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African Agribusiness and Agro-industries Development Initiative

Seaweed Value Chain Assessment of Zanzibar: Creating value for the poor

United Republic of Tanzania

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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Abstract

This study was conducted as part of the 3 ADI program. The present report is a companion document to *Feasibility Assessment for a Zanzibar MUZE Seaweed Processing Facility (ZanMUZE)* (Neish IC, 2013). The two reports were submitted as components of UNIDO Project no 13083 "Building Seaweed Processing Capacities in Zanzibar and Pemba: Creating value for the poor". The present value chain study established the current situation of seaweed production and processing in Zanzibar and its marketing on the international Market. The companion document proposed that a step toward expansion and strengthening of Zanzibar spinosum seaweed markets should be construction and operation of a processing facility (ZanMUZE).

Carrageenan-bearing seaweeds genus Kappaphycus (cottonii of the trade) and Eucheuma (spinosum of the trade) have been commercially cultivated in Tanzania since the early 1990s. Because of successive crop failures, cottonii represents only a minor proportion of Tanzania seaweed production. On the other hand, spinosum has flourished in the two main islands of Zanzibar (Pemba and Unguja). It comprises most of the seaweed production of Tanzania. More than 15 000 dry tons were exported during 2012. This represented about 1/3 of global spinosum production with Indonesia and the Philippines accounting for most of the rest. Spinosum from Zanzibar was sold to companies that produce refined iota carrageenan utilized as dentifrice stabilizer and in high-end processed food products. These markets have shown sluggish growth for more than 20 years. As of 2012 Zanzibar spinosum supply exceeded demand and and had heavy competition from Indonesia and the Philippines. Farm-gate prices were soft and exporters could not buy all the seaweed that farmers hoped to sell. Zanzibar spinosum farmers needed new markets.

Emerging technologies give reason to believe that new processes and innovative products can substantially increase the size of spinosum markets. The basis of these technologies is multi-stream, zero-effluent (MUZE) processing that commences with fresh, live seaweed converted to juice and pulp using packaged processing units near farm sites. Initially such processing would produce liquid and solid products similar to analagous products already produced from cottonii seaweeds in India. These can probably be brought to agricultural nutrient and hydrocolloid markets within three years. In the longer run, advancing biotechnology is almost certain to provide several alternative uses for spinosum biomass.

The next step toward expansion and strengthening of Zanzibar spinosum markets should be construction and operation of a small scale MUZE production facility that can be used to refine process protocols and provide samples for testing and approval by potential customers in local, regional and global markets. As efficacy is demonstrated, production can be scaled up to full commercial levels.

Glossary

Note: (K) is Kiswahili

ATC: alkali-treated chips made from Kappaphycus or Eucheuma

BoT: Bank of Tanzania

CBO: Community Based Organisation

Cottonii: Kappaphycus spp.

CSPro: Census and Survey Programme

Cultivar: A clone derived from vegetative propagation originating from a single seaplant thallus.

DMR: Department of Marine Resources, Ministry of Livestock and Fisheries

DoE: Department of Environment

Eucheuma spp.: A red algal genus that is called "spinosum" of the trade; source of iota carrageenan.

FAD: Fish Aggregating Device

FAO: United Nations Food and Agriculture Organization

FS: Live, fresh seaweed (cottonii or spinosum).

Galactans: A class of polysaccharides that includes carrageenan and agar.

GDP: Gross Domestic Product

GOZ: Government of Zanzibar

Gracilaria spp.: A red algal genus also called "gracilaria" in the trade; source of agar.

ICM: Integrated Coastal Management

IEC: Information Education and Communication

ILO: United Nations International Labour Organization

IT: Information Technology

JUWAMWAZA (K): Jumuiya ya Wakulima wa Mwani Zanzibar (Zanzibar Seaweed Farmers Association

JUWAMPE (K): Jumuiya ya Wakulima wa Mwani Pemba (Pemba Seaweed Farmers Association)

Kappaphycus spp.: A red algal genus that includes both “cottonii” of the trade and “sacol” of the trade; sources of kappa carrageenan.

Kiswahili: Language generally spoken in Zanzibar

MACEMP: Marine and Coastal Environmental Management Project

MLF: Ministry of Livestock and Fisheries

MCT; Ministry of Communication and Transport

MDGs: Millennium Development Goals

MKUZA (ZSGPR)(K): Mkakati wa Kukuza Uchumi na Kupunguza Umaskini Zanzibar (Zanzibar Strategy for Growth and Poverty Reduction)

MoFEA: Ministry of Finance and Economic Affairs

MSME: Micro, small and medium enterprises.

MS(PO)RASD: Ministry of State (President Office) Regional Administration and Special Departments

MT: metric ton.

MTIM: Ministry of Trade, Industry and Marketing

MTTI: Ministry of Tourism, Trade and Investment

MWCEL: Ministry of Water, Construction, Energy and Land

NGO: Non-Government Organisation

NLUP: National Land Use Plan

RAGS: Red Algal Galactan Seaweeds including Eucheuma, Gigartina and Kappaphycus.

RDS: Raw, dried seaweed

SACCOS: Saving and Credit Cooperative Society

Spinosum: Eucheuma spp.

SRC: semi-refined carrageenan (a.k.a. processed eucheuma seaweed, PES or E407a).

UDSM: University of Dar es Salaam

UNEP: United Nations Environment Programme

UNIDO: United Nations Industrial Development Organization

USD: United States Dollar.

Value Chain: A mechanism that allows producers, processors, and traders - separated by time and space – to add value to products and services as they pass from one link in the chain to the next until reaching the final consumer (after UNIDO, 2011).

ZIPA: Zanzibar Investment Promotion Authority

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Introduction

This study was conducted as part of the 3 ADI program. The present report is a companion document to *Feasibility Assessment for a Zanzibar MUZE Seaweed Processing Facility (ZanMUZE)* (Neish IC, 2013). The two reports were submitted as components of UNIDO Project no 13083 "Building Seaweed Processing Capacities in Zanzibar and Pemba: Creating value for the poor". They were based on field work conducted by the authors and UNIDO staff during late July and early August, 2013.

Terms of reference for the project stipulated that the project concept originated from negotiations with the Zanzibar government during the formulation of the country program in 2011. Both the Ministry of Livestock and Fisheries and the Ministry of Trade, Industry and Marketing indicated that developing the seaweed sector is of highest priority because it is a main source of income for many poor on Zanzibar and Pemba islands, especially women.

The project context was such that it will contribute to developing and fine-tuning the project document "Building Seaweed Processing Capacities in Zanzibar and Pemba: Creating value for the poor" is a way specified by the project terms of reference as follows:

> *"The project will generate opportunities for businesses and decent work in sustainable seaweed production, processing and marketing. Drawing from technology that successfully is used in South-East Asia and collaborating with private sector entities that have pioneered the seaweed sector in Zanzibar the idea is to bring value addition closer to the poor and help local seaweed farmers benefit from the value that is added to seaweed as it gets processed and marketed. At the heart of the project is the setting up of modern processing facilities, owned by the provincial government and run by a private operator. The products have enormous market potential when produced to specifications of buyers..."*

1. Geographic & demographic context

(Information assembled from http://www.zanzinet.org [accessed 12 Aug, 2013] MACEMP [2009] and interviews conducted during the present field study)

1.1 GENERAL GEOGRAPHY, DEMOGRAPHY AND INFRASTRUCTURE

Zanzibar is located off the coast of Tanzania in the Indian Ocean (Fig.1.1). As a semi-autonomous part of Tanzania, Zanzibar has its own government, known as the Revolutionary Government of Zanzibar. It is made up of the Revolutionary Council and House of Representatives.

Zanzibar consists of two major Islands, Unguja (sometimes referred to as "Zanzibar") and Pemba (Fig. 1.3) with a group of about 50 small islets surrounding them. The Islands lie in the north-south direction between latitude 04° 50" and 06° 30" South, and east-west direction between longitude 39° 10" and 39° 50" East. The Islands are about 30 km east off the mainland Tanzania coastline. Unguja Island covers an area of 1,666 square km^2 and Pemba Island covers an area of 988 km^2giving a total land area of 2,654 km^2.

According to the 2002 census the total population of Zanzibar was 984,625 with an annual growth rate of 3.1 percent. The population of Zanzibar City, which was the largest city, was 205,870. About 622,459 lived on Unguja and 362,166 lived in Pemba. Zanzibar has a long and colorful history that has resulted in a population with diverse ethnic origins. Zanzibar today is mostly populated by ethnic Swahili, but there is also a minority population of Asians, originally from India and Arab countries. Zanzibari people speak Kiswahili. Many local people also speak English, French, or Italian. Zanzibar's population is about 99 percent Muslim and one percent Christian.

Considerable disparities are said to exist in the standard of living for inhabitants of Pemba and Unguja, as well as the disparity between urban and rural populations. The average annual income is US$250. About half the population lives below the poverty line. Malnutrition affects an estimated to be about one in three.

Zanzibar exports spices, seaweed, other fishery products and raffia. Tourism is the major foreign currency earner. The island's manufacturing sector is limited to import substitution industries including cigarettes, shoes, and processed agricultural products. Since 1992 the government designated two export-production zones and encouraged the development of offshore financial services. Zanzibar still imports much of its staple requirements, petroleum products, and manufactured articles. This has resulted in an apparent surplus of stored empty shipping containers.

In 2000 there were 207 government schools and 118 privately owned schools in Zanzibar. There are also two universities and one college: Zanzibar University, the State University of Zanzibar (SUZA) and the Chukwani College of Education.

Zanzibar has 1,600 km. of roads, of which 85 percent are tarmacked or semi-tarmacked and the rest are dirt or gravel roads. Most are passable throughout the year but some (e.g. in northern Pemba) are barely passable by two-wheel-drive vehicles. There are five ports in the islands of Unguja and Pemba, all operated and developed by the Zanzibar Ports Corporation. The main port is Malindi and it handles 90 percent of Zanzibar's trade.

Zanzibar's main airport, Zanzibar International Airport, can now handle larger planes, which has resulted in an increase in passenger and cargo inflows and outflows. Almost all mobile and Internet companies serving mainland Tanzania are also available in Zanzibar

According to MACEMP (2009) the coastal environment of Zanzibar comprises complex systems of marine and terrestrial ecosystems that form foundations of local cultures and economies. These ecosystems are categorized as follows:

- **Coral reefs:** Zanzibar has an estimated total of 90 km^2 of living corals that form a continuous wall fringing eastern Zanzibar. Patch reefs fringe small islets.
- **Sand banks:** mostly dominate the western sides of Unguja and Pemba.
- **Sea grasses and seaweed habitats:** These occur on large reef flats intermixed with corals.
- Mangroves: Zanzibar mangrove forests occur in sheltered bays. The total area of mangroves in both Unguja and Pemba is about 17,357.48ha.
- **Sandy beaches**: Zanzibar beaches cover a total length of about 149 km. About 49% of beaches of Zanzibar are delineated by rocky shores and the rest are bounded by vegetation including trees. Beaches are used by local communities for canoe landing sites, boat anchorages, boat yards, seaweed drying and recreational activities.

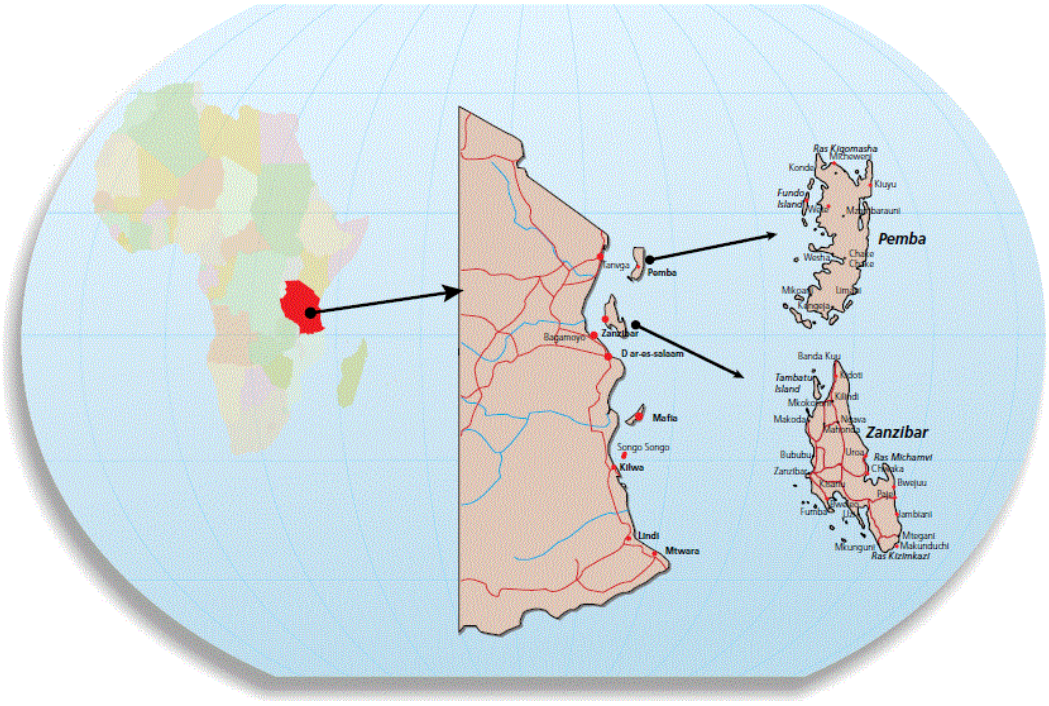
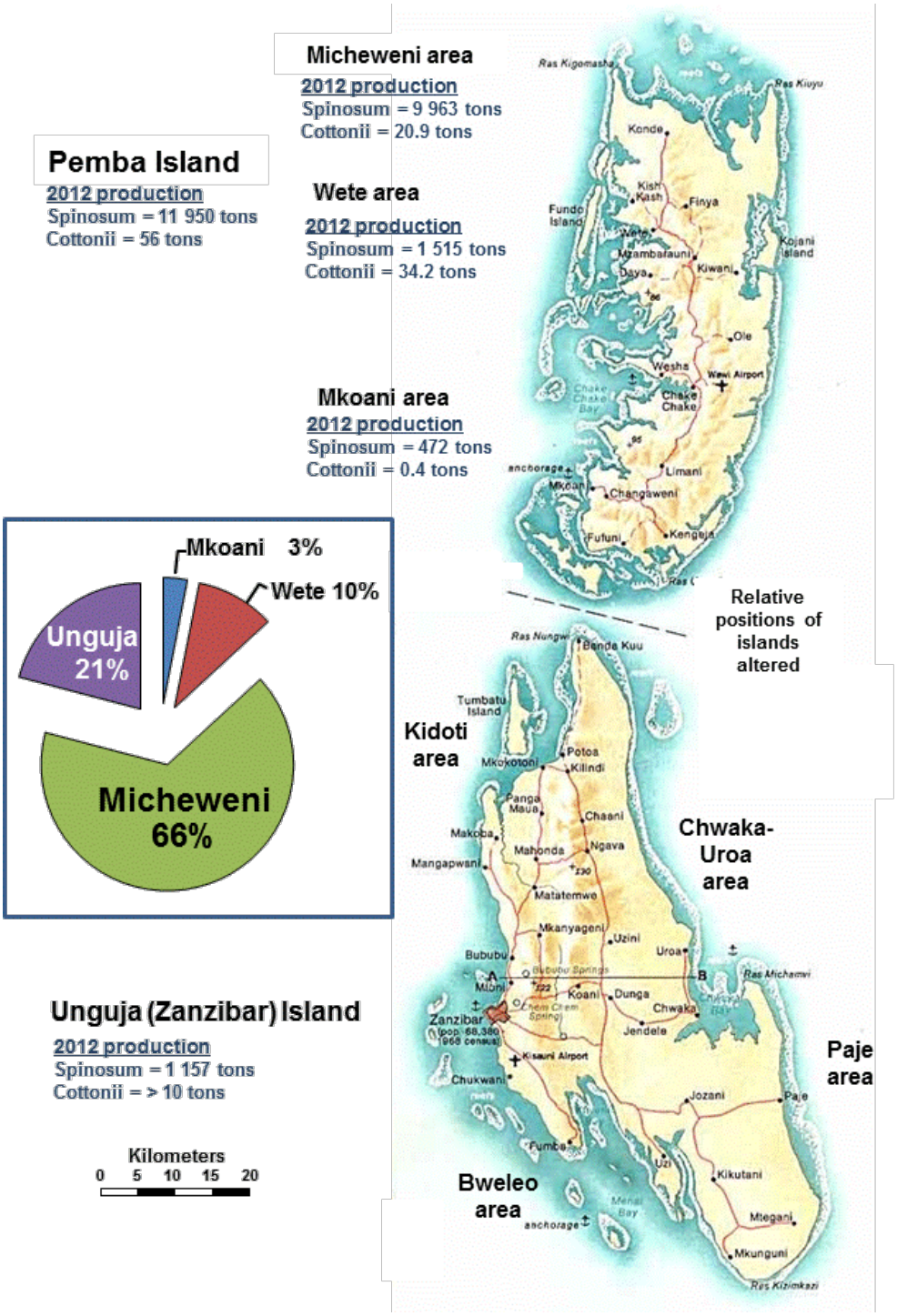


Figure 1.1. Locator map showing position of Zanzibar off the Indian Ocean coast of Tanzania (from Msuya, 2013).

1.2 Zanzibar seaweed farming locations

According to 2012 MLF-DMR data about 2/3 of Zanzibar seaweed production took place in the Micheweni area of northern Pemba (Fig. 1.2). About 21% of production occurred on Unguja and 79% on Pemba. Locations of farming areas are indicated on the maps in Fig. 1.3.

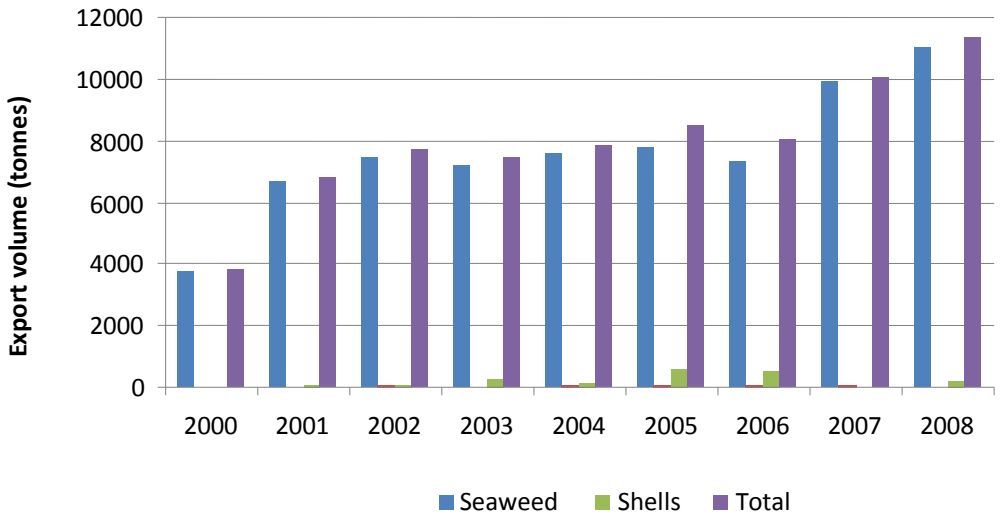
Figure 1.2. Map of Zanzibar indicating the seaweed farming areas and 2012 seaweed production (data provided by Zanzibar Ministry of Livestock and Fisheries – Department of Marine Resources). The pie chart shows proportional production of spinosum from farming areas of Zanzibar during 2012 when about 15 100 tons were produced.



1.3 Overview of seaweed in the context of other fisheries/aquaculture

Seaweeds also represent the largest marine export product from Zanzibar, contributing over 97 percent in most years (Figure 1.3). Other export products include lobsters, fish fins, squids, anchovies, oysters, octopus, crabs and fish offal. (Msuya, 2013)

Figure 1.3. Exports of marine products from Zanzibar, Tanzania. (from Msuya, 2013)



2. Value chain mapping

2.1 Value chain contexts and diagnostic dimensions

UNIDO (2011) defines a value chain as "*a mechanism that allows producers, processors, and traders—separated by time and space—to gradually add value to products and services as they pass from one link in the chain to the next until reaching the final consumer (domestic or global). Main actors in a value chain are firms from the private sector. The private sector draws from a range of public services and private technical, business and financial service providers. They also depend on the national and global legislative context and sociopolitical environment. In a value chain the various business activities in the different segments become connected and to some degree coordinated*." (Fig.2.1).

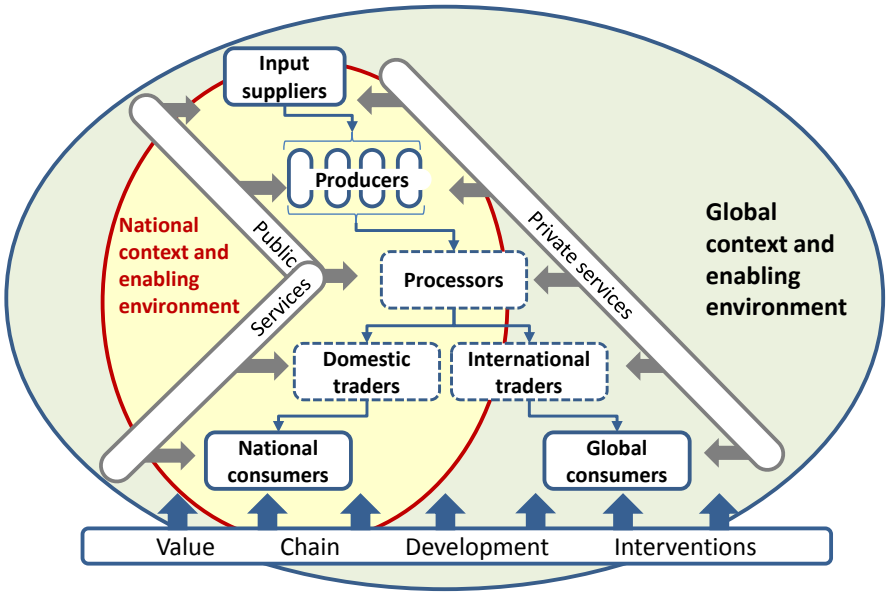


Figure 2.1. Elements of a value chain function within global and national contexts and enabling environments. (After UNIDO, 2010, *Value Chain Diagnostics for Industrial Development* in UNIDO, 2011).

The present study was undertaken within the following seven diagnostic dimensions (after UNIDO, 2011):

1. **Sourcing of Inputs and Supplies**: Emphasis was placed on understanding sources of goods and services that seaweed industry players use in production. Their relationships with providers of primary materials and inputs were examined. Sourcing steps were examined from the farm to the offshore processors.
2. **Production Capacity and Technology**: Here the study examined Zanzibar seaweed industry players' capabilities to manufacture and transform goods, including the means of production (machinery), human capital and the knowledge and technologies used in production. Indicators of technical productivity, cost-efficiency and profit margins were used in the analysis.
3. **End-Markets and Trade**: The study examined markets that ultimately absorbed Zanzibar seaweed products and the seaweed quality demands of those markets.

There was emphasis on understand existing capacity of the Zanzibar seaweed value chain to meet demands and access existing and potential markets.

4. **Value Chain Governance**: Relationships among seaweed farmers and buyers were examined in light of the the complex interdependencies between value chain players. The focus on value chain governance was on rules and regulations that determine the functioning of and coordination in Zanzibar seaweed value chains, existing barriers to entry and the dominance of certain value chain players such as carrageenan processors. It also related to contractual and informal relationships between the various actors in the chain that help businesses operate efficiently, and absorb and diffuse knowledge, technology and competencies.
5. **Sustainable Production and Energy Use**: The seaweed industry is generally regarded as a sustainable, environment friendly industry. The study examined how value chain actors complied with standards of environmentally sustainable production.
6. **Finance of Value Chains**: The emphasis here was to understand how the various actors in the value chain finance their operations, the appropriateness and sufficiency of available finance mechanisms and how delivery can be made more efficient. A distinction was made between credits provided by formal financial institutions and informal financing through buyer-supplier relationships
7. **Business Environment and Socio-Political Context**: The aim of the analysis here was to understand how policies and institutions may have impacted on Zanzibar seaweed value chains and what public institutions can do to support the development of the value chain. The study also examined the availability of public and private support services, and the business culture of public and private actors.

2.2 Value chain actors

2.2.1 Seaweed farmers

According to the Zanzibar MLF the number of seaweed farmers in Zanzibar during 2012 was 23,654 (14 990 from Pemba and 8 664 for Unguja). About 90 percent were women. Numerical distribution of farmers was assumed to be in proportion to the production data shown in Figure 1.2. Therefore, using a rounded total of 20 000 farmers there were about 625 famers in the Mkoani area, 2 000 in the Wete area, 13 190 in the Micheweni area and 4 180 in Unguja.

Given that Zanzibar exported about 15 000 tons of spinosum in 2012 (Fig. 3.1) the average production per farmer would have been about 100 kg per month. At farm gate prices ranging from 300 to 400 TZS/kg (0.19-0.25 USD/kg) this quantity of production would have generated monthly gross seaweed income per farmer of about 19-25 USD per month. The bulk of such income went to farmers' labor but some farmers incurred costs of planting material, transport and other operating costs.

2.2.2 Exporters

At the time of writing companies believed to have exported spinosum seaweed from Zanzibar (and their buyers) were as shown in Table 2.2.

Table 2.2. Companies believed to have exported spinosum seaweed from Zanzibar.

Company	Markets
Major traders	
Birr	Exporting to China & Spain (Hispanagar) since 2006
C-Weed Corp	Exporting to France (Degussa) & USA (FMC) since 2006; ceased exporting to China after 2006; exporting to Denmark (CP Kelco) since 2008; Chile and CEAMSA since 2010
Kai Trading	Exporting to China (2006 – 2011); exporting to Malaysia & Vietnam since 2011
SM Rashid	Exporting to Vietnam since 2009; exported to China & Malaysia in 2009 – 2010
Zanea	Exporting to Spain (CEAMSA – taken over Hispanagar activities) since 2011; exporting to Denmark (CP Kelco) from 2006; exported to USA (FMC) 2008 – 2009
Zanque	Exporting to USA (FMC) since 2006
Zanshells	Exporting to China since 2006; exporting to Vietnam since 2007
Zascol	Exported to USA (FMC) from 2006 – 2010
Minor traders	
Agrotex Ltd	Ceased exporting to China after 2006
Frelling General	Exported to Vietnam in 2010
Gem Sea Co.	Exporting to China since 2011
Inter Link	Exporting to France (Degussa) since 2011
Mwalim Mussa	Exporting to Vietnam since 2011
Mwani Shipping	Exporting to Vietnam since
Saleh Salim Ali	Exporting to China & Vietnam since 2011

2.2.3. International buyers

Information current at the time of writing suggested that virtually all spinosum from Zanzibar since the beginning of commercial cultivation was ultimately purchased by companies that used it as raw material for the manufacture of refined, alcohol precipitated iota carrageenan (E407). This carrageenan was sold primarily to dentifrice and food ingredients markets. The annual market is on the order of 5 500 tons per annum.

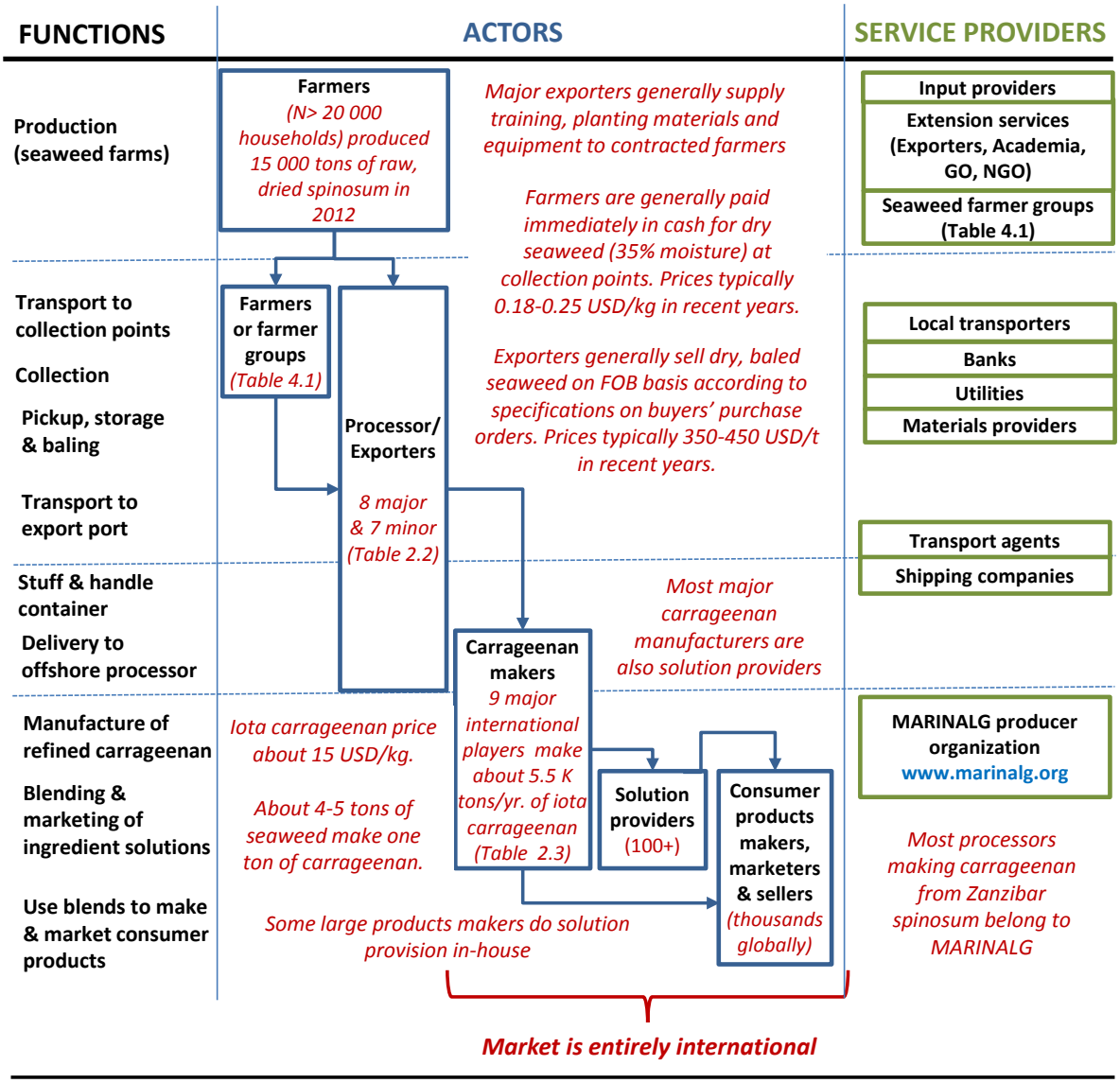
Table 2.3. Known world producers of refined, alcohol-precipitated iota carrageenan (E407) from spinosum. These were the users of Zanzibar spinosum

Country	Company	T/yr capacity
Chile	Gelymar	1 000
China	Unknown	
Denmark	CP Kelco	4 000
France	Cargill (ex-Degussa)	4 500
Japan	Mitsubishi	1 250
Korea	MSC Co. Ltd.	1 500
Philippines	Shemberg Biotech	1 200
Spain	CEAMSA (incl. Hispanagar)	1 750
USA	FMC	6 000
Total		**21 200**

2.3 Value chain map

The Zanzibar spinosum seaweed business had a simple value-chain flow as illustrated in Fig. 2.2. The map in Fig. 2.2 was prepared based on desk research and experience gained with seaweed value chains in other areas. It was corrected and verified based on research conducted during the present study.

Figure 2.2. Map of the value chain for spinosum farmed in Zanzibar, then exported through Zanzibar Port. (Format from UNIDO, 2011). Overlay notes in red italic font.



Various functions relevant to the Zanzibar value chain are listed on the left side of Fig. 2.2. These include not only value chain steps undertaken in Zanzibar but also steps that pass through processing of spinosum seaweed into carrageenan, sale of carrageenan blends and manufacture/marketing/sale of consumer products from the blends. In future all value adding steps may occur in Zanzibar as the seaweed industry develops.

A small range of actors is involved in Zanzibar spinosum seaweed value chains. Overlay notes on the map indicate how some actors can cover more than one function. For example processors/exporters are commonly involved in functions extending all the way from picking up seaweed at farms to stuffing and handling export containers and many carrageenan makers are also solution providers.

Arrows in the map represent the flow of products from one actor to the next. Overlay notes include information on types of contractual arrangements. Arrows indicate market channels, with end-markets at the end of the map. Generic categories of support services are indicated on the right side of the map including extension services, financial services, transport, materials, etc. Data overlays indicate information that is available, relevant and helpful for the chain analysis and they make reference to specific content in the report.

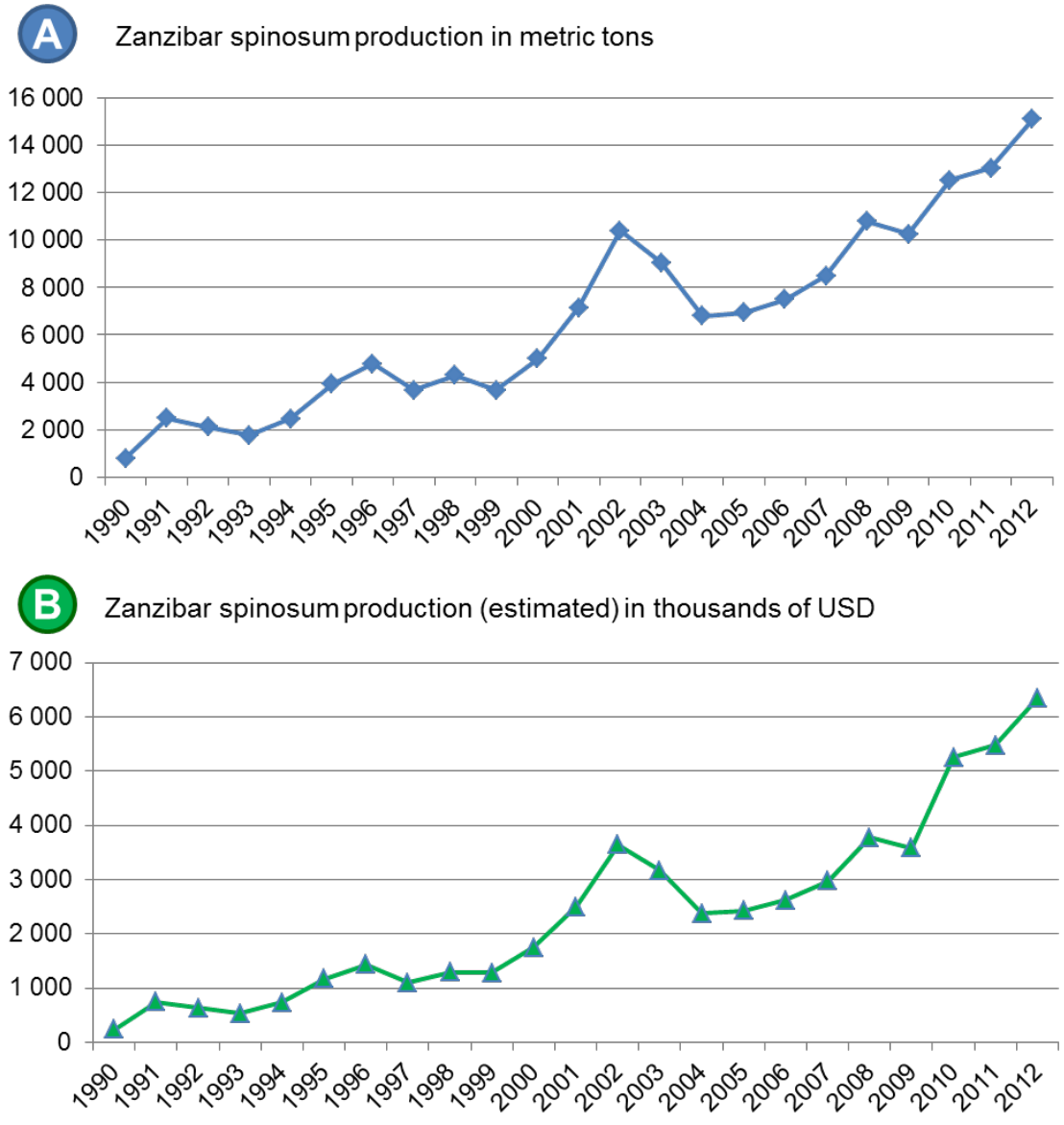
3. Seaweed production

3.1 Production and seasonality

3.1.1 Production

From 1990 until 2012 Zanzibar spinosum seaweed production grew from about 800 t/yr. to more than 15 000 t/yr. (Fig. 3.1.A). Almost all Zanzibar seaweed production is of the genus Eucheuma (spinosum of the trade). Between 1991 and 2000 production increased to about 4000 tons and it rose to 7000-8000 tons during 2001-2007. From 2008 production has been going up steadily (Fig 3.1.A).

Figure 3.1. A. Seaweed production in Zanzibar, 1990 – 2012. (Sources: MLF-DMR, C-Weed Corp., Satoumi.co own data). B. Total estimated values in K USD. Values grew from about 240 K USD in 1990 to 6.4 M USD in 2012.



Cottonii and spinosum were produced and recorded together from 1989 to 2000 because there was no price difference then. However, from the year 2001 the two species were recorded separately. Spinosum production has increased over the years but cottonii has been plagued by repetitive crop failures since 2001. It has been hypothesized that this was due to changes in environmental conditions (e.g. increased seawater surface temperatures in shallow intertidal areas) believed to be associated with climate change (Msuya, *pers. comm*). During 2012 total Zanzibar cottonii production was only about ninety tons (MLF-DMR data). Reliable export value figures were unavailable at the time of writing of the present report but based on interview responses and industry intelligence (e.g. Bixler & Porse, 2010 and raw trade data) it was estimated that approximate FOB export values in were 300, 350 and 420 USD/t for 1990-1998, 1999-2009 and 2010-2012, respectively

3.1.2 Seasonality

The heat of summer (corresponding to the northern hemisphere winter) is often cooled by strong sea breezes associated with the northeast monsoon (known as Kaskazi in Kiswahili), particularly on the north and east coasts. Zanzibar is near the equator so the islands are warm year round. Short rains occur in November but are characterised by brief showers. Longer rains normally occur in March, April, and May in association with the southeast monsoons (known locally as Kusi in Kiswahili). Seaweed growth is known to be lowest during the hotter months (December-February, temperatures 30-32 °C, specific growth rate [SGR] of 3-4%/day) and highest during the cooler months (June-August, temperatures 26-27 ^{o}C, SGR 9-11%/day) (Msuya et al. 2012, Msuya and Salum 2012). Interestingly, the authors found low growth rates in November a month associated with short rains and cooler temperatures than December, in both studies.

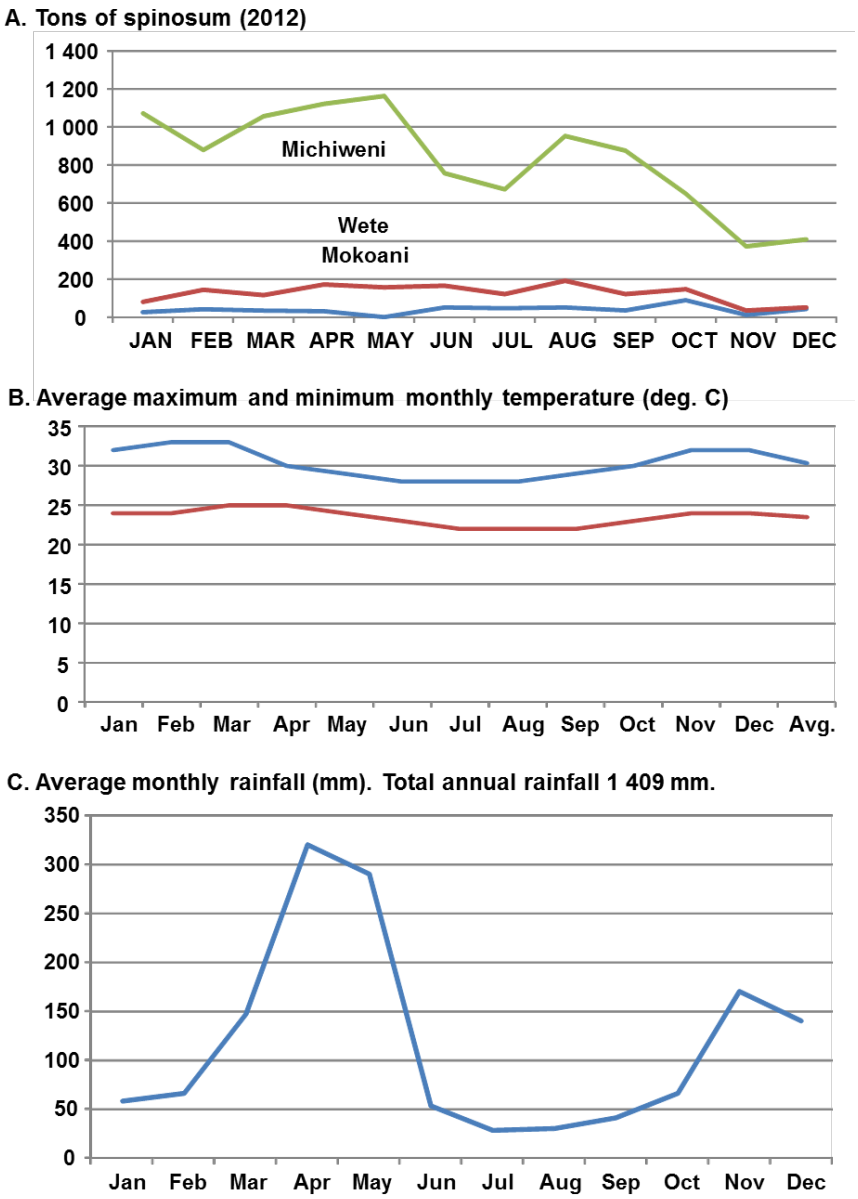
3.1.3 Tides

Zanzibar has asymmetric diurnal tides so there are two high tides and two low tides of unequal magnitude per day (Fig. 3.3). Most Zanzibar seaweed farms utilize the off-bottom cultivation method (lines suspended from wooded stakes driven into the sea floor). They can only be tended by farmers when the lowest tides occur during daylight hours. This means that farmers can tend their crops for periods of about one week, twice per month. About half the time they cannot tend their farms. Reef flats can be very wide in Zanzibar so much effort is expended walking to and from farms, often carrying heavy loads.

3.2 Role of seaweed production in household economics

The importance of the industry to in household economics has been documented and described in Msuya (2013). Income from seaweed farming has allowed farmers to improve their standards of living in several ways. It has enabled them to send children to school, improve their houses, and purchase high quality foods. Probably one of the most notable aspects of seaweed value chains is the earning power acquired by female farmers who make up between as much as 90 percent of the workforce.

Figure 3.2. A. 2012 spinosum production from regions of Pemba (MLR data) are shown against **B.** average monthly temperature values and **C.** average monthly rainfall (from Weatherbase)



3.3 Current production systems

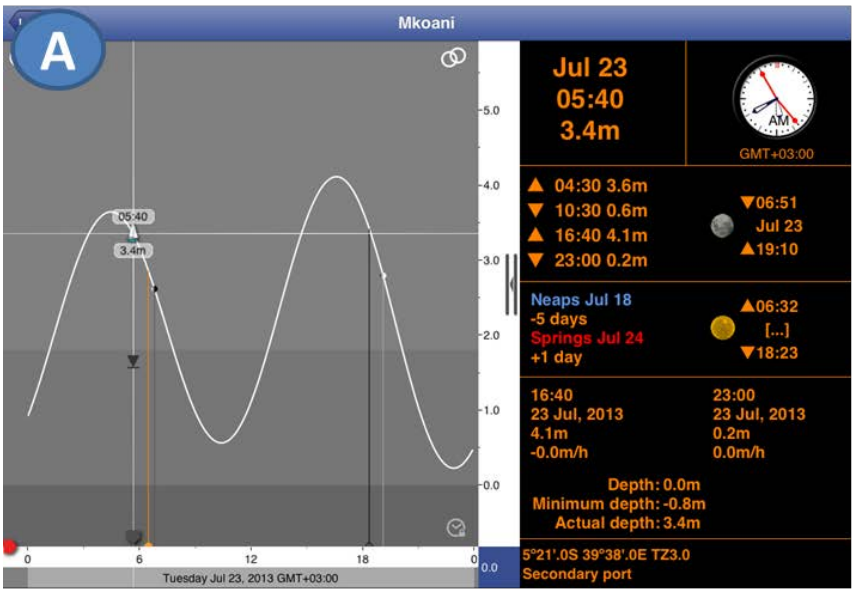
Seaweeds in Tanzania are farmed using primarily the peg and line (off-bottom) method (Plate 3.1). Some farmers use 4-m long lines with one peg at each end while other farmers use from 10- to 20-m long lines with buoys and one peg at each end as well. Nylon ropes with seaweed cuttings are tied to ropes that are suspended from wooden pegs obtained from mangroves or land-based plants. The pegs are driven into the sea floor, which is typically limestone.

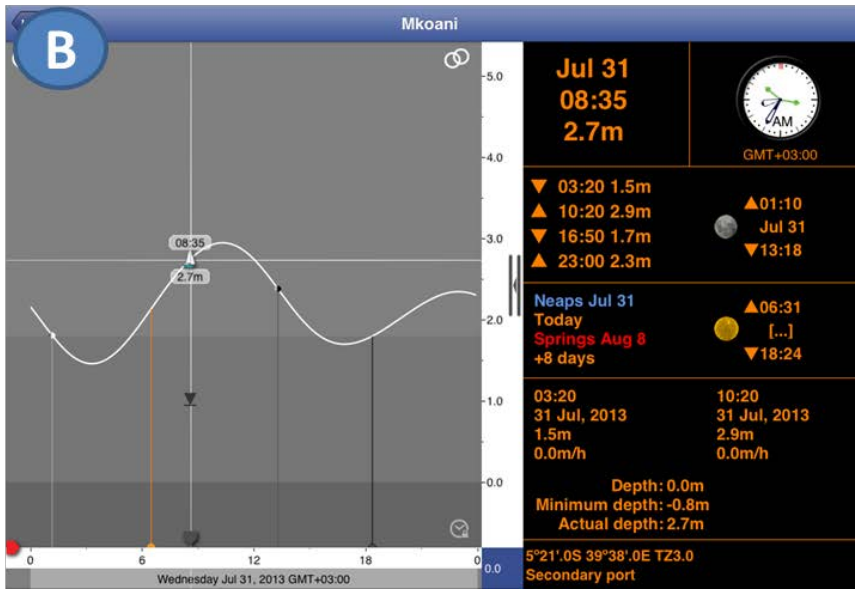
Cuttings (a.k.a. “propagules” or “seed”) are typically vegetative clones from cultivars initially imported from the Philippines. Cuttings biomass is sourced from exporters, from other farmers or from buyers. In addition to cuttings biomass buyers also provide materials (ropes and tie-ties) to the growers, who contract to sell seaweed to the buyer if materials were

provided free of charge. Arrangements are described further in Section 6. See Msuya 2013; Msuya *in prep.* for more details concerning farming methods.

Spinosum seaweed process flow characteristic of current Zanzibar spinosum seaweed markets is shown in Fig. 3.4. Current practice is compared to potential future options in Section 4.

Figure 3.3. In Zanzibar seaweed farmers' work schedules are dictated by the tides, which can have amplitude of as much as 4.6 meters. Some examples are **A.** The 3.4 m daytime tide of 23 July in Pemba was sufficient for farmers to be able to work their farms. **B.** The 2.7 m tide of 31 July prevented farmers from tending their crops during daylight hours in Pemba.



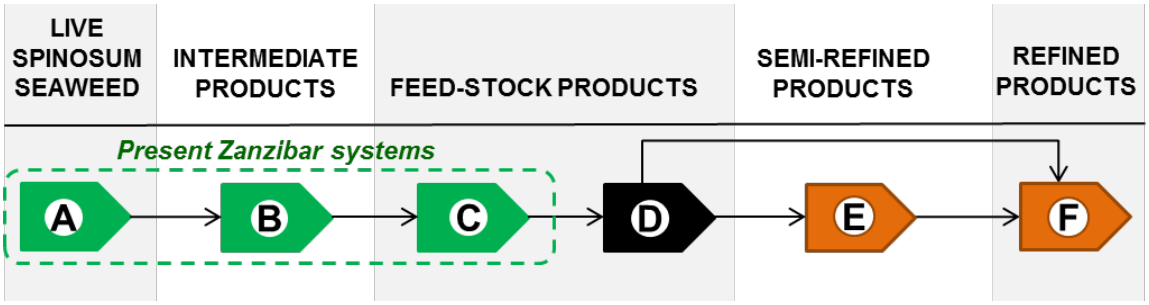


3.3.1 Tenure

Entry to seaweed farming is unrestricted. Any inhabitant from a coastal village can establish a farming location wherever space is available. As long as this person continues to farm its selected space, the area will belong to that person. Protection of property is based purely on "rural modesty" (Msuya 1996, 2010), whereby farmers protect each other's farming areas against any external intruder.

People usually farm near to areas where they live and a villager can grant a farming space to a fellow villager from the same village/area. For villagers from other areas, entry is achieved simply by requesting space from local farmers. No licenses or purchase of land are involved in seaweed farming.

Figure 3.4. Spinosum seaweed process flow characteristic of current Zanzibar spinosum seaweed markets. Only the first three steps (A, B & C) currently take place in Zanzibar. Further steps take place at the factories of regions that import Zanzibar seaweeds.



#	SYSTEMS	ACTIONS	PRODUCTS
		PRESENT ZANZIBAR SYSTEMS	
A	Seaweed agronomy	Plant and grow seaweeds in agronomy systems that include nursery, grow-out and logistics sub-systems	Fresh spinosum seaweed (FS)
B	Whole seaweed drying	Live spinosum sun dried on appropriate surfaces and bagged for sale	Raw-dried seaweed (RDS) – farm gate
C	Logistics & baling	Sacked seaweeds picked up from farmers, moved to warehouse, cleaned, re-dried, baled, moved to port and shipped	Raw-dried seaweed (RDS) – export grade
		OLD CARRAGEENAN TECHNOLOGY OF CURRENT PROCESSORS	
D	ATC plant	Seaweed is treated with alkali to stabilize & modify the carrageenan then is dried & packed for sale	Alkali-treated chips – iota (ATC-I)
E	SRC plant	ATC or ATP is sanitized, treated, further-dried, milled, blended to specifications & packed for sale	Semi-refined carrageenan – iota (SRC-I)
F	RC plant	Acid insoluble matter (AIM) removed from ATC/ATP; dried, milled, blended & packed to specifications	Refined iota carrageenan (RC-I)

Plate 3.1. A. Off-bottom method: 4-m long lines with two pegs at each end. Uroa, Zanzibar. **B.** Underwater of spinosum flourishing on a Micheweni, Pemba seaweed farm. **C. Closer look at a frond of spinosum. D.** A farmer attaching cuttings to a line prior to planting in an off-bottom system. **E.** Fishermen scavenge unattached spinosum that has broken away from farms and grows on tide flats at Micheweni. **F.** The UNIDO team meeting with farmers at Kangani, Pemba.

3.4 Harvesting, transport and post-harvest handling

Seaweed is harvested after 4 to 6 weeks depending on the growth rates at the farming site. Harvesting involves untying the lines from the anchorage pegs and then removing the seaweed. This is followed by selecting new branches from the harvest as re-planting material, and tying the lines back to the pegs. The tying-in of new branches can be performed at the farming site by sitting in shallow water or at home following daytime activities at sea. The remaining portion of the harvest is taken home for drying and selling. Farmers dry the seaweed by spreading it on various surfaces (Plate 3.3). Seaweed takes from two to three days to dry on sunny weather, but drying may take up to seven days on rainy seasons. Upon drying, seaweed is sorted and shaken to remove dirtiness and sand. It is then stored at home or sold directly depending on the harvest volume.

Transport of seaweed from farm sites to drying sites is affected by several methods (Plate 3.2). Farmers may transport harvested seaweeds using their own assets and labor or they may pay others amounts ranging from 2000 – 4000 TZS per harvest or pay for a boat/canoe/ox kart at 5000 – 7000 TZS per trip (40 bags of 25 kg) depending on the distance, to transport the seaweed for them.

Farmers generally deliver their dried crop to exporters' collection stations that are located near to drying areas or collectors may pick up seaweeds from farmers. Collected seaweeds are transported to exporters' warehouses for sorting, re-drying, cleaning and baling as needed to meet specifications in buyers' purchase orders (Plate 3.4)

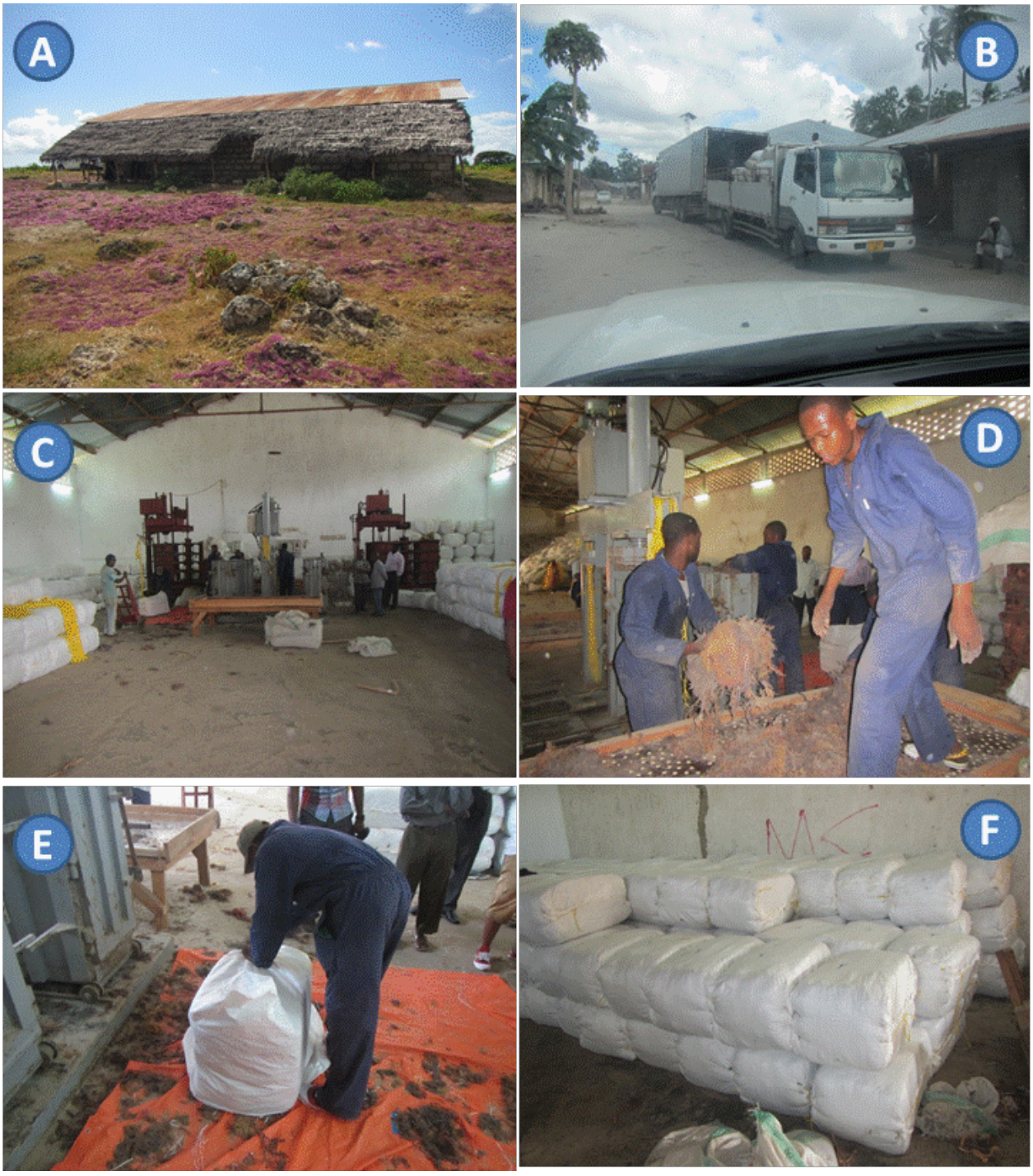
3.5 Productivity

Data cited by Msuya (2013) indicated that production of Zanzibar farms based on 2002-2005 data was 12.277 ± 3.2 tons/ha/yr. This was higher than the 8.5 tons/ha/yr. previously estimated for Zanzibar and was lower than the theoretical potential of 15–25 tons/ha/yr. It was a productivity level comparable to estimates from the Philippines and Indonesia. Msuya (in prep) reported that one set of scientific studies in Tanzania showed that seaweed cultivated in the deep water floating lines systems had specific growth rates (SGR) ranging from 6-24% per day while in the off-bottom method the seaweed grew at 4-9% per day . Another study showed that seaweed in the floating lines system grew at an SGR of 6-15 % per day while the growth in the off-bottom methods was 2.4 – 5.4 % per day. These results confirmed subjective observations during the present study indicating that spinosum flourishes in Zanzibar waters.

Plate 3.2. Harvested seaweed being transported from farm sites to drying areas on shore (Kangani, Pemba, July, 2013). With maximum tides of almost 5 meters and wide tide flats farms may be two or more kilometers from shore. **A.** Porting seaweed manually. **B.** Ox carts are also used to transport seaweed. **C.** Some farmers deliver their harvest to motor-sailing cargo boat. **D.** Other farmers wait for the tide to carry their canoes to shore.

Plate 3.3. Farmers sun-dry spinosum to 35% average moisture content (MC) before selling it to exporters. A. Drying seaweed in the dirt is a method frowned on by buyers but this practice still occurs. B. Most farmers dry their seaweed on grass. C. Some farmers dry their seaweed on purpose-built rock beds. D. In some areas drying platforms were built but farmers did not use them. Here they are being used to store boats. E. Hanging seaweed from racks leads to rapid, clean drying but the method is seldom used. F. Solar dryers have been tested and were effective at drying seaweed but these have not been adopted for general use.

Plate 3.4. A. Farmers deliver sun-dried spinosum at 35% average moisture content (MC) to exporters' field collection station/warehouses such as this. **B.** Sacks of dried spinosum being loaded for transport to a baling warehouse. **C.** A baling warehouse of C-Weed Corporation at Mkoani, Pemba. **D.** Seaweed is sorted over sieve tables (foreground) before being loaded into the baler (background) and then pressed. **E.** 100 kg bales are sewn into plastic cloth wrapping material. **F.** Bales ready for shipment in twenty-foot containers. 200 bales (20 tons) can fit into one container.



3.6 Production challenges

Some challenges noted during the studies of Msuya (2013; in prep) included:

1. Costs and/or difficulties associated with transporting seaweed from farms to the drying areas;
2. Difficulties with drying seaweed during rainy periods;
3. Low seaweed prices that farmers say is not proportional to the amount of work they put into producing the seaweed;
4. Inadequate market volume for the amount of spinosum that farmers can produce (associated with limited markets for the iota carrageenan that is made from spinosum);
5. Health problems such as backaches, itching eyes, dry skin and other issues related to long exposure under the sun and in the sea;
6. Issues related to family matters such as late preparation of meals, children left without proper care, and general domestic related activities.

4. Seaweed trading and processing

4.1 Collection and trading operations (including profit margins)

Figure 4.1 shows the actions undertaken and costs/revenues generated by an integrated Zanzibar spinosum seaweed exporter using costs typical of 2012. These estimates applied to major exporters that tended to provide farmer assistance within relational market governance systems (Section 6) such as C-Weed Corp., Zanea and Zanque. Such companies accounted for most exports (Section 5)

Figure 4.1. Example showing the estimated schedule of exporters' costs and income for raw, dried spinosum seaweed from Pemba through Zanzibar Port to export markets. This case is for major traders who provide planting materials and CSR projects to farmers. (FOREX 1 600 TZS = 1 USD)

#	ACTIONS	Exporter internal TZS/kg	Toll costs TZS/kg	TZS total /kg	USD total /ton	% of total cost	ASSUMPTIONS
A	Planting materials provided to farmers	4		4	3	0.6	These costs also absorbed into overheads
B	CSR projects in farm communities	4		4	3	0.6	These costs also absorbed into overheads
C	Cost of RDCS at farm gate	400		400	250	64.5	Price paid at near-farm collections stations
D	Procurement cost		12	12	8	1.9	Cost of purchasing, handling & sacking
E	Transport village to warehouse		25	25	16	4.0	Loading, trucking & unloading
F	Process shrinkage	9		9	6	1.4	2% lost as sand & debris
G	Process tolling costs (including overhead)	105		105	65	16.9	Baling costs including overhead at 500 t/mo. production volume
H	Transport warehouse to Pemba port		10	10	6	1.6	Loading, unloading & trucking
I	Sea transport Pemba to Zanzibar Port		21	21	13	3.4	Shipped as bulk cargo in local boats
J	Stuffing & documentation		18	18	11	2.9	Port services and requirements
K	Royalty & wharfage		13	13	8	2.0	Estimated as one percent of purchase cost
	TOTAL COSTS	**522**	**99**	**620**	**388**	**100**	
	Sale price				**450**		**FOB Zanzibar port**
	Gross profit				**65**		

4.2 Organization of supplies and logistics

Since the beginning of seaweed farming in Zanzibar and at least until 2006 major exporters undertook most supply and logistics functions in the value chain. Exporters supplied planting materials and logistic support to farmers. Since 2006, when "free-trade" legislation was passed in Zanzibar, many farmers have undertaken more supply and logistic functions in exchange for the option of selling their crop to the highest bidder. Market structure and governance functions are depicted in Fig. 6.1 and are discussed in more detail in Section 6.

4.3 Small group processing initiatives

In recent years several initiatives have involved seaweed farmers in value-adding initiatives that involved seaweeds (table 4.1). These have tended to focus on producing products such as "seaweed soap" and other seaweed containing personal care products. These products generally contain a small proportion of seaweed in their formulations and they are produced in small volumes so their impact on expanding spinosum seaweed markets has been small. They provided income to people who farm seaweed but their potential to materially expand the volume of the spinosum market is minimal.

Table 4.1. Groups that have undertaken seaweed value addition initiatives in Zanzibar.

Name	**Contact Location**
Zanzibar Seaweed Cluster Initiative (ZaSCI)	
Zanzibar Seaweed Cluster Initiative (ZaSCI-www.secitz.com) is an initiative under the Pan African Competitiveness Forum (PACF), a clusters programme across Africa. ZaSCI is one of the eight pilot cluster initiatives formed in 2005 and started operating in 2006 working in innovative farming and value addition. It operates in a Triple Helix model (academia, government, business) and has more than 3,000 members including farmers, exporters, researchers, and government departments divided across 15 villages. It is one of the 61 cluster initiatives currently operative in Tanzania. PACF is coordinated by Tanzania Commission of Science and Technology (COSTECH) and funded by Sida.	
• Kidoti groups o Tusife Moyo Women Group	Kidoti
o Tusonge Mbele Group	
"Tusife Moyo" Women Group. The name can be translated to "We should not lose heart". This group started in 1992 farming food crops and in 1995 started to make spice soaps and in 2006 it joined the Seaweed Cluster Initiative as the first group. It is also the group that produced and marketed the first seaweed value added product, the seaweed soap in 2008. The group has 20 members, all women. It owns soap productions machines acquired under ZaSCI with help from the SMEs Competitiveness Facility (SCF) and PACF and made by the College of Engineering and Technology (CoET) of UDSM. The group was also the first one to try deep water farming in 2006 but the sea is too rough and also the seaweed did not grow well. A research on deep water farming was also conducted by the Institute of Marine Sciences (IMS) in collaboration with this group in 2010 (see Msuya et al. 2010). Tusife Moyo has a shop selling seaweed value added products whose opening was financially facilitated by PACF, COSTECH, SCF, and IMS. "Tusonge Mbele" Group. The name translates to "We should move forward". The group makes seaweed soap mixed with neem and moringa extracts. It was established in 2008 under ZaSCI; it has 12 members, 11 women and 1 man.	
• Bweleo groups	
o Bado Tupo Bweleo	Bweleo
o Jitegemee	Bweleo
"Bado Tupo Bweleo" translates to "We are still there, Bweleo". It was established in 2009 as a member of the Seaweed Cluster Initiative and has 13 members all women. The activity of the group is to make seaweed soap mixed with lime (citrus), seaweed body creams and food especially seaweed cake and seaweed salad.	

"Jitegemee" translates to "You should be Self Reliant" and has 5 five members, 4 women and 1 man. It was established in 2006 as a member of the Seaweed Cluster Initiative. The group makes seaweed soap mixed with Aloe vera, seaweed massage oils, and seaweed foods of juice and cookies. The "Deep water farmers group" started in 2006 under the Seaweed Cluster Initiative with 15 members all men. The group has been trying to farm seaweed in the deeper waters using the floating lines systems but is facing the challenge of strong winds that break the seaweed. The members are working with the academia part of the triple helix to come out with a solution. In Bweleo the groups own a shop in which they sell seaweed farming (and fishing) materials. The shop was acquired with help from the then government project- Participatory Agricultural Development and Empowerment Project (PADEP).	
• Paje group	
o Furahia Wanawake	Paje
"Furahia Wanawake" is a group of women in Paje which translates to "Be Happy Women" with 33 members, all women. It was founded in 2008 under the Seaweed Cluster initiative. The group makes seaweed soap mixed with lime (citrus) and clove. The group also works with the Seaweed Centre where the members make seaweed soap mixed with various spices as well as seaweed foods (e.g. juice, jam, cake, cookies, and salad).	
• Fujoni group	
o Ulezi Kazi	Fujoni
The group called "Ulezi Kazi" which translates to "Upbringing (of children) is hard work" was formed in 2009 and has 24 members, 16 women and 8 men in Fujoni village. Some members are widows and widowers who find the group a place to make their living. Group members make seaweed jam, cake, and cookies. The group also helpings youths and children who face difficulties in life and in pursuing their studies owing to lack of school fees or who are unemployed. The group was formed as a member of the Seaweed Cluster initiative.	
• Uroa group	
o Sie kwa Sie	Uroa
The name of the group is "Sie kwa Sie" which translates to "us within ourselves", was formed in 2011 and has 11 members, 9 women and 2 men. Group is a member of the Seaweed Cluster initiative and makes seaweed soap mixed with lime (citrus) and clove.	
• Tumeendelea Group	Zanzibar town
This is a group whose members are seaweed processors but not farmers. The name of the group, "Tumeendelea" Group translates to "We have moved forward". It was formed in 2012 with 7 members, 5 women and 2 men as a member of the Seaweed Cluster initiative. Located in Zanzibar town (Muungano area) group members make seaweed products such as soap, body creams, massage oils and foods including juice, cookies and cake.	
Paje Seaweed Centre Society (NGO)	Paje
Paje Seaweed Centre Society is an NGO registered in 2012 with 33 members, all women. It is a shareholder of the Seaweed Centre Company Ltd owning 15%. When women make and sell the products, they get paid a small token money and also get 20% of the sales.	
Seaweed Centre Company Ltd	Paje
Seaweed Centre Company Ltd (www.seaweedcenter.com) is located in Paje village on the East Coast of Zanzibar. It was built through collaboration between Chalmers University of Entrepreneurship in Sweden, Seaweed Cluster initiative, and Zanzibar Adventure School. The Centre has a soap factory, shop for selling seaweed value-added products, a kitchen for cooking seaweed food, a roof top meeting and "restaurant" facility. The Centre also conducts Seaweed Farming Tour where visitors are taken through the process of farming and adding value to seaweed. Paje Seaweed Centre Company Ltd works with the women NGO (Paje Seaweed Centre Society) who make the seaweed products. Seaweed products made at the Centre include seaweed soaps, body creams, spa scrubs, and foods.	

4.4 Potential for process and product innovation

This topic is addressed in the companion document to the present report which is entitled ***Feasibility Assessment for a Zanzibar MUZE Seaweed Processing Facility (ZanMUZE)***(Neish IC, 2013b).

Present Zanzibar seaweed value chains are simple in form. Farmers grow seaweed that gets dried, then is exported to international processors that use the seaweed as raw material for manufacture of carrageenan (Section 3 including Fig. 3.4).

Present Zanzibar seaweed value chains are placed in the context of future VC development options in Figs. 4.3 to 4.5. There are two distinctly different paths to take, namely:

1. **Utilize conventional (old) technology** to make semi-refined iota carrageenan (SRC-I) from raw, dried seaweed (RDS) in Zanzibar-based production facilities;
2. **Employ newly developing multi-stream, zero-effluent (MUZE) technology** that commences processing using live, fresh seaweed (FS) to produce not only SRC-I but also agricultural nutrient products and various products that may be made possible from developing bio-technology.

4.4.1 Conventional (old) SRC technology

A generalized process flow for SRC-I (E407a) is depicted in Fig. 4.2. Some pertinent features of this technology are:

1. Non-carrageenan seaweed components are wasted, with accompanying waste treatment costs.
2. SRC-I is the only value-added product produced unless a wastewater market can be found.

4.4.2 Newly developing multi-stream, zero-effluent (MUZE) technology

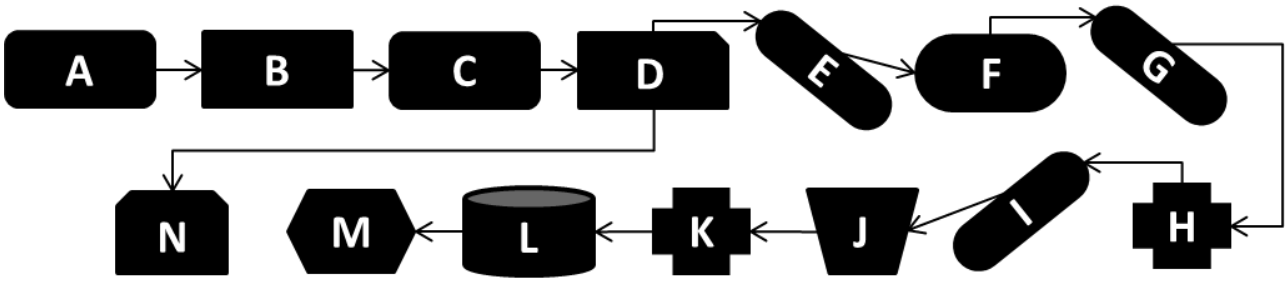
MUZE technology is placed in the context of current Zanzibar seaweed processes and old SRC processes in Fig. 4.3. Fig. 4.4. shows examples of yield & value partitioning for1 000 Kg of live spinosum (see Neish, 2013b for more detail). Some pertinent features of this technology are:

1. By definition MUZE processing produces several value-added products and zero-waste.
2. The pulp from MUZE processing can be used to make SRC-1 as shown in Fig 4.2 or it can be used to produce agricultural nutrient products or chemical feedstock.
3. The juice from MUZE processing can be used as the basis for a variety agricultural nutrient products than can benefit both plants and animals.
4. Agricultural nutrient products have local and regional markets in Africa; not just export markets as in the case of SRC-I.
5. According to the comparison shown in Figure 4.4 total product value derived from 1 000 kg of live spinosum would be on the order of 71 USD for current Zanzibar

processes, 238 USD for old technology SRC processes and 382 USD for MUZE processes. These numbers are estimates but the principle holds true; more value streams and zero waste lead to more added value.

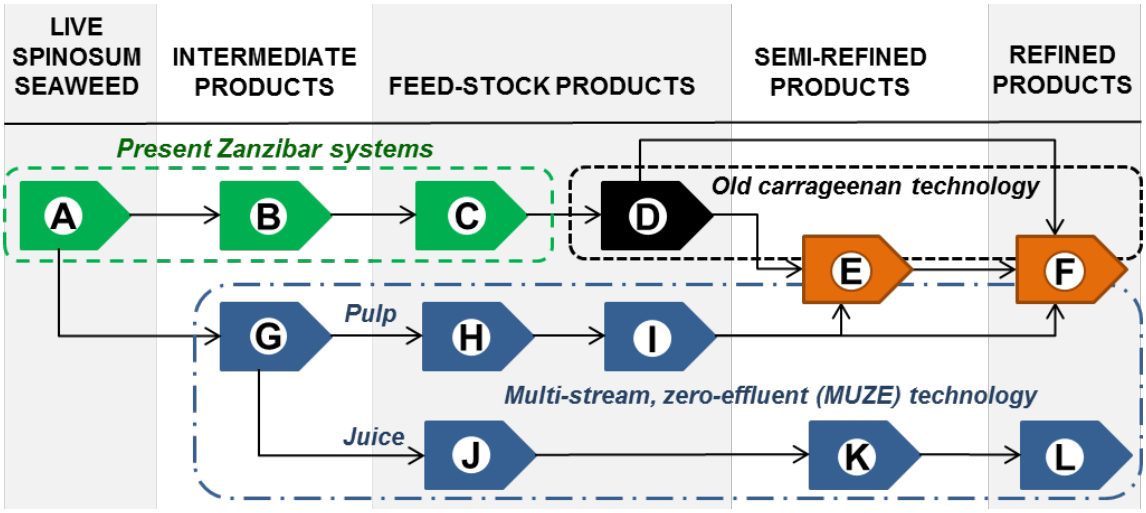
6. MUZE processing lends itself to adaptation to new process technology being developed by the biotechnology industry.

Figure 4.2. Schematic diagram of the conventional process for making semi-refined iota carrageenan (SRC-I).



#	EQUIPMENT	ACTION
A	Pre-wash conveyor	RDS spinosum is pre-washed and conveyed into baskets (uses waste wash water)
B	Cooker & basket	Washed RDS spinosum or spinosum pulp from MUZE processing subjected to alkaline modification in KOH at 60 degrees C for about1 hour
C	Wash tank & basket	Cooking basket dumped into wash basket. Wash in fresh water.
D	Unloading hopper	Wash basket dumped into hopper, gets sorted & dewatered;
E	Conveyor 1	cottonii is conveyed to dryer
F	Fluidized bed dryer	Dry at 60 degrees C
G	Conveyor 2	Lifts dried cott to cutting mill 1
H	Cutting mill	:Chops dried spinosum to ATC-I size
I	Conveyor 3	moves ATC-I to mill feed hopper
J	Mill feed hopper	meters ATC-I into powder mill
K	Powder mill	reduces ATC-I to SRC-I with mesh size required by application
L	Blender	makes pre-blends and final blends
M	Packing system	packs SRC-I in bags for shipment
N	Waste processing	All non-carrageenan seaweed constituents treated & discarded

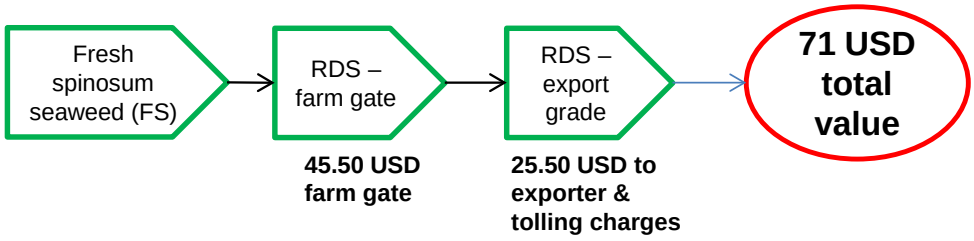
Figure 4.3. Spinosum seaweed process flow options for Zanzibar.



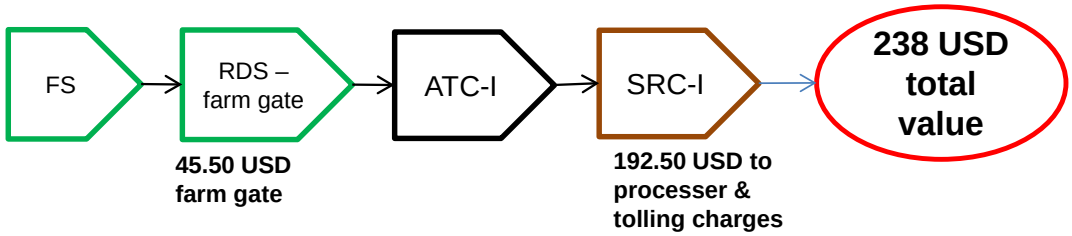
#	SYSTEMS	ACTIONS	PRODUCTS
		PRESENT ZANZIBAR SYSTEMS	
A	Seaweed agronomy	Plant and grow seaweeds in agronomy systems that include nursery, grow-out and logistics sub-systems	Fresh spinosum seaweed (FS)
B	Whole seaweed drying	Live spinosum sun dried on appropriate surfaces and bagged for sale	Raw-dried seaweed (RDS) – farm gate
C	Logistics & baling	Sacked seaweeds picked up from farmers, moved to warehouse, cleaned, re-dried, baled, moved to port and shipped	Raw-dried seaweed (RDS) – export grade
		OLD CARRAGEENAN TECHNOLOGY	
D	ATC plant	Seaweed is treated with alkali to stabilize & modify the carrageenan then is dried & packed for sale	Alkali-treated chips – iota (ATC-I)
		OLD AND/OR MUZE CARRAGEENAN TECHNOLOGY	
E	SRC plant	ATC or ATP is sanitized, treated, further-dried, milled, blended to specifications & packed for sale	Semi-refined carrageenan – iota (SRC-I)
F	RC plant	Acid insoluble matter (AIM) removed from ATC/ATP; dried, milled, blended & packed to specifications	Refined iota carrageenan (RC-I)
		NEW MULTI-STREAM, ZERO-EFFLUENT (MUZE) TECHNOLOGY	
G	Juicing units	Juicing systems mill live seaweed near farm sites then separate juice from pulp	Seaweed juice & pulp
H	Wet pulp	Wet pulp in vessels transported to process plant	Wet seaweed pulp (WSP)
I	ATP plant	Wet pulp is treated with alkali to stabilize & modify the carrageenan then pulp is semi-dried or dried	Dry or semi-dry alkali stabilized pulp (ASP)
J	Raw juice	Raw juice in vessels transported to process plant	Raw seaweed juice (RSJ)
K	Juice concentrate	Juice is concentrated, preserved, blended & packed	Seaweed juice concentrate (SJC)
L	Juice powder	Concentrated seaweed juice (CSJ) is dried to powder, blended & packed for sale	Powdered seaweed juice (PSJ)

Figure 4.4. Example of value generated from 1 000 Kg of live spinosum according to three alternate processing scenarios that are (or may be) utilized in Zanzibar based on assumptions shown in Fig. 6. (Note: FOREX 1 600 TZS = 1 USD; "tolling charges" include transport costs, levies, cost of money and other third-party costs).

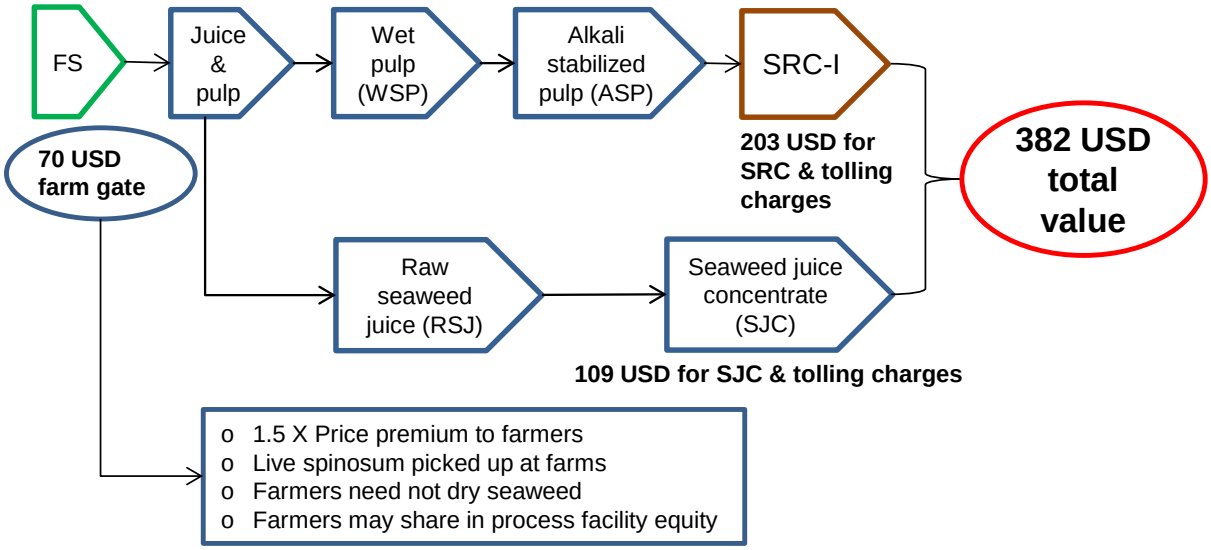
A. Present case in Zanzibar. Raw, dried seaweed sold from farmers through exporters.



B. Old technology case. Semi-refined iota carrageenan (SRC-I) produced in Zanzibar using old technology methods then sold to export markets.



C. New MUZE technology case. Semi-refined iota carrageenan (SRC-I) and agricultural nutrient products produced in Zanzibar using multi-stream, zero-effluent (MUZE) technology then sold to local, regional export markets



5. End markets and trade

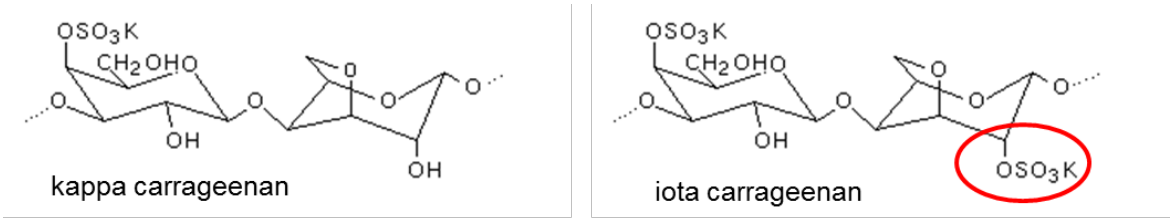
5.1 Commercial arrangements, standards and product characteristics

In the past letters of credit were the common form of commercial arrangement for seaweed purchases but current practice is generally for a buyer to issue purchases orders for a given number of container loads. Purchase orders typically specify the following:

1. Product defined as dried Eucheuma denticulatum (spinosum seaweed of the trade);
2. Price per ton denominated in United States dollars;
3. Price based on 35% average moisture content (MC) and maximum 2% contaminants;
4. Excess or low MC offset by negotiated adjustment of future volume shipped (usually "free" tonnage shipped to offset excess MC in previous shipments);
5. Seaweed packed in wrapped bales of 100 kg weight (20 tons per 20 foot container);
6. Payment on FOB basis within about two seeks from presentation of shipping documents.

At the time of writing Zanzibar seaweed production was almost entirely as dried Eucheuma denticulatum (spinosum seaweed of the trade). Small amounts of Kappaphycus alvarezii (cottonii seaweed of the trade) were produced. Spinosum flourishes in Zanzibar waters but cottonii has experienced repeated die-backs despite more than two decades of attempts to grow it in Zanzibar waters.

Figure 5.1. Structures of kappa and iota carrageenan. The ester sulfate at the 6 position of the 3,6 anhydro galactose unit causes iota carrageenan to perform in a radically different way than kappa carrageenan in food, personal care and industrial applications.



Although cottonii and spinosum have a similar appearance they contain different types of carrageenan. Spinosum contains iota carrageenan and cottonii contains kappa carrageenan. Kappa and iota carrageenans are performance chemicals that are utilized in food, personal care and industrial applications. They behave in radically different ways due to sulfation patterns of the carrageenan molecules (Fig. 5.1). They can have complementary uses but they cannot replace each other.

Iota carrageenan forms soft, elastic gels in the presence of calcium salts. Refined iota carrageenan forms clear gels with no bleeding of liquid (no syneresis). Gels are freeze/thaw stable and can form in the presence of high salt concentrations. Major applications include dentifrice gels (toothpaste), capsules, industrial slurries and food texturization.

Kappa carrageenan forms strong, rigid gels in the presence of potassium salts. Brittle gel forms with calcium salts. The slightly opaque gels become clear with sugar addition. There is some syneresis. Major applications include stabilization of dairy products, gelled pet foods, meat processing and water gels such as jelly desserts and candies.

5.2 Zanzibar's position in global spinosum seaweed markets

The global spinosum market is divided fairly evenly among Tanzania (mainly Zanzibar), Indonesia and the Philippines (Fig. 5.2). Indonesia is the world's major source of carrageenan seaweeds. Indonesia and the Philippines produced over 80% of cottonii and spinosum. Tanzania was the third largest producer but produced mostly spinosum with little cottonii.(Fig. 5.8.).

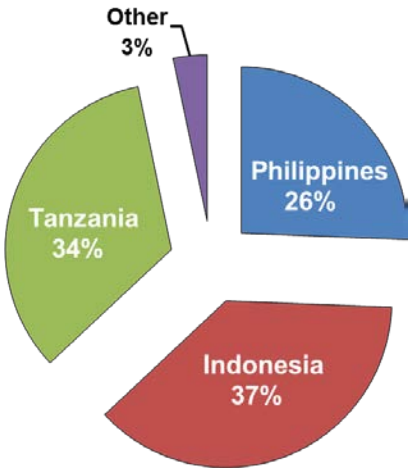


Figure 5.2. Estimated proportion of global spinosum supply from 2006 to 2011. Tanzania productions represented about 1/3 of the total on average. (From Dakay (2010) and own trade data).

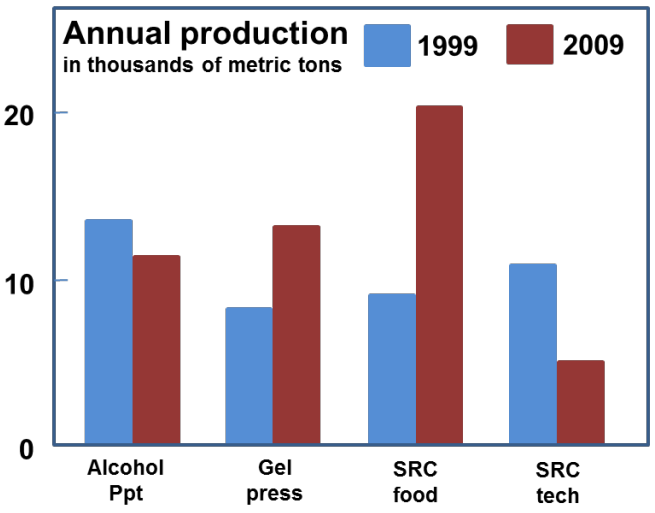


Figure 5.3. Markets moving toward the most cost-effective products. Refined iota carrageenan from spinosum is made only by the alcohol precipitation process. Essentially all Zanzibar spinosum is used as raw material for this market. The iota SRC market is only weakly developed (Bixler & Porse, 2010).

Figure 5.4. World production of seaweeds by major groups 2000 to 2010. Cottonii and spinosum showed a major increase (Neish 2012e after FAO 2012).

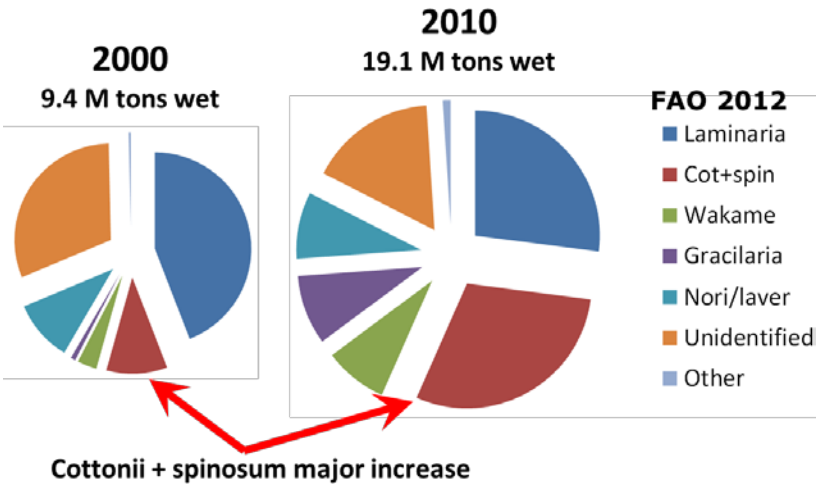


Figure 5.5. Robust revenue growth due to price increases but weak profit growth 1999 to 2009. Alcohol precipitated iota carrageenan was one of the industry's most profitable products. (Bixler & Porse, 2010). Amounts are shown as billions of USD.

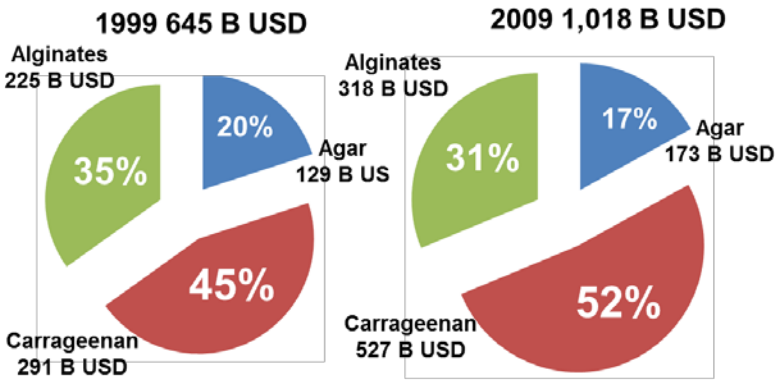


Figure 5.6. Market volume growth in hydrocolloid markets from 1999-2009. Iota carrageenan from spinosum is included in the carrageenan totals. Market growth was sluggish and no new major carrageenan applications were developed. (Bixler & Porse, 2009)

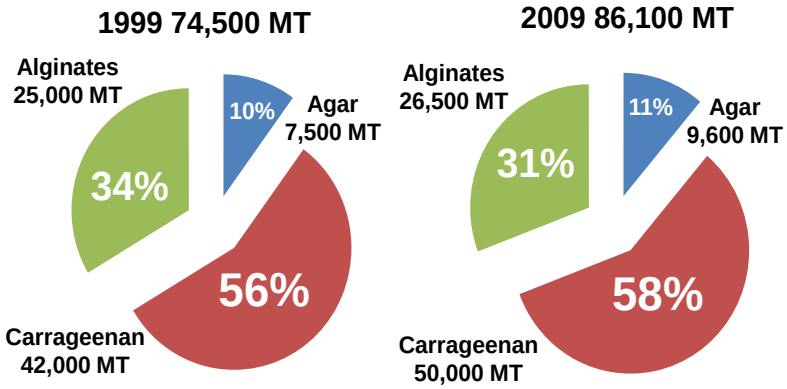


Figure 5.7. Cultivated tropical seaweeds are the dominant carrageenan raw material. Spinosum was about 11-12% of total carrageenan raw material and Tanzania produced about 1/3 of the total. (after Bixler & Porse, 2010)

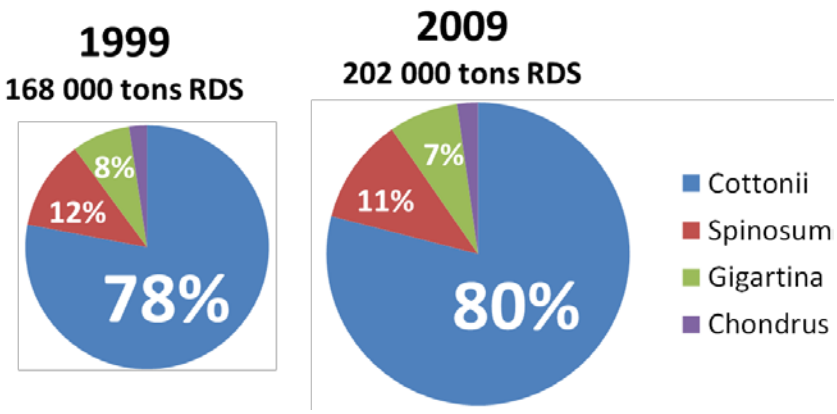
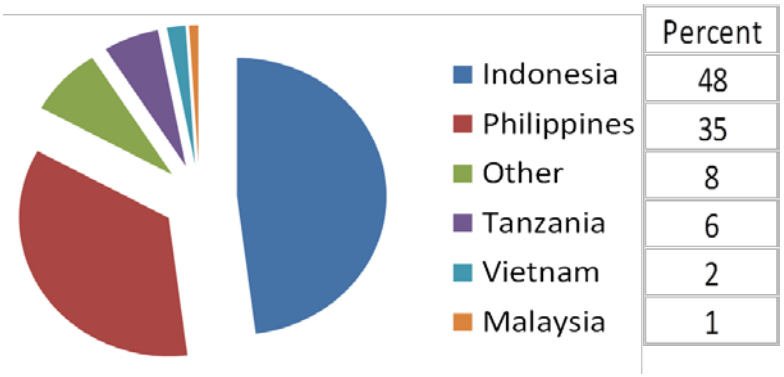


Figure 5.8. Producers of cultivated tropical red seaweeds. Indonesia is the world's major source of carrageenan seaweeds. Indonesia and the Philippines produced over 80% of cottonii and spinosum. Tanzania was the third largest producer but produced mostly spinosum with little cottonii.(after FAO, 2012).

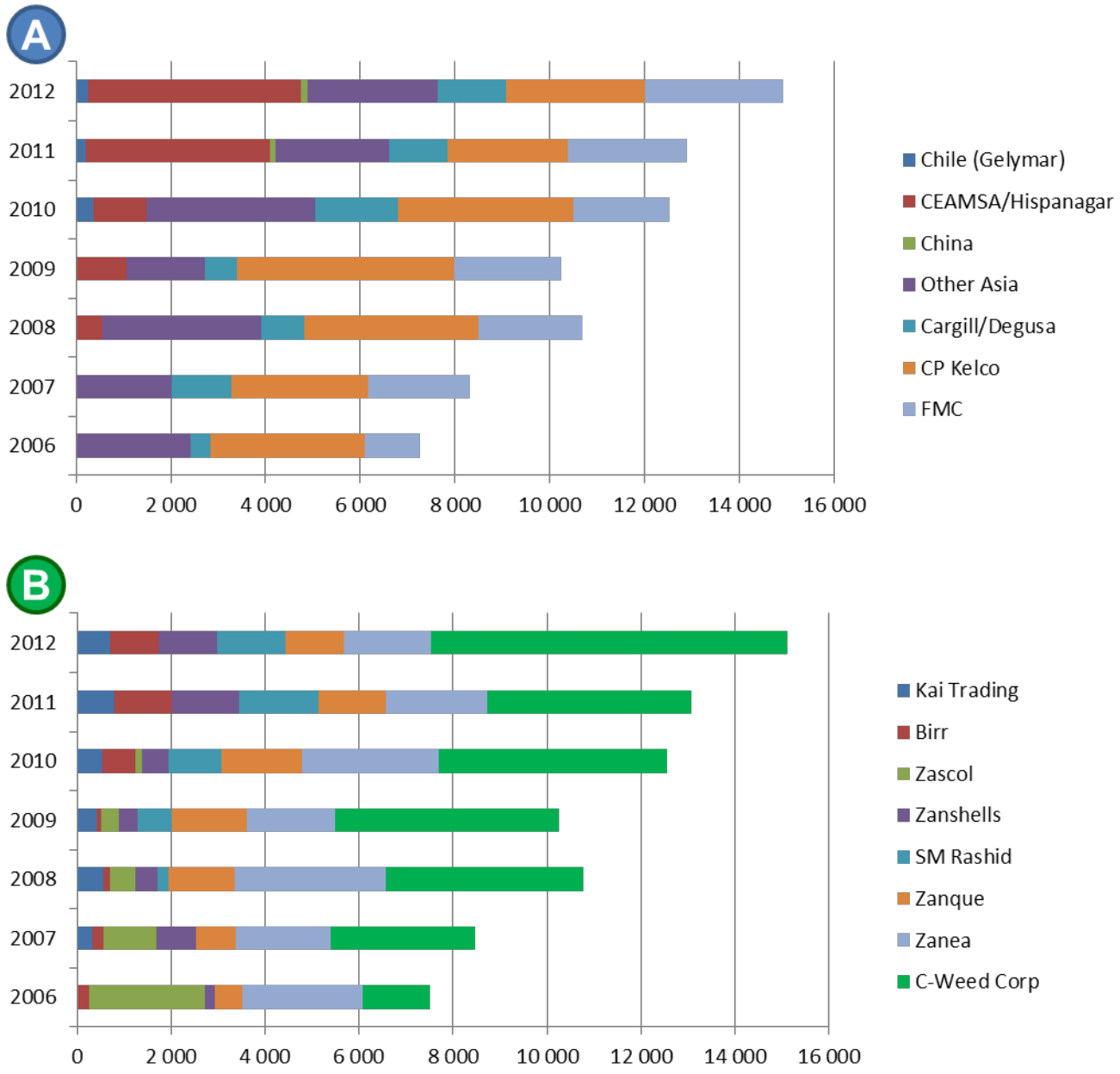


Refined iota carrageenan from spinosum is made only by the alcohol precipitation process. Essentially all Zanzibar spinosum is used as raw material for this market. The iota SRC market is only weakly developed (Fig. 5.3.). During the past decade cottonii and spinosum volumes showed a major increase (Fig. 5.4) Robust revenue growth due to price increases but weak profit growth 1999 to 2009. Alcohol precipitated iota carrageenan was one of the industry's most profitable products. (Fig.5.5). Market growth was sluggish and no new major carrageenan applications were developed. (Fig.5.6). Cultivated tropical seaweeds are the dominant carrageenan raw material. Spinosum was about 11-12% of total carrageenan raw material and Tanzania produced about 1/3 of the total. (Fig.5.7).

5.3 Zanzibar seaweed export sources and destinations

Zanzibar spinosum exports from 2006 until 2012 are shown by exporter and destination in Figure 5.9

Figure 5.9. Seaweed exports from Zanzibar, 2006 – 2012. (Own data). **A.** by export destination. **B.** by exporter.



5.4 Summary of market challenges

1. Since the capacity to produce spinosum exceeds the size of existing markets there was a “buyer’s market” for raw, dried spinosum at the time of writing.
2. The present market for alcohol precipitated iota carrageenan seems to be mature and no major applications have been developed for at least two decades so spinosum seaweed market growth appears to be stagnant.
3. Zanzibar must compete with the Philippines and Indonesia and in doing so it suffers three significant disadvantages:
    a. Except for Europe, Zanzibar shipping costs to markets are comparatively high;
    b. Zanzibar exports are almost entirely spinosum but major buyers buy both cottonii and spinosum and may bundle shipments from Indonesia and Philippines exporters;
    c. There are no domestic processors in Tanzania (including Zanzibar) but farmers in the Philippines and Indonesia can sell to several domestic processors.
4. Expansion of Zanzibar spinosum markets depends on development of new processes to make new products for new markets but there is presently little innovative capacity in place in Zanzibar to undertake such research and development.

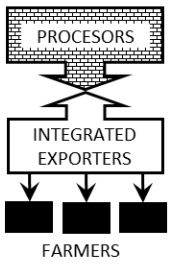
6. VC governance and competitiveness

6.1 Market structure and governance

The project team's perceptions of Zanzibar seaweed value chain structures and governance is summarized in Fig. 6.1. The sector is dominated by nine major carrageenan manufacturers (Table 2.3) most of whom belong to the producer association known as Marinalg International (www.marinalg.org). Each of these negotiates among eight major and seven minor exporters (Table 2.2) with whom they have developed varying degrees of relational capital. They also buy from exporters in Indonesia and the Philippines and play suppliers off against each other in the manner typical of most commodity trading.

Figure 6.1. Market structure and governance in Zanzibar fitted into two development periods. (adapted after Gereffi et al 2005).

A. Before 2006. Exporters developed sites and operated as sole buyer from sites they developed. Modular governance prevailed.



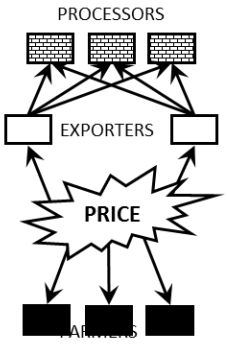
Modular mode

- Processors operated an oligopsony with several buyers buying from several exporters
- Integrated exporters operated monopsonies as exclusive buyers from sites that they developed
- "Modular governance" prevailed with processors collaborating with exporters to determine product specifications and trade rules.
- Farmers received planting materials and other support from exporters and sold their seaweed to those exporters.

B. After 2006. Government regulations decreed "free trade" regulations that permitted any company to purchase seaweed from any site. This resulted in two modes of operation; one where relational governance developed and another where market governance prevailed.

Relational mode

- Processors operated an oligopsony with a few buyers buying from several exporters
- Integrated exporters operated oligopsonies as two or more buyers commenced operation in sites that they developed
- "Relational governance" developed with processors collaborating with exporters to determine product specifications and trade rules for allied farmers and farmer groups.
- Farmers received planting materials and other support from allied exporters and sold their seaweed to allied exporters.



Market mode

- Processors operated an oligopsony with a few buyers buying from several exporters
- Trader- exporters operated oligopsonies as two or more buyers commenced operation in sites that others had developed
- "Market governance" developed with price being the major basis for buyer-seller transactions.
- Farmers purchased their own planting materials and sold their seaweed to the highest bidders.

6.2 Strategic alliances, trust and commitment

During early days of seaweed farm development in Zanzibar strategic alliances were formed between major carrageenan processing companies and aspiring seaweed exporters (e.g. FMC with C-Weed and CP Kelco with Zanea). Until the mid-2000s companies that developed specific areas retained substantial monopsonies that enabled them to recoup development investments. With the advent of free trade" regulations exporting companies had difficulty protecting farm development investments. Development of new farm areas diminished and alliance relationships weakened as processors "played the field" by buying from two or more competing exporters.

There was some chaos in value chains during the first few years of "free trade" because exporters limited planting materials to farmers and relationships fell into some disarray. By 2012, however, some major exporters had forged alliance with farmer groups under value chains typified by relational governance. They resumed provision of planting materials to allied farmers and purchased from allied farmers (albeit in limited quantities and at reduce price) even during time when they had no open purchase orders. Such was the case in Pemba during the time of the present study when one major exporter with no current purchase order was buying up to 500 tons of RDS per month from allied farmers at a price reduced from 400 TZS/kg to 300 TZS/kg.

Farmer groups were working well during high seaweed production period but most of these have disintegrated. Usually there are two types of farmer groups; those that are formed spontaneously by farmers themselves and those that are formed from advice or call from the government and donors. Groups that were formed spontaneously lasted longer than those formed because of a call from an external organ/person.

There were groups formed as a result of a call from the then Department of Fisheries Marine Resources under the MACEMP project mentioned in this report. Most of these groups ceased to exist because the financial help that was to come from MACEMP did not come or the project ended. Even the spontaneous groups that were formed when seaweed production was high have disintegrated more recently because of low production and price of seaweed. However, a new push came with the start of the Zanzibar Seaweed Cluster Initiative (www.secitz.com) which was established in 2005. Farmers started to form new groups involved mainly with value addition but also farming and a number of those have been started and are working well.

Msuya (2013; in prep) has written accounts of farmer group formation and a list of some such groups is shown in Table 6.1.

Table 6.1. Several groups have been formed at the farmer level in Zanzibar including those listed below.

Name	Contact Location
Zanzibar Seaweed Cluster Initiative (ZaSCI)	Institute of Marine Sciences, Zanzibar town
• Kidoti groups	
o Tusife Moyo Women Group	Kidoti
o Tusonge Mbele Group	Kidoti
• Bweleo groups	
o Bado Tupo Bweleo	Bweleo
o Jitegemee	Bweleo
o Deep water farmers group	Bweleo
• Kisakasaka group	
o Mvivu Hendi	Kisakasaka
• Chwaka group	
o Tuwe Pamoja	Chwaka
• Paje group	
o Furahia Wanawake Group	Paje
• Fujoni group	
o Ulezi Kazi”	Fujoni
• Uroa group	
o Sie kwa Sie	Uroa
• Uzi groups	
o Jiunge Ule	Uzi
o Umoja ni Nguvu	Uzi
o Nyota Njema	Uzi
o Youth group	Uzi
• Tumeendelea Group	Zanzibar town-Muungano area
• Pemba Island	
o Tumbe	Tumbe
o Fundo	Fundo
o Maziwa Ng’ombe	Maziwa Ng’ombe
o Wingwi	Wingwi
o Msuka	Msuka
Zanzibar Seaweed Farmers Association-Jumuiya ya Wakulima wa Mwani Zanzibar (JUWAMWAZA)	Zanzibar town
Seaweed Centre Company Ltd	Paje
Paje Seaweed Centre Society	Compan
Socio-Economic Research and Training Association (SERTA)	Zanzibar town

Pemba Seaweed Farmers Association-Jumuiya ya Wakulima wa Mani Pemba (JUWAMPE)	Pemba
The Cooperative and Rural Development Bank (CRDB), Zanzibar Brach	Zanzibar town
SWITCH Responsible Ventures	Zanzibar town
Mr. Juma Omar	DMR, Zanzibar town
Mr. Rajab Ameir	Kizimbani Research Institute
Mr. Makame Machano	SERTA, Zanzibar town
Mr. Ali Hamad	Birr Co., Zanzibar town

6.3 Dominance and market power relationships

Since the capacity to produce spinosum exceeds the size of existing markets there is something of a "buyer's market" for raw, dried spinosum.

Zanzibar seaweed exporters sell to an oligopsony comprising fewer than ten major carrageenan processors (Table 2.4). Also, thanks to "free market" regulations exporters compete with each other and cannot recoup development costs by establishing protected source areas. Major buyers purchase most of their spinosum from Indonesia, the Philippines and Tanzania in roughly equal proportions (Fig. 5.1). Prices are fairly transparent as they can easily be discovered with a few calls or text messages from a mobile phone.

Within countries buyers also gain bargaining leverage by buying from two or more exporters within one country. This is illustrated in Table 2.3 and figure 5.8.

It seems to be true that FOB spinosum prices were somewhat lower on average than FOB prices from Indonesia and the Philippines but prices appeared to be similar on a CNF basis. This results from comparatively high shipping costs from Zanzibar compared to costs from major Philippine and Indonesia ports. Although shipping costs to Europe are similar between Zanzibar and other source areas, shipping costs to China are about 400 USD/container from Indonesia and close to 2 000 USD/container from Zanzibar. Disparities for shipment to South America and the USA are even larger.

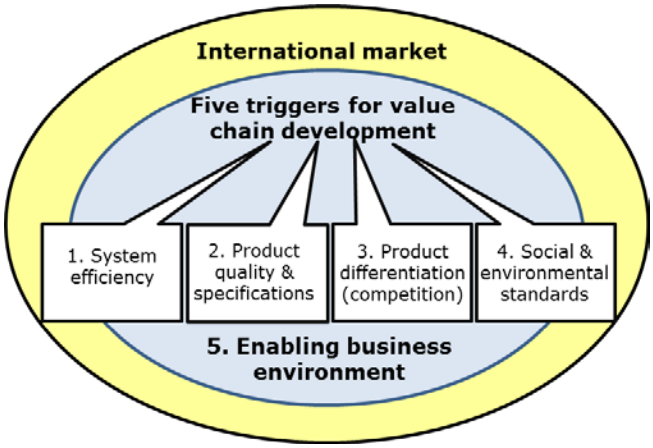
6.4 Participation in and distribution of value addition

Figure 4.1 provides an example showing the estimated schedule of exporter costs and income for raw, dried spinosum seaweed from Pemba through Zanzibar Port to export markets. Farmers purchase planting materials themselves or obtain them from exporters. They then invest their labor and/or hire labor to produce raw, dried seaweed. Exporters buy that seaweed at collecting stations and take it from there.

6.5 Value chain competitiveness (5 triggers SWOT analysis)

Value Chain Development is an improvement of cooperation between stakeholders of a particular sector and the coordination of their activities along different levels of a value chain with regard to the “five triggers” shown in Fig. 6.2.

Figure 6.2. Five triggers for value chain development. The ultimate goal is to increase the competitiveness of a sector in the international market.



To reach consumers seaweed enterprises must go through other market system stakeholders. Using the five triggers as a framework helps to identify opportunities and constraints to making the local target sector more competitive and integrate it more effectively into value chains and markets. The five triggers (Fig. 6.2) are:

1. **System efficiency** Access to information and knowledge, delivery time and reliability, flexibility, communication between value chain stakeholders and embedded business and customer services.

2. **Product quality & specifications** Product design and quality, price and costs (value addition), market and buyer requirements, consumer trends, product presentation (packaging & advertisement).

3. **Product differentiation (competition)** Main competitors, price and cost comparison, local competitive advantage/disadvantage, research & development, buyers' appraisal of different (competing) suppliers.

4. **Social and environmental standards including labour practices** Labour standards and wages (and other labour costs), gender equality, workplace security, motivation of workers, training and skills, organisation, self-employment.

5. **Enabling Business environment** Business support services, availability and capacity of SME organisations, legal and regulatory framework.

Table 6.3. Preliminary 5-triggers/SWOT analysis of the Zanzibar seaweed value chain situation based on findings of the present study and previous studies by Msuya. More comprehensive analyses should be based on interviews and focus group findings.

<table>
<tr><th colspan="2">1. SWOT Analysis</th><th>2. Value Chain Triggers</th></tr>
<tr><td>1.1 Strengths
Spinosum grows very well
Production costs lowest in industry
Stable and favorable “peace and order” situation
Large human resources base
Seaweed industry has high priority with government</td><td>1.2 Weaknesses
Cottonii has not been produced successfully in large volume
Current buyer’s market
Supply exceeds demand
Limited current capacity for developing & implementing value adding capacity
Distance from major markets
Weak infrastructure for factory facilities</td><td>2.1 System:
Zanzibar has robust systems for bringing raw, dried seaweed to market. Major exporters are financially strong and eager to expand into value addition. Government is supportive and has seaweed as a high priority.</td></tr>
<tr><td colspan="2" rowspan="2"></td><td>2.2 Product quality/specification:
Zanzibar produces spinosum of excellent quality and at very competitive costs. It provides an attractive basis for value addition.</td></tr>
<tr><td>1.3 Opportunities
Large areas available for farm expansion
Close to potential agricultural nutrient markets
Political and business environment favorable for joint venture development with global technology and market players</td><td>1.4 Threats
Possible spinosum crop failures similar to those encountered with cottonii
Displacement of seaweed farming and competition for human resources by tourist industry</td><td>2.3 Product differentiation (competition):
Current production is not differentiated at all from competitors in Indonesia and the Philippines. For differentiation to occur there must be innovative value addition that aims new products at new markets.</td></tr>
<tr><td colspan="2">3. Market requirements.
Zanzibar spinosum production meets market requirements for quality and exceeds market demand for volume. Value chain development requires innovative value addition that aims new products at new markets.</td><td>2.4 Social and environmental standards:
Seaweed farming has developed as an important source of cash for people living in poverty – especially for women. Environmentally, seaweed farming is sustainable.</td></tr>
<tr><td colspan="2"></td><td>2.5 Business environment:
Farmers still lack organization that enables farmer groups to operate as enterprise units. Overall, though, there is an excellent business environment for development of value adding capacity.</td></tr>
<tr><td colspan="3">4. Other observations (e.g. surprises) – or main findings:
The Zanzibar seaweed industry occurs within a compact geographical area where there is adequate transport, logistics and communication and developing infrastructure. Private and public elements necessary for the development of value adding facilities are in place. People at the highest levels of business and government are accessible and appear to be willing to work together and also to work with farmers.</td></tr>
</table>

7. Value chain finance

7.1 Financial needs for production, trading and processing

Most funding for seaweed farm development in Zanzibar has been provided by exporting companies; in some cases with support through strategic alliance with major processors. The strongest exporters appear to be well funded with their own capital and they also appear to have strong relationships with banks. It is lack of technology and new products to market - not lack of finance - that seems to be limiting development.

7.2 Sources of funding for farmers

Aside from support by exporters in the form of planting materials, boats and other farm related items, seaweed farmers get support from the government of Zanzibar which provides funding through projects that are based in its departments and ministries. The government has also helped farmers to start farmers' associations for Zanzibar (JUWAMWAZA) and Pemba (JUWAMPE) through which funding opportunities can be channeled. Small credits are obtained through the Savings and Credit Cooperative Societies (SACCOS) and Village Corporate Banks (VICOBA), systems that are formed by farmers purely to be used for financial purposes. Funding may come from the government through projects, NGOs and associations, as well as contributions from members. The Zanzibar Seaweed Cluster Initiative supports the farmers when funding is available through the Pan African Competitiveness Forum cluster programme. In 2004, the Socio-Economic Research and Training Association (SERTA) started a project on better farming practices and value addition in 2012 working with farmers from a few villages. The Institute of Marine Sciences and Commission for Science and Technology helped farmers to attend exhibitions. Seaweed Centre is engaged in farming and value addition in Paje village. ACRA Tanzania has been helping farmers in packaging materials and seaweed soap designs for more than 2 years. RAA Brandenburg – Regional Offices for Education, Integration and Democracy, Brandenburg, German, is an NGO which is stating a project as part of the "Encounters with Zanzibar" project to work with women in one village (Pwani Mchangani) in value addition.

8. Environmental issues & energy use

8.1.1. Environmental issues

Five categories of environmental impact relevant to cottonii and spinosum plantations are:

1. Primary impacts caused by effects of seaplant metabolism and demography;
2. Secondary impacts caused by wastes or other impacts from post-harvest treatment and handling of crops;
3. Collateral impacts caused by activities that are directly related to plantation operation including installation of habitat systems; trampling the sea floor; damage caused by the use of boats and vehicles; processing activities; and effluents;
4. Indirect impacts caused by domiciles, work places and process facilities placed near plantations;
5. Direct processing impacts caused by effluents, solid wastes and other aspects of processing activities.

Negative plantation impacts are most strongly associated with crop production on or very near the sea floor, namely:

1. Disruption of benthic community structure by removal of organisms and cutting of sea grasses.
2. Substrate abrasion and disruption caused by crops coming into contact with the sea floor.
3. Skewing of species composition caused by the introduction of new sets of ecological niches due to the physical presence of seaplants and plantation habitats.

Positive impacts include increases in fish numbers; replacement of destructive activities by farming; and farmers gaining a sense of "stewardship" over coastal areas.

Impacts with either positive or negative effects include changes in primary production; and farms changing the nitrogen regime of the reef community.

At the time of writing seaweed farming in Zanzibar was mostly done using the "off-bottom" method using planted lines suspended from wooden stakes driven into the sea floor on reef flats. This approach does not appear to be causing major damage and seaweed farming seems to co-exist with fisheries activities such as collection of clams, snails and other invertebrates from reef flats.

Most present farm areas are next to wide reef flats so deep water is far from shore. Some areas seem to be amenable to the floating, deeper water systems that predominate in Southeast Asian farming. Preliminary farm trial have indicated that cottonii may grow well in such areas. Four ways of minimizing cottonii and spinosum plantation impacts by using floating systems include:

1. New habitat is created rather than existing benthic habitat being interfered with.
2. Substrate is placed into the water column where nutrients are most available.
3. Benthic communities are left intact. Planting cot+spin on or near the sea floor disrupts natural benthic communities and effects species diversity.
4. Crops can be tended using minimally destructive methods. The use of vessels, rafts and dive gear minimizes trampling of benthic habitats and organisms.

8.1.2. Energy and water use

The energy sector in Zanzibar consists of unreliable electric power, petroleum and petroleum products; it is also supplemented by firewood and its related products. Coal and gas are rarely used for either domestic and industrial purposes but the consumption capacity of petroleum, gas, oil and kerosene is increasing annually as the tourism industry expands.

According to MTIM sources Unguja gets most of its electric power from mainland Tanzania through a 39 kilometer, 100 megawatt submarine cable from Ras Kiromoni (near Dar es Salaam) to Ras Fumba on Unguja. This cable became operational during April, 2013. Since May 2010, Pemba Island has had a 75 kilometer, 25 megawatt, subsea electrical link directly to mainland Tanzania. The project ended years of dependence on unreliable and erratic diesel generation subject to frequent power cuts. Only about 20 percent of the cable's capacity was being used in January 2011, so it is anticipated that the cable will meet the island's needs for 20 to 25 years. Between 70 and 75 percent of the electricity generated is used domestically while less than 20 percent is used industrially.

Energy consumption by the present Zanzibar seaweed industry is almost negligible. Seaweeds are sun dried and most water craft are propelled by wind, poles or paddles. The major energy use is for road and sea transport and electricity used to operate baling machines. If processing plants are built in Zanzibar they will require three phase power on the order of 300-500 KVA each in order to operate cookers, dryers and mills.

The present Zanzibar seaweed industry does not use fresh water except for human consumptions as farmers walk long distances work under the sun. . If processing plants are built in Zanzibar they will require fresh water on the order of thirty cubic meters per factory per day (assuming production of 100 tons of SRC per factory per month). This water requirement would be greatly reduced if MUZE technology is used and water is recycled using waste water evaporation systems. Such systems could be solar assisted to minimize electricity consumption.

9. Business and socio-political contexts

9.1 Product and trade regulations

Seaweed as a product undergoes stages of quality control before it can be exported. Farmers need to dry the seaweed to the required moisture content (less that 35%) and make sure that the seaweed is clean. Exporters do re-checking to make sure that the quality is reached before exporting. To market/export seaweed or seaweed products one has to get approvals and export permits/licenses from the Ministry of Trade, Ministry of Livestock and Fisheries and the Zanzibar Investment Promotion Authority. These steps are regulated under the Fisheries Act No. 8 of 1988 and the Zanzibar Trading Act No. 4 of 1989, Section 17.

9.2 Governance and support from government and academia

Zanzibar government agencies exert legal governance over value chain functions and also provide support to the industry in terms of information, knowledge, training and trade facilitation. Some academic institutions also provide extension support (Table 9.1). The Revolutionary government of Zanzibar (RGZ) is a link between farmers and exporters. It plays roles such as looking for markets, negotiating prices, settling issues related to taxes or revenue, and importation of seaweed strains for cultivation. Sometimes RGZ also provides farming materials to farmers. RGZ encourages farmers to form groups and associations and also start small credit systems such as Savings and Credit Cooperative Societies (SACCOS) and Village Corporate Banks (VICOBA). The Department of Marine Resources Mariculture Section deals with seaweed farming and this is helping seaweed farmers. Formation of Seaweed Farmers Associations for Zanzibar and Pemba (JUWAMWAZA and JUWAMPE respectively) that collect farmers under one umbrella was spearheaded by RGZ. RGZ is finalizing the Fisheries and Marine Resources Policy in which emphasise is put on helping seaweed farmers in various ways. A draft Strategic Plan of the MLF has an objective of reducing poverty and implementing the MDGs. The Development Strategic Plan (SDSP, MNRT 2005) which was produced by the Government of Tanzania is being used by RGZ to promote the production of cottonii geared towards a cottonii production of 500 kg per farmer stipulated in the SDSP. In recent years the government has been engaging in value addition where training has been conducted for farmers and government officials. Research geared toward solving challenges in seaweed value chain is conducted by the Institute of Marine Sciences, Zanzibar Agricultural Research Institute addressing problems of farming (innovative farming), value addition and marketing. A recent initiative is by the Zanzibar Institute of Financial Administration which is working on business related issues including running a business, value addition and marketing. National and international organizations that give help to farmers include Zanzibar Seaweed Cluster Initiative, Zanzibar Adventure School, Seaweed Centre, Socio-Economic Research & Training Association, and ACRA that help farmers in issues related to farming, value addition including packaging, product finishing, and marketing.

Table 9.1. Government and academic organizations that exert governance or provide information and knowledge to seaweed value chain players.

POLICY LEVEL	
Ministry of Livestock and Fisheries	Zanzibar town
Ministry of Labour, Empowerment and Cooperatives	Zanzibar town
Ministry of Trade, Industries and Marketing	Zanzibar town
Zanzibar Investment Promotion Authority	Zanzibar town
Ministry of Agriculture	Zanzibar town
Department of Women and Youths	Zanzibar town
Depute Principal Secretary, Ministry of Livestock and Fisheries	Zanzibar town
RESEARCH LEVEL	
Zanzibar Seaweed Cluster Initiative	Zanzibar town
Institute of Marine Sciences	Zanzibar town
State University of Zanzibar	Zanzibar town
Ministry of Agriculture	Zanzibar town

9.3 Public service provision

In most seaweed-related business in Zanzibar there is provision for a percentage of profit to enhance community development or support community activities including constructing buildings for schools and health centers. RGZ has a role of overseeing that such provisions are put in place when seaweed exporters sign agreements to export seaweed. RGZ also monitors businesses to see that agreed percentages are released to communities. Msuya (2013) gives an example of one seaweed export company, C-Weed Company that provided 5% of what the farmers produced to the Farmers Committee Fund for community development. However, some of these provisions may stop when the business is bad. Regulations also require that exporters employ local villagers as collectors of seaweed and providers of extension services in the areas where they work.

9.4 Social and cultural context

Seaweed farming has changed the lives of the Zanzibar women both socially and culturally. Zanzibari women had very limited chances of getting cash income and they were mostly housewives. With the commencement of seaweed farming, the women “went out’ of their homes to farm seaweed. This was seen as a strange move and husbands were reluctant at the beginning but with time they all saw and accepted the benefits of seaweed farming. The money power of the women which used to cause conflicts with the husbands as was shown at the beginning of seaweed farming (Eklund and Pettersson 1992; Shechambo et al. 1996) no such situations were found in the later studies (e.g. Msuya 2011, 2012, 2013). The new position of the women was welcomed by all communities in Zanzibar and money obtained from seaweed sales is considered a big positive contribution to family economics.

10. Conclusions and recommendations

This report section focuses on major conclusions and on what can be done to develop Zanzibar seaweed value chains from end-to-end. It addresses not only seaweed processing issues that are the main focus of UNIDO but also other activities that are within the purview of other organizations including production, governance, government support and private sector involvement.

1. A quintessential concern is that seaweed production in Zanzibar is unproductive and yields low cash returns relative to seaweed farming in other major producing areas. For example:
    a. A population of estimated at 20-24 K farmers produced about 15 000 tons of spinosum in 2012 therefore average production per farmer was about 100 kg of spinosum per farm unit per month;
    b. At farm gate prices ranging from 300 to 400 TZS/kg (0.19-0.25 USD/kg) this quantity of production generated monthly gross seaweed income per farmer of about 19-25 USD per month;
    c. By contrast, a similar number of farm family units in Indonesia typically produced about 500 kg of cottonii (with a small proportion of spinosum) per month and generated monthly gross seaweed income per farmer of over 400 USD per month (Neish, 2013a).
2. The low unit seaweed price paid to Zanzibar farmers is tied to these facts:
    a. They produce spinosum almost entirely because sustained cottonii production has not happened in Zanzibar;
    b. In world markets cottonii generally fetches a price 3-5 times the price of spinosum;
    c. Although cottonii and spinosum have a similar appearance they contain different types of carrageenan that behave in radically different ways in applications. They can have complementary uses but they cannot replace each other.
3. Aside from an inability to grow cottonii, production issues cited by farmers included:
    a. Costs and difficulties associated with transporting seaweed to drying areas;
    b. Difficulties with drying seaweed during rainy periods;
    c. Inadequate market volume for the amount of spinosum that farmers can produce and associated price issues;
    d. Health problems related to long exposure under the sun and in the sea;
    e. Issues related to family disruption due to work scheduling.
4. Based on experience gained elsewhere the authors conclude that teaching and implementation of improved agronomy protocols (as per planned FAO programs)

can increase spinosum productivity; can possibly enable sustained cottonii production in some areas of Zanzibar; and can alleviate several of the health and social maladies attributed to seaweed farming.

5. Market challenges cited by Zanzibar seaweed value chain actors included:
    a. Since the capacity to produce spinosum exceeds the size of existing markets there was a “buyer’s market” for raw, dried spinosum at the time of writing.
    b. The present market for alcohol precipitated iota carrageenan seems to be mature and no major applications have been developed for at least two decades so spinosum seaweed market growth appears to be stagnant.
    c. Zanzibar must compete with the Philippines and Indonesia and in doing so it suffers three significant disadvantages:
        i. Except for Europe, Zanzibar shipping costs to markets are comparatively high;
        ii. Zanzibar exports are almost entirely spinosum but major buyers buy both cottonii and spinosum from Indonesian and Philippine exporters;
        iii. There are no domestic processors in Tanzania but farmers in the Philippines and Indonesia can sell to several domestic processors.
6. Expansion of Zanzibar spinosum markets depends on development of new processes to grow new crops, and make new products for new markets but there is presently little innovative capacity in place in Zanzibar to undertake such tasks.
7. The Zanzibar spinosum seaweed industry has developed to a point where future market expansion seems unlikely unless the industry goes beyond simply selling raw, dried seaweed to an oligopsony of global alcohol-precipitated carrageenan producers;
8. Although there are complaints about prices (as with most farmers in the world) it seems that even at 300 to 400 TZS/kg there are many seaweed farmers anxious to produce and sell seaweeds beyond current market capacity;
9. The Zanzibar seaweed industry occurs within a compact geographical area where there is adequate transport, logistics and communication and developing infrastructure;
10. Private and public elements necessary for the development of value adding facilities are in place;
11. People at the highest levels of business and government are accessible and appear to be willing to work together and also to work with farmers;
12. The authors recommend that the initiative undertaken by the present UNIDO project should be followed up by joint private/public establishment of a pilot/commercial scale MUZE processing facility capable of producing both semi-refined carrageenan products and agricultural nutrient products. A feasibility assessment of a MUZE facility has been prepared as a companion to the present value chain assessment (Neish, 2013b).

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