweed coating materials such as reagent which can be employed as an anti-seaweed diseases, fungus and deteriorations. These may be acquired from available stores. However, while applying these materials, the government through Zanzibar Food and Drug Authority (ZFDA) and the ministry of agriculture should scrutinize the reagent to make sure that it is free from any harm marine life. Similarly, sensitization and awareness on value addition and quality should be provided for the farmers in order to improve seaweed quality.

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