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FINAL REPORT

Igniting the Ocean Economy in South Africa: Exploring Seaweed Cultivation and Value Chains for Enterprise Development in the Coastal Communities of the Western Cape

Prepared for:
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EXECUTIVE SUMMARY

Background

About 250 of the more than 12 000 seaweed species worldwide are used or cultivated, providing an option for alternative livelihoods in vulnerable sectors of coastal society. Selected seaweeds have multiple uses as direct human or animal foods, for extraction of valuable compounds that can be used in other industries, for replacement of fossil-fuel derived ingredients, and other ecosystem services. Seaweed aquaculture has been the fastest growing marine production sector for last 20 years.

Interest in seaweeds led to the implementation of the South African Kelp Farming Project funded by the UK International Development via the Foreign, Commonwealth and Development Office (FCDO), implemented by the Bivalve Shellfish Farmers Association of South Africa (BSASA), and supported by the Department of Forestry, Fisheries and the Environment (DFFE).

The United Nations Development Programme (UNDP) is also investigating the potential of seaweed to accelerate the realisation of the Sustainable Development Goals (SDGs) as part of its programme "Igniting the Ocean Economy in South Africa".

The UNDP South Africa, in collaboration with the DFFE, contracted Bio Soluciones Técnicas (Pty) Ltd (BST), an international projects company, to undertake a project entitled "Exploring Seaweed Cultivation and Value Chains for Enterprise Development in the Coastal Communities of Saldanha Bay, St. Helena Bay and Velddrif" in the Western Cape. This is the final project report.

The project aimed to inform the design of future enterprise development programmes to support entrepreneurs in developing seaweed cultivation businesses, by:

- ⇒ Compiling a generic value chain for the local seaweed industry
- ⇒ Engaging with the coastal communities to explore and define seaweed products and value chains
- ⇒ Providing practical introductory training to community members
- ⇒ Documenting local insights into the uses and cultivation of seaweeds.

The main activities undertaken included a market and value chain analysis, community workshops, and the preparation of a final report. The market and value chain analysis included the following activities:

- ⇒ Undertaking a desktop study of relevant published and readily available data and information
- ⇒ Engaging with stakeholders and seaweed specialists
- ⇒ Analysis of the data and information gathered
- ⇒ Preparation of a draft market and value chain analysis report used for the development of training content for the interactive community engagement workshops.

The community workshops included the following activities:

- ⇒ Selection of workshop locations and venues in Saldanha Bay, Velddrif and St Helena Bay
- ⇒ Publicity and invitations
- ⇒ Securing PSSA involvement
 - ◆ An offer of a 2-year PSSA membership to all community workshop delegates
 - ◆ A competition for community workshop delegates, with the prize being sponsorship to attend the next PSSA congress
- ⇒ Conducting three physical community workshops and one virtual stakeholder workshop
- ⇒ Preparation of a community workshop report.

World Seaweed industry

The farming, processing and utilisation of selected seaweeds is increasing among western nations due to multiple benefits for human and animal health and nutrition, agricultural and industrial applications, as well as environmental benefits.

The Food and Agriculture Organization of the United Nations (FAO) indicates that the global seaweed market grew significantly from 10 million t (fresh weight) in 2001 to 36.5 million t in 2022. Five seaweed groups (*Saccharina*, *eucheumatoids*, *Gracilaria*, *Pyropia* and *Undaria*) constitute 95% of seaweed volumes. The market value of farmed seaweed reached USD 17 billion in 2021, and the global seaweed market is conservatively projected to reach USD 28.7 billion by 2030.

The table below illustrates the current, emerging and new opportunity trends for seaweeds.

Market Segment	2024	2025	2026	2027	2028	2029	2030	2030 USD million
Human Food and Beverages								15 653
Phycocolloids	Conventional market applications							1 447
Aquaculture feed								560
Biostimulants								1 876
Animal Feed additives	Short-term markets (before 2025)							1 122
Pet food								1 078
Methane reducing additives								306
Nutraceuticals								3 954
Alternative proteins	Medium-term emerging opportunities (realisable 2024-2028)							448
Bioplastics								733
Fabrics								862
Pharmaceuticals	Long-term emerging opportunities (post-2028)							-
Construction materials								1 396

South African Seaweed Industry

Currently, the most important commercial seaweed species in South Africa include:

- ⇒ Kelps - *Ecklonia maxima*, *Laminaria pallida* and *Macrocystis pyrifera*
- ⇒ *Gracilaria gracilis*
- ⇒ *Gelidium pristoides*
- ⇒ *Porphyra capensis/Pyropia*
- ⇒ *Ulva lacinulata*

⇒ Other *Ulva* spp.

The South African seaweed industry dates back to the 1950's, and has included:

- ⇒ Dried and milled beach cast kelp exported for alginate production
- ⇒ Fresh kelp used as abalone feed
- ⇒ Liquidised kelp used for biostimulants
- ⇒ Dried *Gracilaria* exported for agar extraction
- ⇒ Dried *Gelidium* exported for agar extraction.

The local seaweed industry is based mainly on wild harvested and collected seaweeds; however, substantial quantities of *Ulva* and the red seaweed *Gracilaria* have been grown in land-based systems on abalone farms for more than 20 years. The table below gives an overview of the current South African seaweed production.

Seaweed group	Seaweed name species	Uses and method of production	Estimated biomass use FW equivalent (t p.a.)	Estimated raw market value (ZAR)
Brown	Kelp (<i>E. maxima</i> and <i>L. pallida</i>)	<ul style="list-style-type: none"> • Fresh, for abalone feed and for agricultural liquid plant growth enhancer (harvested) • Dried, milled, graded for local product manufacture and export (collected beach-cast) 	±24 245	56.5 million
Red	<i>Gelidium</i>	<ul style="list-style-type: none"> • Dried, export for agar (hand-picked) 	±124	Not available
	<i>Gracilaria</i>	<ul style="list-style-type: none"> • Fresh, produced in tank systems on abalone farms, for abalone feed 	±600	Not sold, used on-farm
	<i>Porphyra/Pyropia</i>	<ul style="list-style-type: none"> • Dried, crushed, added to food products (hand-picked) • Fresh, used as abalone feed 	Not available	Not available
Green	<i>Ulva lacunculata</i>	<ul style="list-style-type: none"> • Fresh (produced in integrated land-based farm systems with abalone), for abalone feed 	±2 500	Not sold, used on-farm
	<i>Ulva</i>	<ul style="list-style-type: none"> • Dried, added to food products (hand-picked) • Fresh, for abalone feed (harvested) 	Not available	Not available
Minimum estimated biomass (FWE) and raw market value			±27 388	56.5 million

The South African Kelp Farming Project (<https://www.phycologysa.co.za/kelp-farming-project>) which has been running since 2022, has thus far:

- ⇒ Identified nine potentially suitable areas for kelp farming along the west coast of South Africa
- ⇒ Produced a comprehensive kelp market and value chain analysis and roadmap for the expansion and strengthening of the kelp value chain in South Africa to enable the development of an environmentally and financially sustainable kelp farming industry in South Africa.
- ⇒ Refined the hatchery/nursery technologies for *Ecklonia maxima*, *Laminaria pallida* and *Macrocystis pyrifera*
- ⇒ Tried various weaning/grow-out technologies in Saldanha Bay obtaining initial yields similar to that obtained for kelps being farmed profitably in the USA.
- ⇒ Conducted food safety, nutritional and microbial analyses on all 3 species to assist with food safety certification which will determine the commercial potential and market suitability of these species.
- ⇒ Monitored environmental parameters to assess the environmental interactions and benefits that may be associated with kelp farming.

⇒ And have determined which epiphytic species occur on the 3 species that could possibly affect blade quality and ultimately the price when sold.

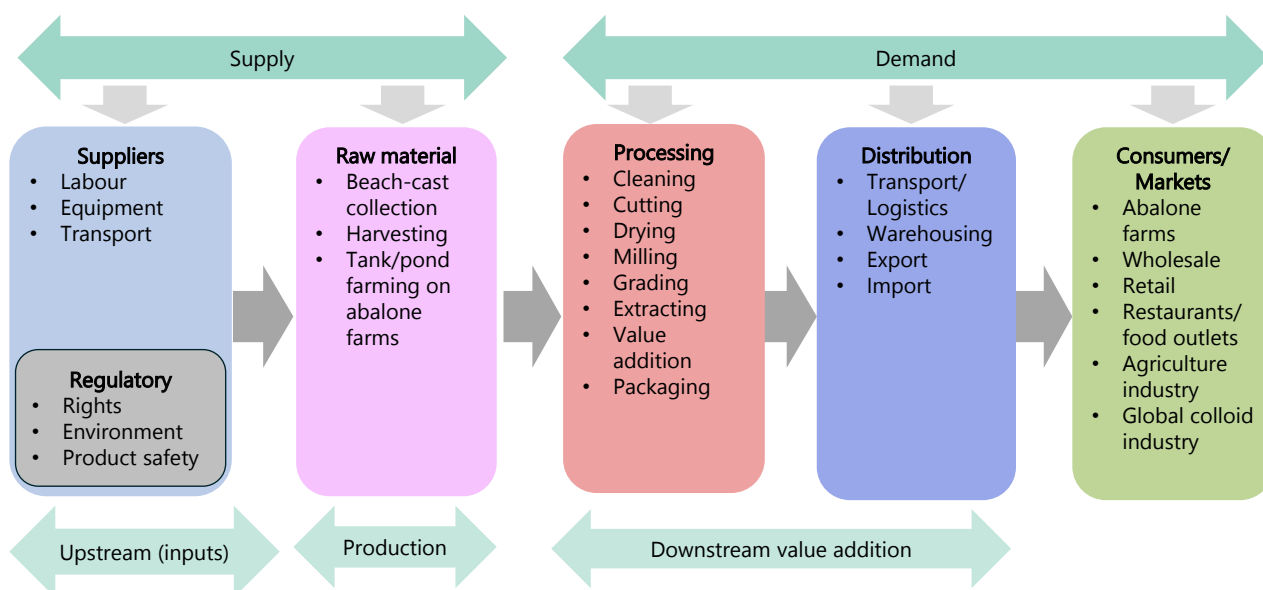
The table below illustrates the potential for seaweed aquaculture in South Africa.

Species	Potential product	South African occurrence	Notes
<i>Gracilaria gracilis/Gracilariopsis longissima</i>	Agar/other chemicals, feed for juvenile abalone, biostimulants, nutraceuticals	South African west coast	At-sea growth trials and on-land cultivation is successful; agar of acceptable quality to Japanese market
<i>Ecklonia maxima and Laminaria pallida</i>	Abalone feed, biostimulants, nutraceuticals, cosmeceuticals, bioplastics, food products alginate, chemicals	South African west coast	Currently tested in laboratory and sea-based growth trials on the west coast
<i>Porphyra/Pyropia</i>	Human food ('nori')	Likely South African species on west coast	Large, profitable industry in East Asia; local species harvested and used in human food products
<i>Ulva</i> spp.	Abalone feed, human food products	West, southwest and southeast coast	This species is already harvested. Current on-land cultivation is successful
<i>Ecklonia radiata</i>	Kelp (many potential uses)	Patchy distribution on south and east coasts	Large-scale cultivation experiments ongoing in Tasmania/New Zealand
Gigartinaceae	Carrageenan (especially λ)	Several species of <i>Gigartina</i> , <i>Sarcothalia</i> , <i>Chondracanthus</i>	Related to Irish Moss (<i>Chondrus crispus</i>) cultivated in N. Atlantic
<i>Pachymenia</i>	Carrageenan	Three species on west coast (including former <i>Aeodes orbitosa</i>)	<i>P. orbitosa</i> has been suggested before as a carrageenophyte
<i>Hypnea</i>	Carrageenan	Harvest of <i>H. spicifera</i> ? Cultivation of smaller species (both south coast)	Previous studies on <i>H. spicifera</i> . Cultivation of other species in e.g. Brazil
<i>Asparagopsis</i> spp.	Cattle feed additive	Both species present, but introduced and currently illegal to cultivate	Rapidly growing industry to prevent methane release (esp. Australia).
<i>Gelidium</i> spp.	Agar	<i>G. pristoides</i> collected from wild: cultivation of <i>G. vittatum</i> , others	Unable to grow <i>Gelidium pristoides</i> , but subtidal species not investigated
<i>Macrocystis pyrifera</i>	Kelp (many potential uses)	Limited distribution on southwest coast	Large-scale cultivation experiments in Namibia & Chile; cultivation experiments ongoing in South Africa

Simplified Current Value Chain

The current seaweed value chain, based mostly on the wild harvesting and collection of seaweed, is illustrated in the figure below. It is based on *E. maxima*, *L. pallida*, *G. pristoides*, *Porphyra/Pyropia* spp., *Ulva* spp. and *G. gracilis*. *Ulva* and *Gracilaria* are cultivated on abalone farms and fed to abalone.

Dried, packaged seaweed food products (e.g. nori (*Porphyra*) sheets) to nutraceutical products (e.g. kelp tablets) are imported and distributed to consumers.



Raw material production is mostly based on harvesting of living biomass, or collection of washed-up material. Suppliers include labour, equipment such as boats, and transport.

The national Department of Forestry, Fisheries and the Environment (DFFE) is responsible for the regulation and management of harvest and collection of raw materials. Commercial or small-scale seaweed rights holders can harvest or collect raw material from twenty-three demarcated Concession Areas along the coastline. Aquaculture (including seaweed grown on aquaculture farms) is also regulated by DFFE.

Primary processing includes the cleaning and stabilisation of fresh material, drying, sorting, milling and grading. Secondary processing includes further processing such as manufacturing of feed pellets, plant biostimulants and other products.

Distribution is undertaken by seaweed rights holders, processing companies or independent parties. Various companies are involved in the importation of products containing seaweed as an ingredient.

The main markets or consumers of seaweed products in South Africa are abalone farms; wholesale, retail companies, restaurants and food outlets, the agriculture and horticulture industry using biostimulants and the global colloid industry. Phycocolloids are imported into South Africa and sold through wholesale and retail outlets.

A number of gaps and inefficiencies in the value chain are limiting the expansion of the industry, including:

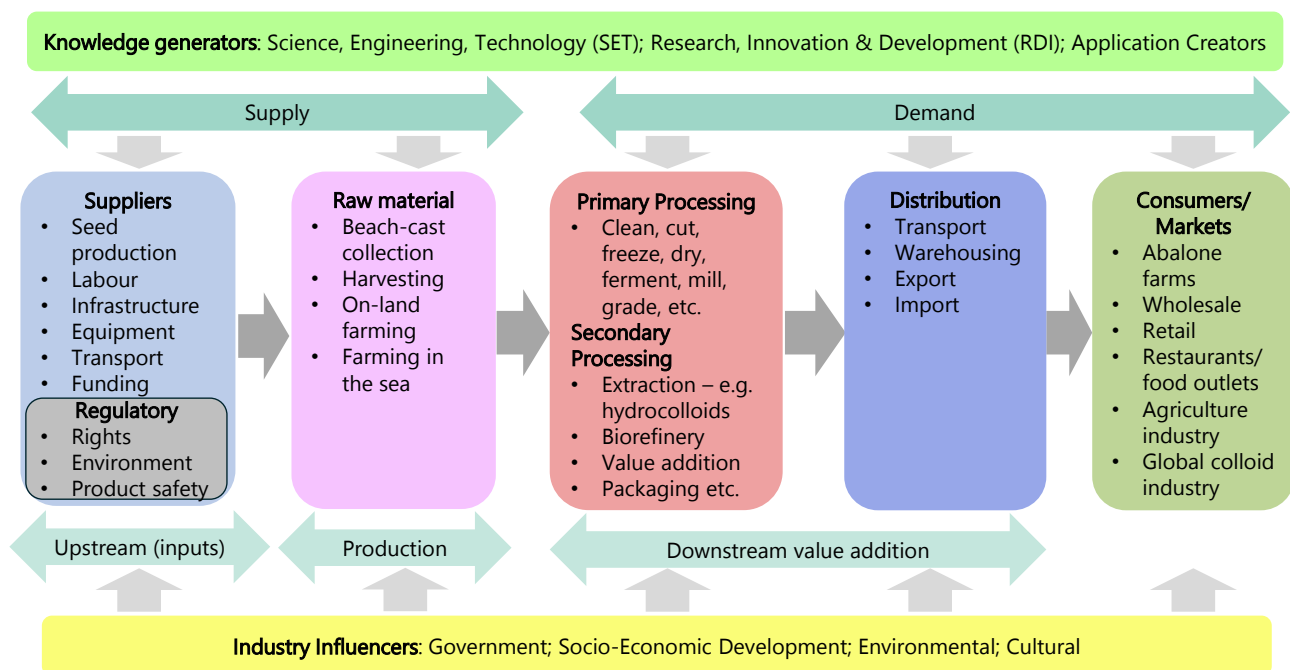
- ⇒ Lack of a food-grade processing facility in the Western Cape
- ⇒ Insufficient supply to the niche restaurant market
- ⇒ Inconsistent supply across the industry and difficulty in accessing raw product
- ⇒ No commercial seaweed cultivation other than on abalone farms.

Based on increasing demand there are opportunities for seaweed in South Africa including:

- ⇒ Kelp farmed to produce biostimulants, animal feeds, nutraceuticals, cosmeceuticals, bioplastics, -textiles and food
- ⇒ *Porphyra/Pyropia* (human food)
- ⇒ *Ecklonia radiata*, *Macrocystis pyrifera* and *Laminaria pallida* (kelp has many uses; e.g. much of the European kelp industry (e.g. Brittany, Norway) is based on natural stocks of *Laminaria hyperborea*)
- ⇒ Gigartinaceae, *Pachymenia*, *Hypnea* (carrageenan)
- ⇒ *Asparagopsis* spp. (cattle feed additive); included due to its potential even though it is not indigenous and currently not approved for cultivation
- ⇒ *Gelidium* spp. (agar)
- ⇒ Cultivation of *Gracilaria*, for export.

Potential Future Seaweed Value Chain

This could lead to the seaweed industry being further developed into a vibrant, growing, and vertically integrated sector as illustrated in the figure below.



This would entail expanding the current activities in the value chain and adding new aspects. The key elements of the expanded value chain include:

- ⇒ **Knowledge Generators:** Role players include Higher Education Institutions (HEIs), Research Councils, private companies, government, development agencies, non-profit organisations and associations such as the Phycological Society of Southern Africa (PSSA)
- ⇒ **Suppliers:** A strong base of suppliers addressing the needs of the seaweed sector is key to growth, including seed production, labour, Infrastructure, equipment, transport, funding
- ⇒ **Production of Raw Materials:** Harvesting and collection by commercial operators and small-scale cooperatives in the 23 Concession Areas, and future aquaculture activities
- ⇒ **Processing:** Primary processing includes washing, drying, cutting, freezing, fermenting, milling and grading. Secondary processing into value added products including extraction, bio refining, manufacturing, packaging etc.
- ⇒ **Distribution:** Including transport and logistics, warehousing exports, and imports
- ⇒ **Consumers/markets:** Including abalone farms, wholesalers, retailers, restaurants and food outlets, agriculture and horticulture, and the global colloid market

⇒ **Industry Influencers:** Including government (DFFE, DSBD, dtic, provincial departments, local municipalities), socio-economic development agencies (International e.g. UNDP, FAO, World Bank, FCDO etc.; Local e.g. BSASA, AFASA, Innovation Hub, Abalobi, etc.), environmental organisations (CSA, WWF, SBWQT, etc.) and community/cultural organisations (e.g. Cochoqua, !Kwattu, Small scale Fishing Cooperatives, Masifundise trust etc.).

Potential Market Opportunities for the Western Cape

There is a possible opportunity for South Africa and the Western Cape to develop an efficient and cost-effective seaweed industry, based on a collaborative approach to ensure vertical integration within the industry and not only at company level. This could potentially provide access to markets for:

- ⇒ Semi-processed products based on value for money
- ⇒ Processed products for niche value added products
- ⇒ New products and applications as they develop.

As most of the collection and harvesting rights are already allocated, accessing these new opportunities would depend on improving efficiency at an industry level and the introduction of cultivation of species that exhibit a market demand.

The table below summarises the opportunities for kelp species. Bioplastics, textiles and construction materials could be considered in the long term, if large amounts of biomass with a high consistency and low cost can be produced.

Species:	Kelps - <i>Ecklonia maxima</i> , <i>Laminaria pallida</i> , <i>Macrocystis pyrifera</i> , <i>Ecklonia radiata</i>		
Broad application	Primary product	Secondary product	Potential client/s
Human foods	Fresh and dried kelp blades/stipes in sheet, flake or powder form	Ingredients in dishes; Artisanal foods (Kelp noodles, pickles, jams, chutneys etc.)	Retail (Woolworths, Spar, Asian shops, formal & informal markets), more restaurants
Aquaculture feed	Fresh blades	Value-added (fermented) product using bacteria for better bioavailability	Aquaculture, pet food/ companion pet markets
Hydrocolloids	Alginic acid/ alginate	FDA-approved food ingredient used as emulsifier, thickener, stabiliser in applications e.g. food, cosmetics, pharmaceuticals etc.	Overseas extraction; South African production not sufficient for local extraction
Biostimulants	Regional production of agricultural biostimulants	Remaining solids after processing sometimes used in compost. Being tested as cattle feed additive.	The agriculture industry (current and rapidly growing component)
Animal feed additives	Currently small-scale, selling dried kelp	Possible potential for biorefinery (several products from same material)	Local and overseas feed manufacturers

Species:	<i>Kelps -Ecklonia maxima, Laminaria pallida, Macrocystis pyrifera, Ecklonia radiata</i>		
Broad application	Primary product	Secondary product	Potential client/s
Pet food	Not currently in SA, overseas	Biorefinery potential. Blending, fermentation to increase protein content and efficacy	Local and overseas feed manufacturers
Nutraceuticals, cosmetics	Products containing seaweeds for their wellness and cosmetic properties;	Product/s to test on various skin models	Local and global traditional cosmetics companies (act as supplier)
	Artisanal cosmetics -soaps/ creams etc.	Non-regulated products that do not require high levels of testing and costs	Local tourist and hospitality industry

The table below summarises the opportunities for Gracilarioids. Using a biorefinery approach, carbohydrates (e.g. agar) could be removed, leaving a high protein remainder, from which other useful functional components could be extracted.

Species:	<i>Gracilaria gracilis/Gracilariopsis longissima</i>		
Broad application	Primary product	Secondary product	Potential client/s
Human Foods	Is eaten elsewhere	Artisanal food products (pickles, noodles) etc.	Potential overseas
Aquaculture feed	Fresh feed for juvenile abalone in aquaculture		Animal aquaculture farms
Hydrocolloids	Agar	Chemicals e.g. protein and agar. Agar has food, pharmaceutical, industrial, applications	Current large overseas markets; interest from Japanese companies in farmed <i>Gracilaria</i> for agar
Biostimulants	Not currently, locally?	Fairly low tech grinding and separation of "sap" from fibre; Fibre is used as "bagasse" for cooled extraction	Agricultural/ horticultural markets
Animal feed additives	Experimental		Animal feed companies
Pet food	Experimental		Pet feed companies
Nutraceuticals	Products containing seaweeds for their wellness and cosmetic properties.	Product to test on various skin models	Local and global traditional cosmetics companies (act as supplier)

The potential market opportunities based on *Ulva* species are set out in the table below. Food products such as "Sea lettuce salt" are currently produced on a small scale. It should be noted that cultivated *Ulva* can produce higher levels of protein than in nature.

Species:	<i>Ulva</i>		
Broad application	Primary product	Secondary product	Potential client/s
Human foods	Live or dried seaweed		Restaurants
Aquaculture feed	South Africa one of world's largest producers for aquaculture feed (abalone farms)		Animal aquafarms and feed producers
Hydrocolloids	Ulvans —sulphated polysaccharides	Health, cosmetics and agricultural applications	Cosmetics/nutraceutical companies, agricultural industry
Biostimulants	Ulva liquid from biorefinery processes used in biostimulants (France)	Biostimulant with Ulva and red seaweed (Seamel) produced in France	Agricultural/horticultural industry
Animal feed additives	Experimental in SA, proprietary blends of red, brown and green seaweed	Species-specific and unique blends e.g. seaweed prebiotics	Livestock and aquaculture industries
Pet food	Proprietary blends of red, brown and green seaweed	Specific formulations to enhance pet gut health and digestive efficiency	Pet food industry

The potential market opportunities for *Porphyra/Pyropia* are highlighted in the table below. The market for human food products is currently mostly in Asia, and local producers have to compete with low-priced, imported nori products.

Species:	<i>Porphyra/Pyropia</i>		
Broad application	Primary product	Secondary product	Potential client/s
Human foods	Dried seaweed		Currently mostly in Asia
Aquaculture feed	Supplementary abalone feed		Abalone farms
Animal feed additives	Potentially good additional biomass for blends for feeds and supplements	Specific feed formulations for improved animal health	Agricultural industry

Summary, Discussion and Conclusions

The South African seaweed industry has a long history. Supply is currently the main constraint, necessitating the stimulation of large-scale cultivation.

A substantial body of knowledge is already available that could form the foundation for further seaweed aquaculture development:

- ⇒ In the 1990s, *Gracilaria* was experimentally successfully grown in Saldanha Bay and St Helena Bay
- ⇒ The South African Kelp Farming Project is currently conducting kelp cultivation experiments of *E. maxima*, *L. pallida* and *M. pyrifera*
- ⇒ Various abalone farms are successfully growing *Ulva* and *Gracilaria*
- ⇒ The Saldanha Aquaculture Development Zone has 884 ha of sea water space approved for aquaculture, including seaweed cultivation

- ⇒ Several offshore areas have been identified along the west coast as potentially suitable for kelp cultivation
- ⇒ There is substantial international and local interest in seaweed for use in food, feed, health, pharmaceutical, industrial and environmental applications (A Seaweed Revolution)
- ⇒ The Kelp Value Chain Analysis, Market Assessment and Roadmap study identified the need for a food-grade processing facility in the Western Cape, and various market opportunities.

The future seaweed value chain could include farming of existing and additional species with commercial value, processing and manufacturing of seaweed-based products, and marketing and distribution opportunities.

The following should be taken into consideration:

- ⇒ Seaweed aquaculture and beneficiation is seen as a potential contributor to multiple Sustainable Development Goals, including decent work and economic growth, and reduced inequalities.
- ⇒ The current seaweed industry is characterised by a few big players and depends on a sustainable access process to seaweed resources. The existing industry and businesses should not be harmed whilst expanding the seaweed value chain. However, it is important to address past inequalities and ensure that entrepreneurs from historically disadvantaged coastal communities have the support required to become successful players in the value chain.
- ⇒ Past experiences of involvement of historically marginalised individuals and coastal communities in collaborative aquaculture projects highlighted how the nature of benefit sharing arrangements, institutional arrangements and power dynamics could influence the extent to which individuals and the greater community gain from such projects. Future aquaculture enterprise development programmes must, therefore, consider factors such as power dynamics, skills and knowledge transfer, mentoring and support, and effective benefit sharing arrangements.
- ⇒ The regulatory environment for seaweed resource access and cultivation is still daunting, despite efforts by Government to reduce red tape, and make information more accessible.
- ⇒ Investigating the commercial viability of cultivation of any seaweed species will require studies.
- ⇒ The development of new seaweed-derived products and markets will also require considerable investment.
- ⇒ Meaningful investment in education, skills development, incubation, and other enterprise development support will be required to assist entrepreneurs in the seaweed value chain.
- ⇒ Seaweed coexists with other marine value chains such as fish, mussel and abalone farming, etc., and can be used for bioremediation of excess nutrients in integrated multi-trophic aquaculture (IMTA) with other species such as shellfish and sea urchins.

This report demonstrates that there is an opportunity as well as international interest in growing the SA seaweed industry. It is not a simple or trivial task to develop an extensive world class industry, especially when considering the challenges of ensuring inclusive socio-economic development. The way forward should include:

- ⇒ An integrated effort to establish South Africa as a Seaweed force
- ⇒ Establishing cultivation of various species in line with market demands
- ⇒ Establishing various cultivation methods and practices
- ⇒ Establishing processing facilities to suit market demands
- ⇒ Establishing standards, testing protocols and accredited test facilities
- ⇒ Developing the value chain, including small local enterprises, medium scale enterprises and big industries, including
 - ◆ SA seaweed branding

- ◆ Provenance
- ◆ Product development
- ◆ Integrating circularity in the industry
- ◆ Support services, suppliers, distributors, integrators
- ◆ Local market development
- ◆ International market development.

Recommendations

The recommendations of this report are aimed at developing a strong vertically integrated industry that provides opportunities for all, including the previously disadvantaged.

A well thought out and well-resourced, integrative and inclusive sector approach is required, starting with:

- ⇒ Expanding on the excellent recommendations of the kelp value chain study (BSASA, 2023) regarding the kelp sector to include the broader seaweed industry:
 - ◆ Establishment of a credible Seaweed Industry Association
 - ◆ A national Seaweed Industry Development Strategy, vision and implementation plan, driven by the above Industry Association in co-operation with government
 - ◆ Environmental Impact Assessment for the remainder of the Velldrif-Saldanha ADZ (including St Helena Bay) to determine approved areas for aquaculture (including seaweed).

This is key to the sustainability and inclusivity of the sector.

Such a sector-based approach should be supported by the undertaking of focused research, development and implementation activities:

- ⇒ Continued support for the SA Kelp Farming Project to proceed to Pilot phase
- ⇒ Experimental cultivation of kelp in one of the other areas approved for aquaculture in the Saldanha Bay ADZ
- ⇒ Off-shore experimental cultivation of kelp in one of the areas identified along the west coast during Phase 1 of the SA Kelp Farming Project
- ⇒ Expansion of the UNDP project to include:
 - ◆ *Gracilaria* Feasibility study and Pilot Production to determine viability of various cultivation techniques and test product in potential markets
 - ◆ Testing of other *Ulva* species for constituents, food and feed desirability and aquaculture potential
 - ◆ *Porphyra* cultivation experiments
 - ◆ Additional community awareness workshops
 - ◆ Development of products by entrepreneurs from local communities for small scale trials in local markets.
- ⇒ Investigating opportunities for circularity, including those based on linkages with other aquaculture and marine activities in the region
- ⇒ Undertaking additional research into:
 - ◆ Primary and secondary processing
 - ◆ Product design.

The above would underpin the successful cultivation of various species of seaweed to meet market demand.

An enabling environment is required to facilitate the development of new seaweed companies, cultivation technologies, production processes, and product development, including:

- ⇒ Knowledge generation and transfer
- ⇒ Incentives (national, provincial and municipal)
- ⇒ Support for undertaking feasibility studies and developing business plans

⇒ Establishment of shared processing facilities for the benefit of the sector.

The proposed Seaweed Industry Association in partnership with government (DFFE, DSBD and the dtic) should take the lead in creating this environment to the benefit of all role players, with a special emphasis on ensuring inclusivity.

All successful businesses need to access sustainable market opportunities. It is, therefore, recommended to create a West Coast Seaweed (and other marine product) identity/brand to stimulate a strong market presence and assist new members in their market entry. This would include:

- ⇒ Unified branding
- ⇒ A local story providing product provenance
- ⇒ Ongoing publicity regarding seaweed, its uses and benefits
- ⇒ Consolidated marketing efforts
- ⇒ Establishing an efficient export processing help desk.
- ⇒ Market intelligence.

Again, the Seaweed Industry Association in partnership with government (DFFE, DSBD and the dtic) should take the lead in creating this market support.

Supporting enterprise development is critical in the effort to ensure inclusivity. A collaborative approach is required to redress the effects of past inequalities. It is proposed to establish a structured seaweed value chain incubation programme incorporating implementation based on the World Bank's "Global Aquabusiness Investment Guide". The enterprise Development activities should include the following:

- ⇒ An outreach and education programme to seaweed entrepreneurs from coastal communities
- ⇒ A technical support programme with experienced technical mentors supporting the development of enterprises across the value chain
- ⇒ A business development and support programme
- ⇒ A market development programme
- ⇒ Establishment of physical infrastructure and facilities to be utilised for industry development and support activities.

The recommendations are quite ambitious and far reaching. It is understood that it will take considerable time and effort to address all aspects. The high-level roadmap illustrated below, serves to outline the vision of how an integrative and inclusive seaweed sector could be developed in the Western Cape.

Seaweed Sector Recommendations - Implementation Roadmap

Activity	Year																							
	2025				2026				2027				2028				2029				2030			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Foundation																								
Establish a sound, well-represented and all inclusive industry body	█																							
Develop National Seaweed Vision and Strategy	█				█																			
Environmental Impact Assessment for the balance of Veldrif Saldanha ADZ	█				█																			
Seaweed industry with strong cohesive foundation	█				█				█				█				█				█			
Focused Research, Development and Implementation																								
Continuation of SA Kelp Farming Project	█				█				█															
Kelp trials in Big Bay and Outer Bay North	█				█				█				█											
Off-shore Kelp cultivation trials	█				█				█				█											
Establishment, development and expansion of commercial Kelp cultivation	█				█				█				█				█				█			
UNDP <i>Gracilaria</i> Feasibility Study	█				█				█				█											
UNDP <i>Gracilaria</i> Pilot	█				█				█				█											
Establishment, development, expansion of commercial <i>Gracilaria</i> cultivation	█				█				█				█				█				█			
UNDP testing of other <i>Ulva</i> species	█				█				█				█											
UNDP <i>Porphyra</i> cultivation experiments	█				█				█				█											
UNDP other species feasibility studies & pilot projects	█				█				█				█				█				█			
UNDP ongoing community awareness workshops	█				█				█				█				█				█			
Artisanal product development, market testing by local entrepreneurs	█				█				█				█											
Research circularity and other aquaculture linkages	█				█				█				█											
Primary and secondary processing research	█				█				█				█				█				█			
Product development	█				█				█				█				█				█			
Increasing numbers of species farmed, applications and products developed	█				█				█				█				█				█			
Enabling Environment																								
RDI coordination and online portal	█				█				█				█				█				█			
Generate knowledge base	█				█				█				█				█				█			
Regulatory helpdesk	█				█				█				█				█				█			
Regulatory review	█				█				█				█				█				█			
Develop standards and protocols	█				█				█				█				█				█			
Establish local accredited test facility	█				█				█				█				█				█			
Design and implement incentives	█				█				█				█				█				█			
Support for feasibility studies and business plans	█				█				█				█				█				█			
Growing numbers of successful enterprises in the seaweed value chain	█				█				█				█				█				█			
Market Development																								
Establish a unified brand/identity	█				█				█				█				█				█			
Develop provenance story	█				█				█				█				█				█			
Ongoing seaweed publicity	█				█				█				█				█				█			
Establish and operate export processing help desk	█				█				█				█				█				█			
Ongoing market research	█				█				█				█				█				█			
Vertical integration and circularity in Seaweed sector	█				█				█				█				█				█			
Enterprise Development																								
Establish Enterprise Development Centre/incubator	█				█				█				█				█				█			
Establish new enterprises based on RDI above	█				█				█				█				█				█			
Technical support and mentoring	█				█				█				█				█				█			
Business support and mentoring	█				█				█				█				█				█			
Market support and mentoring	█				█				█				█				█				█			
Piloting/demonstration infrastructure	█				█				█				█				█				█			
New entrants to seaweed sector achieving inclusivity	█				█				█				█				█				█			

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GLOSSARY

AASA	-	Aquaculture Association of Southern Africa
ADZ	-	Aquaculture Development Zone
ASTRAL	-	All Atlantic Ocean Sustainable, Profitable and Resilient Aquaculture
BSASA	-	Bivalve Shellfish Farmers Association of South Africa
BST	-	Bio Solutiones Technicas
DFFE	-	Department of Forestry, Fisheries and the Environment
EIA	-	Environmental Impact Assessment
EU	-	European Union
CAGR	-	Compound Annual Growth Rate
CPUT	-	Cape Peninsula University of Technology
CSA		Conservation South Africa
GMI	-	Global Market Insights
GSC	-	Global Seaweed Coalition
HEIs	-	Higher Education Institutions
FCDO		Foreign, Commonwealth and Development Office
IMTA	-	Integrated multi-trophic aquaculture
IRD	-	French National Research Institute for Sustainable Development
ISA	-	International Seaweed Association
KSC	-	Kelp Scientific Collaboration
MLRA	-	Marine Living Resources Act
NRF	-	National Research Foundation
PAIA	-	Promotion of Access to Information Act
PPP	-	Public-Private-Partnership
PSSA	-	Phycological Society of Southern Africa
PSSFs	-	Policy for the Small-scale Fisheries Sector
RDI	-	Research, development and innovation
SABS	-	South African Bureau of Standards
SADC	-	Southern African Development Community
SAMS	-	Scottish Association for Marine Science
SAMSA	-	South African Maritime Safety Authority
SAquaDC	-	Saldanha Aquaculture Development Centre
SBWQFT	-	Saldanha Bay Water Quality Forum Trust
SDGs	-	Sustainable Development Goals
SEA	-	Strategic Environmental Assessment
TNPA	-	Transnet National Ports Authority
t	-	Tonnes
TVET	-	Technical and Vocational Education and Training
UNDP	-	United Nations Development Programme
UK	-	United Kingdom
WAS		World Aquaculture Society
WBG	-	World Bank Group

1 INTRODUCTION

1.1 BACKGROUND

There are more than 12 000 seaweed species worldwide, of which only a small number (about 250 spp.) are used or cultivated. This represents a small percentage of the diversity that is available, and therefore, tremendous opportunity. Seaweed farming is considered a potential option for alternative livelihoods in vulnerable sectors of coastal society. Selected seaweeds have multiple uses as direct human or animal foods, for extraction of valuable compounds that can be used in other industries, for replacement of fossil-fuel derived ingredients, and other ecosystem services. Seaweeds can be grown without costly inputs such as energy or fertiliser—and, on a global scale, seaweed aquaculture has grown faster than other marine production sector over the last 20 years. However, though seaweed farming has many positive ecosystem services, it is a balancing act. A large influx of farmed biomass (that was not there before) taking up large amounts of nutrients may impact other trophic levels and in the case of tropical seaweeds, inorganic fertilisers may be used to boost production and yield.

Interest in seaweeds led to the implementation of the South African Kelp Farming Project, funded by the UK International Development via the Foreign Commonwealth and Development Office (FCDO), implemented by the Bivalve Shellfish Farmers Association of South Africa (BSASA), and supported by the Department of Forestry, Fisheries and the Environment (DFFE). The first phase (Pre-feasibility study) was completed in 2022, and the second phase (Feasibility study) is currently ongoing with laboratory-based and at-sea cultivation experiments of three local kelp species in Saldanha Bay.

The United Nations Development Programme (UNDP) established an Accelerator Lab in South Africa in 2019, to accelerate the realisation of the Sustainable Development Goals (SDGs). As part of its programme “Igniting the Ocean Economy in South Africa”, the UNDP is also investigating the potential of seaweed to contribute to the SDGs.

To this end, the UNDP South Africa, in collaboration with the DFFE, contracted Bio Solutions Technicas (Pty) Ltd (BST) to implement a six-month project entitled “Exploring Seaweed Cultivation and Value Chains for Enterprise Development in the Coastal Communities of Saldanha Bay, St. Helena Bay and Velddrif” in the Western Cape. Though broader in scope, this work is building on the work and linkages established through the South African Kelp Farming Project.

BST is an international projects company with engineering and specific aquaculture expertise. The BST project team includes a wealth of complementary relevant knowledge, expertise and experience that ensured successful delivery of the results desired by the UNDP.

This report describes the work conducted to achieve the aim and objectives of the project. It includes the results of a market and value chain analysis of the seaweed industry in South Africa, interactive workshops conducted in three local communities, and a broader stakeholder workshop conducted to obtain further insights.

1.2 AIM AND OBJECTIVES

The project aim was to inform the design of future enterprise development programmes to support entrepreneurs in developing seaweed cultivation businesses, supported by local market analysis research. The project objectives included the following:

- ⇒ Compile a generic value chain for the local seaweed industry
- ⇒ Engage with the coastal communities to explore and define a variety of different seaweed products and value chains that could bring economic benefit and job creation to community members
- ⇒ Provide practical introductory training to community members on the basics of seaweeds, local current and potential commercial seaweeds, the local seaweed industry, cultivation of seaweeds (with a specific focus on *Gracilaria* and kelps), global perspectives on economic seaweeds, the regulatory environment, and the requirements for turning ideas into opportunities.
- ⇒ Document local insights regarding the uses and cultivation of seaweeds, including local and indigenous knowledge in relation to future seaweed production.

1.3 METHODS USED

The main activities undertaken included a market and value chain analysis, community workshops, and preparation of a final report. The market and value chain analysis included the following activities:

- ⇒ **Desktop study.** Published and readily available data and information on global and South African seaweed utilisation, markets and industries sourced from published literature, grey literature and electronic sources were reviewed as part of a desktop study to understand the markets and value chains; the focus was on, but not limited to, kelps and gracilarioids in South Africa. The Kelp Value Chain Analysis, Market Assessment and Roadmap study conducted in 2023 (BSASA, 2023) as an output of the South African Kelp Farming Project, provided valuable information about the kelp industry, which is a key commercial species in the South African seaweed industry. The value chain analysis for this study built on the above-mentioned kelp value chain analysis and investigated the most important seaweeds, seaweed-derived products and value chains in South Africa, the market role players, and the size and value of the South African seaweed market.
- ⇒ **Seaweed specialist inputs and focused stakeholder engagements.** Two seaweed specialists (Prof. John Bolton and Dr Alan Critchley), globally recognised for their expertise on the scientific and industrial aspects of seaweed and their cultivation, were part of the implementation team. The results of the desktop study were reviewed by this implementation team, and further stakeholder consultations were, therefore, limited to a small number of role players as set out in Table 1. These role players included experts from the seaweed industry, research and academia, government and other stakeholders. Consultations were either formal (unstructured interviews) or informal (verbal conversations).
- ⇒ **Analysis.** The data and information gathered were analysed and interpreted to develop the understanding required to support the desired project outcomes.
- ⇒ **Preparation of draft market and value chain analysis report.** A draft report was prepared and presented to the UNDP for comment. Once this feedback was received, the report was used as input for preparation of the content for the training component and interactive sessions of the community engagement workshops, and as input to the final project report.

Table 1: Stakeholders consulted

Stakeholder	Value chain segment
Department of Forestry, Fisheries and the Environment (DFFE); Small-scale Fisheries Management and New Fisheries Research Unit	Government
Cape West Coast Biosphere Reserve	Non-governmental organisation
Conservation South Africa	Non-governmental organisation
ABALOBI	Development organisation
Viridis Marine	Seaweed processor
Taurus Cape Kelp	Seaweed concessionaire, harvester and processor
Weskusmandjie	Seaweed processor
Khoi Kelp	Seaweed processor
Cochoqua Kingdom	Indigenous community
Verdino 143	Seaweed concessionaire
Yes4Youth Genesis Hub Vredenburg	Development organisation
Enough	Cosmetics company
South African Kelp Farming Project	Collaborative project – Industry, Academia, Government

The community workshops included the following activities:

- ⇒ **Selection of workshop locations and venues.** After physical inspection of potential venues, and based on local knowledge, three suitable locations were selected in Saldanha Bay, Velddrif and St Helena Bay.
- ⇒ **Publicity and invitations:** The final workshop dates, objectives and application process were publicised during a multi-stage process, involving 18 organisations and individuals:
 - ◆ Identification of target participants
 - ◆ Meetings with representatives of selected organisations with links to target participants
 - ◆ Publication of open information sessions and application process for workshops
 - ◆ Open access information sessions on 27 July.
- ⇒ **PSSA involvement:** As an incentive to attract participation, BST negotiated with management of the Phycological Society of Southern Africa (PSSA) to:
 - ◆ Offer a two-year free (PSSA) membership to the delegates who attend the physical workshops. This membership will give them access to the best technical expertise, including aquaculture specialists
 - ◆ Hold a competition for delegates after the completion of the workshops. The prize winner will receive sponsorship to travel to and attend the PSSA congress in Mozambique (to take place in February 2025).
- ⇒ **Community and virtual workshops.** Three in-person workshops and one online were conducted to introduce seaweed opportunities and value chains, obtain local and indigenous understanding about South African seaweeds, and obtain insights from a broader group of stakeholders:
 - ◆ The community workshops were attended by 66 members of local communities on 12, 14 and 16 August. A detailed Community Workshop Report is contained in [Appendix B](#).
 - ◆ A virtual workshop was arranged by the UNDP through an MS Teams platform. It was attended by 49 stakeholders from various backgrounds, including government, private/corporate industry, academia, non-governmental organisations, development organisations, consultancy and others.
- ⇒ **Preparation of community workshop report.** A draft report was prepared and presented to the UNDP for comment. Once this feedback was received, the report was used as input to the final project report.

2 THE GLOBAL SEAWEED INDUSTRY

Data from the Food and Agriculture Organization of the United Nations (FAO) indicates that the global seaweed market grew significantly from 10 million t (fresh weight) in 2001 to 36,5 million t in 2022 (BSASA, 2023; FAO, 2024). Production includes wild-harvested and farmed seaweed, with 97% of production coming from farmed seaweed. Asia (especially China, Indonesia, South Korea and the Philippines) contributes 98% to production. Only five seaweed groups, including *Saccharina*, eucaumatoids, *Gracilaria*, *Pyropia* and *Undaria* provide 95% of seaweed volumes (World Bank, 2023).

Since 2015, growth of global seaweed aquaculture slowed in most regions. The COVID-19 pandemic of 2020 played a role, due to the global effect on most aquaculture farms. However, there were other challenges such as climate change, lower levels of available labour, lack of good quality seed supply, and lack of innovation—especially with regard to cultivation or processing methods. This suggests that caution needs to be exercised in adapting Asian methods of seaweed production and processing in other regions (World Bank, 2023).

Currently, the three main uses of seaweeds are for direct human consumption, for feeding to other species in aquaculture, and for production of hydrocolloids (World Bank, 2020). Hydrocolloids are substances that form a gel in the presence of water, and include substances such as gelatin, pectin, guar gum, xanthan gum etc. Seaweed-derived hydrocolloids are called phycocolloids, and include alginates, agar and carrageenan. The European Union has a system for food additives, with phycocolloids numbered from E400 to E408 (<https://www.seaweed.ie/additives/e-number.php>). In South Africa, ingredient lists for milk products often use the description “plant-based stabilisers” if the product is only intended for the South African market. This is often carrageenan, which is a reliable milk stabiliser (e.g. in yoghurt products).

There is increasing interest from Western countries in the farming, processing and utilisation of selected seaweeds due to their multiple benefits for human and animal health and nutrition, agricultural and industrial applications, and environmental benefits. Farming technologies are being updated, knowledge about the biologically active substances find applications in pharmaceutical, cosmetics and agricultural industries, and investment in seaweed farming and processing technologies is needed to develop high value-added products with integrated aquaculture (Zhang, et al., 2022).

It is difficult to obtain dependable market information about the seaweed market or market segments. Market reports sold by various companies are custom-prepared and based on information requested by clients. In addition, estimates about the values and potential growth of seaweed markets and segments vary widely.

In 2021, Global Market Insights (GMI) forecasted the seaweed industry’s value as USD 85 billion in 2026. GMI currently estimates growth at 7.8% CAGR to a market size of USD 120.5 billion by 2032 (Global Market Insights, 2024). In comparison, other market research companies valued the global seaweed market at USD 7 billion, (expected to grow at a CAGR of 8.7%) (Allied Market Research, 2024), and at USD 17.68 billion (expected to grow at a CAGR of 10.3%), in 2023 (Meticulous Research, 2024).

However, in 2021, UNCTAD estimated the global seaweed market as USD 17 billion, having tripled since 2000 (UNCTAD, 2024). This represented an average Compound Annual Growth Rate (CAGR) of 6% for all segments. For this study, a 6% CAGR, based on the UNCTAD valuation, is assumed for

growth of the overall seaweed market (and any other segments where credible figures were not available), to an estimated value of USD 28.7 billion by 2030. These conservative estimates are considered more credible than those from commercially available market reports and have been used as the basis for the market analysis in this document.

Table 2 describes the conventional market applications (human food and beverages, phycocolloids and aquaculture feed), potential new and emerging seaweed market opportunities in the short-, medium-, and long-term, and the potential value of these market segments by 2030.

Table 2: Current, new and emerging seaweed market opportunities and estimated size by 2030

Sources: (Future Market Insights, 2023); (World Bank, 2023); (Allied Market Research, 2024); (Meticulous Research, 2024); (UNCTAD, 2024)

Market Segment	2024	2025	2026	2027	2028	2029	2030	2030 USD million
Human Food and Beverages								15 653
Phycocolloids	Conventional market applications							1 447
Aquaculture feed								560
Biostimulants	Short-term markets (before 2025)							1 876
Animal Feed additives								1 122
Pet food								1 078
Methane reducing additives								306
Nutraceuticals	Medium-term emerging opportunities (realisable 2024-2028)							3 954
Alternative proteins								448
Bioplastics								733
Fabrics								862
Pharmaceuticals	Long-term emerging opportunities (post-2028)							-
Construction materials								1 396

The human food and beverage market segment (not including phycocolloids) is estimated to be 54.5% of the global seaweed market by application (Meticulous Research, 2024), leading to an estimated value of USD 10.4 billion in 2023, and assumed to grow at a CAGR of 6% to a potential value of USD 15.7 billion by 2030. Phycocolloids have numerous applications such as food additives, industrial uses such as textile printing, ingredients in products such as cosmetics, and applications in biotechnology e.g. use of agar in agar plates and DNA gels. In 2018, IMR International (cited in (World Bank, 2020)), estimated the market for phycocolloids at 87 000 t p.a. and USD 1.101 million, growing at an average CAGR of 2.3%. Assuming the average CAGR remains at 2.3%, the value of the phycocolloid market is estimated at USD 1.447 billion by 2030. Seaweeds are an important feed source for aquaculture species due to their nutritional, economic and environmental benefits. The

aquaculture feed market segment was estimated at USD 357 million in 2023, growing at a CAGR of 6.67% to USD 560 million in 2030 (Future Market Insights, 2023). The estimates for these conventional market applications assume that East Asian production will grow at conservative rates, and do not include assumptions about rapid growth in “new geographies”.

Interest in, and investigation of potential new uses and emerging markets for various seaweeds have indicated that there are opportunities for growth in new regions and applications. A World Bank study identified ten relatively new and emerging global seaweed markets (outside of the phycocolloid, food and aquaculture feed sectors) with the potential to grow by an additional USD 11.8 billion by 2030 (World Bank, 2023). Biostimulants, animal feed additives, pet food and methane-reducing additives were identified as short-term opportunities (i.e., they could be realised before 2025). Nutraceuticals, alternative proteins, bioplastics and fabrics were identified as medium-term (2024–2028), while pharmaceuticals and construction materials are long-term opportunities (after 2028). One of the key findings of the study was that the climate and environment benefits of seaweed farming will help drive growth as interest in “green” products continues to increase. However, to fully realise the potential of these new and emerging opportunities, key issues need to be addressed. These include the availability of seaweeds, suitable domesticated strains and seed banks, developing competitive price levels, and over-coming regulatory barriers (World Bank, 2023).

Whilst the renewed interest in seaweeds, their applications and cultivation is encouraging, a cautionary approach is recommended. Previous cycles of aquaculture promotion in “new geographies” (i.e. almost everywhere outside of Asia) and the realities experienced over decades, are well remembered (Costa-Pierce & Chopin, 2021). We would be well advised to review their reality checks e.g. around carbon sequestration, methane reduction, removing too many nutrients, etc., and recommendations for aquaculture in new geographies, to promote a realistic and sustainable approach to seaweed aquaculture and new application development.

3 THE SOUTH AFRICAN SEAWEED INDUSTRY

There are ca. 900 species of indigenous seaweeds (marine macroalgae) in South Africa; however, only a small number of these have been commercially exploited since the 1950's (Anderson, Simons, & Jarman, 1989). Historical and currently used commercially important species and their distribution in Southern Africa are described in Table 3.

Table 3: Areas of occurrence of seaweeds of historical and current commercial interest in South Africa

Species	Southern African occurrence
Kelp- <i>Ecklonia maxima</i> , <i>Laminaria pallida</i> and <i>Macrocystis pyrifera</i>	Western and southwest transition area of SA coast, to Namibia
<i>Gracilaria gracilis</i>	Sheltered bays on south and west coasts
<i>Gelidium</i> spp.	Southwest transition area and south coast of SA (only <i>Gelidium pristoides</i> is currently collected in Concession Area 1; some of the other species were collected in the past when collections were from other Areas in the former Transkei- currently part of Eastern Cape)
<i>Gelidium vittatum</i> (formerly <i>Suhria vittata</i>)	Found as epiphyte on kelp <i>Ecklonia maxima</i> on southwest transition/west coast to Namibia
<i>Gigartina/Sarcothalia</i> spp.	Southwest transition, west coast to Namibia (different species on south coast)
<i>Hypnea spicifera</i>	South coast of SA
<i>Porphyra capensis/Pyropia</i>	West coast of SA
<i>Ulva</i> spp.	All coasts of SA, most abundant on west coast
<i>Ulva lacunculata</i>	Abalone farms on west, southwest and southeast coasts of SA

The species that are currently exploited or under investigation, are described in more detail in [Appendix A: Species](#) pages. These species pages include descriptions for *Ecklonia maxima*, *Laminaria pallida*, *Macrocystis pyrifera*, *Gelidium pristoides*, *Ulva*, *Porphyra* and *Gracilaria gracilis*.

3.1 HISTORY

The main commercial seaweeds exploited in South Africa and Namibia, from the 1950's to the late 1980's, are described in Table 4. The main species groups include the brown seaweeds *E. maxima* and *L. pallida* (kelps), red seaweeds *Gracilaria/Gracilariopsis*, *Gelidium* spp. and *Porphyra/Pyropia*, and green seaweed *Ulva* (Anderson, Simons, & Jarman, 1989).

Table 4: South African seaweed species with historical commercial use or interest (before 1989)

Source: (Anderson, Simons, & Jarman, 1989)

Species	Primary products in Southern Africa	Secondary product	Eventual/final uses
Kelp- <i>Ecklonia maxima</i> and <i>Laminaria pallida</i>	Dried, milled kelp chips from beach-cast biomass (for export)	Alginate	Gelling, emulsifying and stabilising agents in food, paper, textiles, welding rods, pharmaceuticals etc.
	Dried, powdered kelp from beach-cast biomass	Feed and fertiliser preparations (locally manufactured)	Animal feeds, soil fertilisers
	Fresh cut kelp from attached biomass	Liquid plant growth stimulant/ biostimulant (locally manufactured)	Foliar spray to increase agricultural crop yields
Kelp - <i>Laminaria pallida</i>	Dried frond segments from attached biomass		Direct human consumption
<i>Gracilaria gracilis</i>	Dried material from beach-cast biomass (SA and Namibia) and raft culture (Namibia) for export and some local extraction of agar	Agar (some locally extracted)	Gelling agent in foods (jellies, sweets etc.)
<i>Gelidium</i> spp.	Dried, sorted and graded material picked from attached biomass, for export and some local extraction		Bacteriological culture base
<i>Gelidium vittatum</i> (formerly <i>Suhria vittata</i>)	Seaweed jelly made locally from plants picked off beach-cast kelp		Gelling agent in foods (jellies, sweets etc.)
<i>Gigartina/ Sarcothalia</i> spp.	Dried material from harvested biomass, for export; some used locally as finings in brewing industry	Carrageenan	Stabiliser and gelling agent in confectionery, ice cream, meats, sauces, etc.
<i>Hypnea spicifera</i>	Dried material from harvested biomass, for export		Cosmetics industry—thickening or gelling ingredients
<i>Porphyra capensis</i>	Pulped and dried material picked from attached biomass, for export		Direct human consumption ("Nori")

All Southern African *Laminaria* is now known to be the single species *L. pallida*. In Namibia it was formerly known as *L. schinzii*. Processing of kelp for alginate extraction in Southern Africa did not proceed beyond the pilot stage, and small quantities of *L. pallida* fronds were harvested in a Namibian trial for the Far Eastern food market (Anderson *et al.* 1989).

Beach-cast kelp was typically dried and milled and exported for alginate extraction or used in the local manufacture of feed and fertiliser preparations. Fresh kelp was liquidised and used in the production of a liquid biostimulant. In the 1980s, typical annual volumes were between 2000- and 3000 t dry mass (collected), and 200 t wet mass (harvested)—see Figure 1.

Alginates (i.e., calcium and sodium alginate) are used in many applications such as gelling, emulsifying and stabilising agents in food, paper, textiles, welding rods, pharmaceuticals, etc.

(Anderson, Simons, & Jarman, 1989). Biostimulants are generally described as substances or micro-organisms that could enhance plant growth, yield or quality through improved nutrient uptake, nutrient-use efficiency or tolerance to stress factors. Biofertilisers are described as materials of biological origin that contain sufficient levels of available plant nutrients to increase plant growth or quality. Fertilisers contain major plant nutrients that limit growth when not in sufficient supply (e.g. nitrogen, phosphorus, potassium and other nutrients), while major active ingredients in biostimulants are compounds such as plant hormones that control various aspects of plant development.

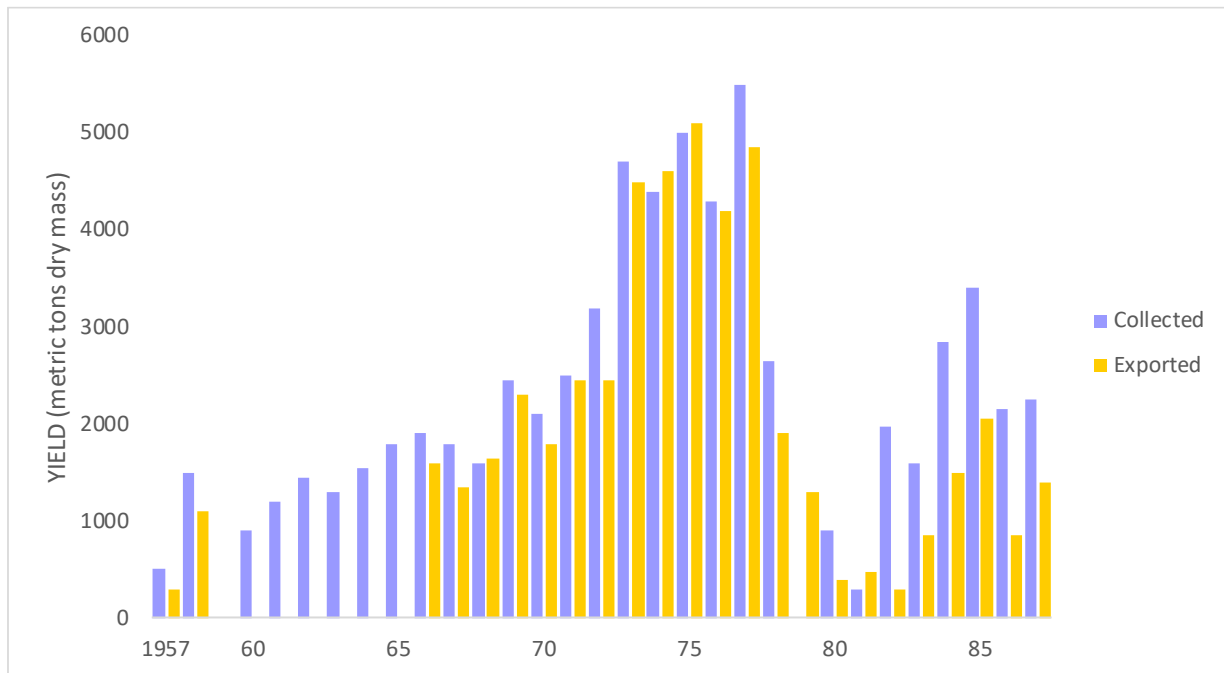


Figure 1: Commercial yields and exports of beach-cast kelp in South Africa, 1957-1987

Source: Adapted from (Anderson, Simons, & Jarman, 1989)

Gracilaria gracilis and *Gracilariopsis longissima* are extremely similar agar-producing red seaweeds which used to be treated as one species (*Gracilaria verrucosa*). These seaweeds only grow in sheltered bays such as Saldanha Bay and St Helena Bay. Historically, beach-cast material (wash-ups) was collected in Saldanha Bay, South Africa, and Lüderitz Bay, Namibia, which in the past was *Gracilaria gracilis*.

Gracilaria was dried and exported for agar extraction, with some material used in agar extraction facilities (for unrefined agar extraction) in South Africa and Namibia (see Figure 2). Agar was mostly food-grade quality, with a lower price than for bacteriological grade. Agar is used as a gelling agent in foods (jellies, sweets etc.), and as a bacteriological culture base. Local production of agar started during World War Two and continued until 1974 (SA) and at least 1989 (Namibia). Biomass volumes in South Africa peaked at 1 000 t dry mass annually until 1974, but declined to about 170 t thereafter (Anderson, Simons, & Jarman, 1989).



Figure 2: Drying, baling and agar extraction activities, in the past, in Lüderitz, Namibia
 Photo credits: John Bolton

A commercial aquaculture operation grew about 300 t p.a. of *Gracilaria* in ponds (Anderson, Simons, & Jarman, 1989)—and later on rope systems in Lüderitz Bay, Namibia (J.J. Bolton, pers. comm) (see Figure 3). Similar rope rafts (Dawes, 1995) were used in experimental cultivation of gracilarioids in Saldanha Bay and St Helena Bay in the 1990s (see Figure 4). These experiments showed that cultivation in both bays was possible, and yielded agar of acceptable quality (Anderson, Levitt, & Share, 1996; Wakibia, Anderson, & Keats, 2001).



Figure 3: Commercial *Gracilaria* on rope systems in Lüderitz, Namibia
 Photo credits: John Bolton

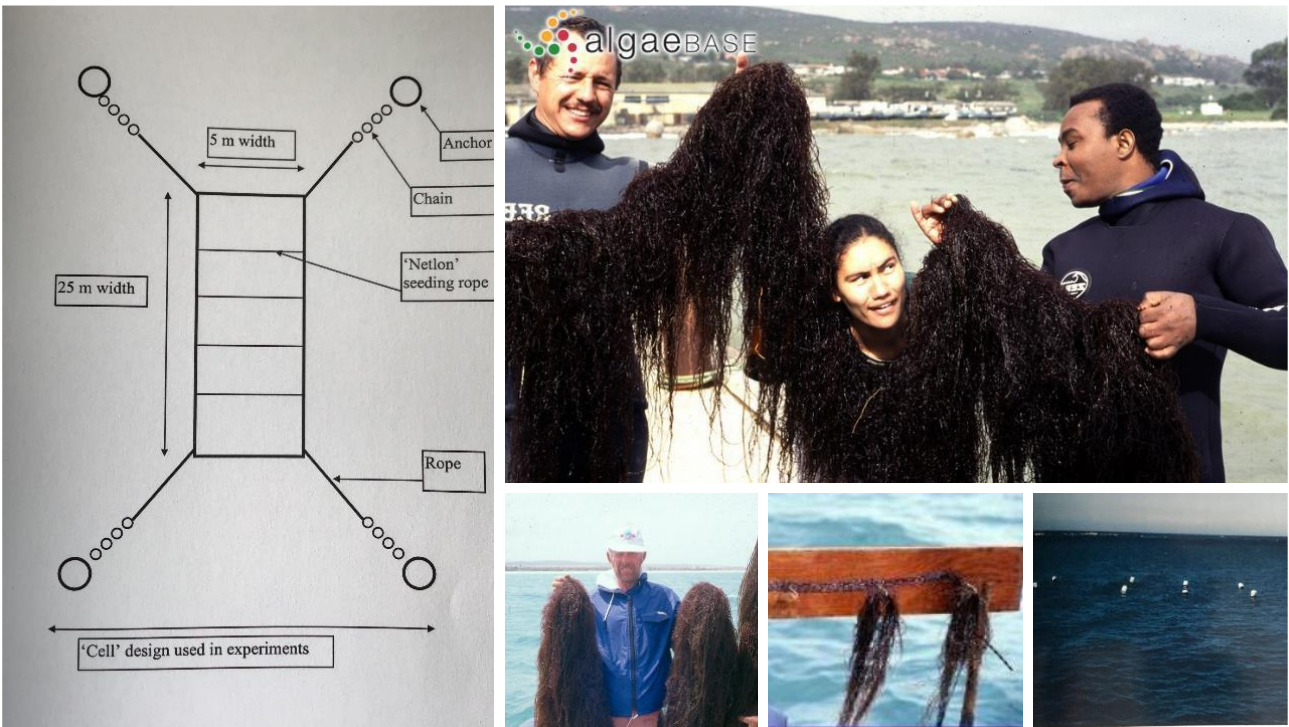


Figure 4: Experimental *Gracilaria* cultivation on rope rafts in Saldanha Bay and St. Helena Bay
 Sources: Diagram- (Dawes, 1995); Photo credits - Robert J. Anderson, John J. Bolton, Bernadette Brown-Webb

Gelidium vittatum (formerly *Suhria vittata*), *Gigartina radula* and *Sarcothalia stiriata* were harvested sporadically in small quantities. Exploitation of *Hypnea spicifera* began in 1988 but was halted with introduction of new permits in 1988. As set out in Figure 5, *Porphyra capensis* was harvested in small quantities (maximum between 10–15 t dry p.a.) between 1965 and 1978, with the likely destination Japan (Anderson, Simons, & Jarman, 1989).

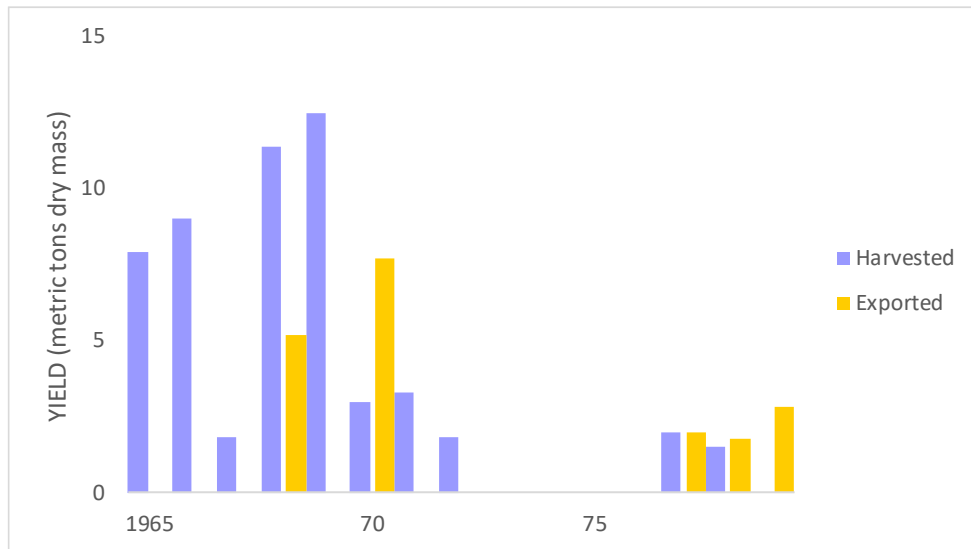


Figure 5: Commercial yields and exports of *Porphyra capensis* in South Africa, 1965 -1979
 Source: Adapted from (Anderson, Simons, & Jarman, 1989)

Gelidium has been dried and exported for agar extraction. Mostly *G. pristoides* was used, but *G. pteridifolium*, *G. abbotiorium* and *G. capense* have also been harvested in small amounts. *Gelidium* agar quality was bacteriological grade (better grade than *Gracilaria*), with a higher price. Annual volumes were estimated at 57 t dry mass between 1983 and 1987 (Anderson et al. 1989). *G. vittatum* also contains good quality agar, but supplies are limited (they are mostly found on beach-cast kelp).

Gigartina, *Hypnea* and *Hypnea* spp. were exported for the extraction of carrageenan, which is used as a stabiliser, gelling or thickening agent in confectionery, ice cream, meats, sauces, cosmetics etc. (Anderson, Simons, & Jarman, 1989). Carrageenan is also the active ingredient in some beer finings (used to clarify and stabilise beer).

Therefore, kelp, *G. gracilis* and *Gelidium* spp. formed the backbone of the Southern African seaweed industry between the 1950s and late 1980s.

3.2 CURRENT INDUSTRY

The current uses of seaweeds in South Africa are described in Table 5. The export of dried beach-cast kelp (*E. maxima* and *L. pallida*) represents a major use of seaweed since the 1950s, albeit in fluctuating amounts. The uses of kelp have increased with the growth of the abalone industry, as kelp is harvested for abalone feed and there are now more producers of liquid plant biostimulants in the industry than before (at least four). The main uses of kelp are for abalone feed (fresh), for extraction of liquid biostimulants and plant fertilisers (fresh and dried), and for alginate extraction in export markets (dried). Some of the kelp is used as an additive in the production of formulated abalone feed. There are also more people experimenting with new products incorporating kelp, such as cosmetics, nutraceuticals and food products for human consumption (Rothman M. D., Anderson, Kandjengo, & Bolton, 2020; BSASA, 2022; BSASA, 2023).

Table 5: South African seaweed species currently used in the industry (up to 2023)

Sources: (Rothman M. D., Anderson, Kandjengo, & Bolton, 2020; BSASA, 2022; BSASA, 2023)

Species	Primary products in Southern Africa	Secondary product	Eventual/final uses
Kelp <i>Ecklonia maxima</i> and <i>Laminaria pallida</i>	Dried, milled kelp for export, produced from beach-cast material	Alginate	Gelling, emulsifying and stabilising agents in food, paper, textiles, welding rods, pharmaceuticals etc.
	Dried, milled kelp for local manufacturing, produced from beach-cast material	Ingredient in products such as formulated abalone feed and agricultural/horticultural preparations, cosmetics etc.	Abalone feed, soil fertiliser, natural plant growth promotion, natural skin care products etc.
	Dried, stabilised kelp from beach-cast material, for local manufacturing	Novel products such as jewellery, décor	Personal grooming, Interior design/home décor
Kelp <i>Ecklonia maxima</i>	Fresh cut kelp fronds	Formulated abalone feed	Used as abalone feed
	Fresh cut kelp fronds	Fresh cut kelp frond pieces	Used as abalone feed
	Fresh whole kelp including stipes	Liquid plant fertilisers and biostimulants used as foliar spray, dip/drench or through irrigation systems	Natural plant growth promotion, increasing agricultural crop stress resistance, quality and yields
<i>Gelidium pristoides</i>	Air-dried, sorted, cleaned and baled material picked from attached biomass	Agar	Gelling agent in foods (jellies, sweets etc); Bacteriological culture base

Species	Primary products in Southern Africa	Secondary product	Eventual/final uses
<i>Ulva</i> spp	Dried, milled material picked from attached biomass	Used in the human food industry	Used in specialty salts/food spices
	Fresh cultured material (<i>Ulva lacunculata</i>)		Used as abalone feed, and to remove ammonia from the abalone wastewater (allowing partial water recirculation)
	Fresh, cleaned and processed material picked from attached biomass	Used in the human food industry	Used in small quantities in the restaurant industry or niche food products
<i>Porphyra/Pyropia</i>	Dried, milled material picked from attached biomass	Used in the human food industry	Used in dried food products such as local nori or specialty salts/spices
	Fresh, cleaned and processed material picked from attached biomass	Used in the human food industry	Used in small quantities in the restaurant industry or niche food products
<i>Gracilaria gracilis</i>	Fresh cultured material in integrated on-land tank systems		Used as juvenile abalone feed

The kelp yields in South Africa, from 1986 to 2018, as reported by concession holders, are illustrated in Figure 6. This reflects a steady increase in the kelp used as a growth enhancer.

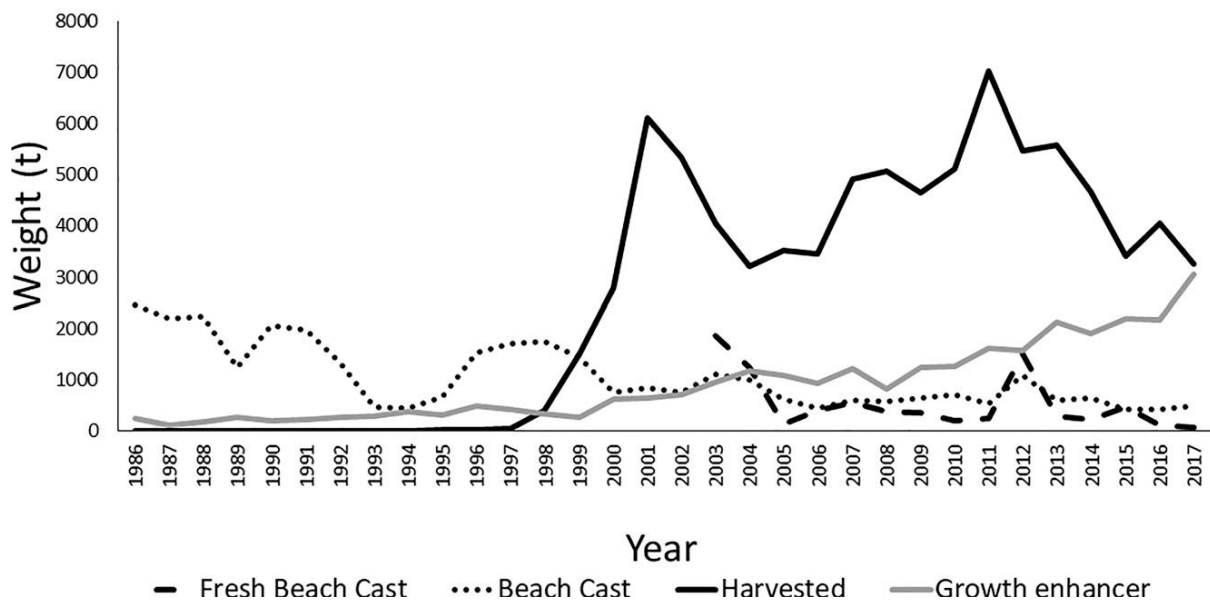


Figure 6: Kelp yields in South Africa, from 1986 to 2018, as reported by concession holders

Source: (Rothman M. D., Anderson, Kandjengo, & Bolton, 2020)

The kelp industry is estimated to use about 24 245 t of biomass (fresh weight) per annum. Roughly 12 719 t are from beach-cast collections, and 11 525 t from harvested material. The total market value for kelp before value-addition was estimated at ZAR 56.5 million, with the entire value chain providing about 350 direct jobs (BSASA, 2023).

The commercial yields of *Gracilaria* in Saldanha Bay, from 1951 to 2006 are described in Figure 7. Because of the decline, collection of beach-cast became economically unviable and stopped in the late 2000s. The volume of annual beach-cast material is still not commercially viable.

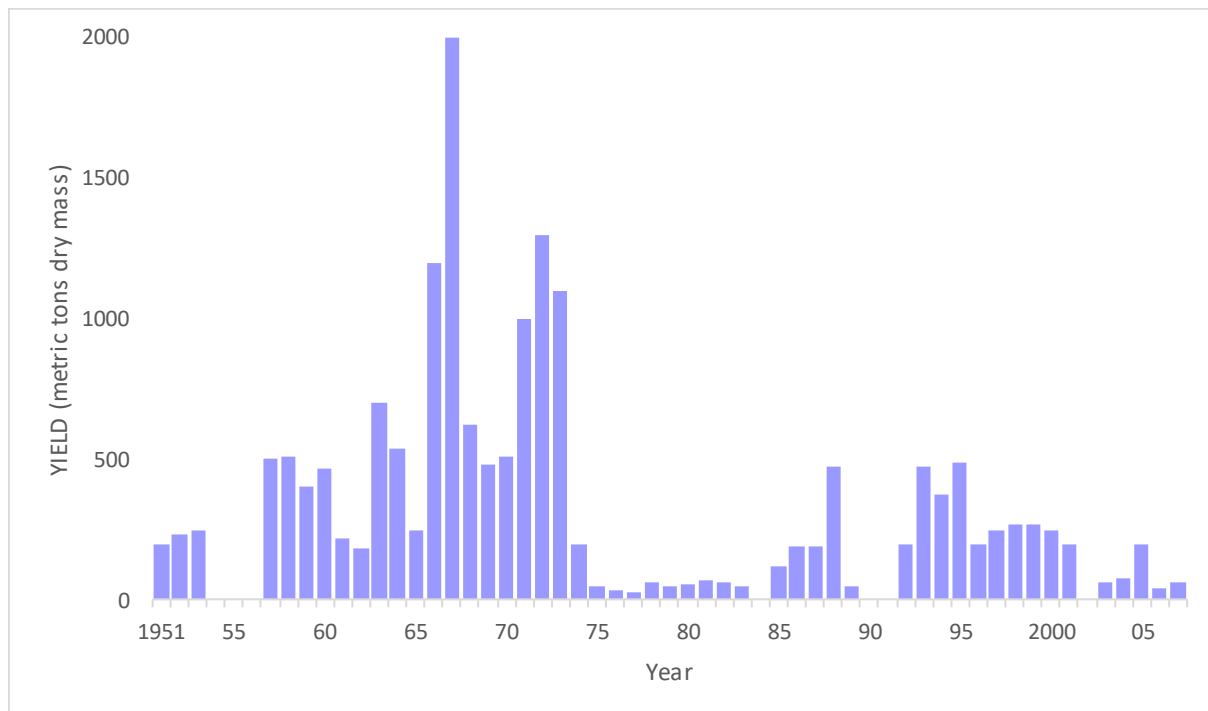


Figure 7: Commercial yields of *Gracilaria* from Saldanha Bay, 1951-2006 (data from 1951-1987 after Anderson et al. 1989; data 1988-2006 as reported by concession holders)

Source: Adapted from (Rothman M. D., Anderson, Boothroyd, Kemp, & Bolton, 2009)

Gelidium pristoides is now the only species from this genus that is regularly collected. *Gelidium* yields were generally 100–150 t dry per annum from 1986 to 2003 (Rothman M. D., Anderson, Kandjengo, & Bolton, 2020). However, data obtained from the DFFE indicated that yields have dropped to 40–60 t dry per annum between 2020 and 2023 (which could be due to the COVID-19 pandemic). *Ulva* and *Porphyra/Pyropia* spp. are also harvested for use in human food products (Rothman M. D., Anderson, Kandjengo, & Bolton, 2020). However, small-scale concession holders are not required to submit production data for these two species.

The estimated biomass, uses, and raw market value of the current South African seaweed industry is described in Table 6. In 2023, the annual kelp biomass use (fresh weight equivalent) was estimated at 24 245 t, with a raw market value (pre-value addition) of R56.5 million. The wholesale market value for biostimulants and liquid fertilisers was estimated to be around ZAR 317 million, and the entire value chain was valued at ZAR 357 million (BSASA, 2023). Using yields data from 2020 to 2023 (obtained from the DFFE), and a fresh to dry conversion rate of 60% (obtained from industry), the average annual *Gelidium* biomass (fresh weight equivalent) was estimated at 124 t. The raw market value of this biomass could not be confirmed.

It was not possible to obtain information about the annual harvested or collected biomass for *Ulva* and *Porphyra*, as seaweed concessionaires have not submitted this information to the DFFE. Although some local enterprises use *Ulva* and *Porphyra* in artisanal food and fertiliser production, commercial uses of these species are not widespread, and only low volumes were reportedly used.

Therefore, the total biomass use in the South African seaweed sector is estimated at 27 388 t p.a. (fresh weight equivalent), with a minimum raw market value of R56.5 million.

Table 6: Estimated annual production and value of South African seaweed

Sources: (Rothman M. D., Anderson, Kandjengo, & Bolton, 2020; BSASA, 2023); DFFE 2024

Seaweed group	Seaweed name species	Uses and method of production	Estimated biomass use FW equivalent (t p.a.)	Estimated raw market value (ZAR)
Brown	Kelp (<i>E. maxima</i> and <i>L. pallida</i>)	<ul style="list-style-type: none"> Fresh, for abalone feed and for agricultural liquid plant growth enhancer (harvested) Dried, milled, graded for local product manufacture and export (collected beach-cast) 	±24 245	56.5 million
Red	<i>Gelidium</i>	<ul style="list-style-type: none"> Dried, export for agar (hand-picked) 	±124	Not available
	<i>Gracilaria</i>	<ul style="list-style-type: none"> Fresh, produced in tank systems on abalone farms, for abalone feed 	±600	Not sold, used on-farm
	<i>Porphyra/Pyropia</i>	<ul style="list-style-type: none"> Dried, crushed, added to food products (hand-picked) Fresh, used as abalone feed 	Not available	Not available
Green	<i>Ulva lacinulata</i>	<ul style="list-style-type: none"> Fresh (produced in integrated land-based farm systems with abalone), for abalone feed 	±2 500	Not sold, used on-farm
	<i>Ulva</i>	<ul style="list-style-type: none"> Dried, added to food products (hand-picked) Fresh, for abalone feed (harvested) 	Not available	Not available
Minimum estimated biomass (FWE) and raw market value			±27 388	56.5 million

In contrast to the global situation, the South African seaweed industry is based mostly on wild-harvested and collected seaweeds. There has never been commercial cultivation of seaweeds in the sea in South Africa (Rothman M. D., Anderson, Kandjengo, & Bolton, 2020). The only commercially successful seaweed aquaculture in South Africa is production of the green seaweed *Ulva* and the red seaweed *Gracilaria*, which have been grown in land-based systems on abalone farms for more than 20 years. The first large-scale system for this cultivation was built at Wild Coast Abalone in Haga Haga in 2002. Currently South African production estimates are around fresh weight 2 500 t of *Ulva* and 600 t of *Gracilaria* per annum, grown mostly on five farms. Both these seaweeds are grown vegetatively, without going through the reproduction cycle involving microscopic spores and/or gametes. All the seaweed is used on-farm as abalone feed, and not sold, making accurate figures difficult to obtain, although a recent estimate is 2 400 t of *Ulva lacinulata* produced on South African abalone farms per annum (J.J. Bolton, pers. comm). A single species of *Ulva*, now known as *Ulva lacinulata*, is grown at all these abalone farms, from the extreme Northern Cape to the Eastern Cape (Bachoo, Bolton, Macey, Kandjengo, & Reddy, 2023), and the *Gracilaria* species is *G. gracilis*. The *Gracilaria* is particularly favoured as feed for juvenile abalone, whereas the *Ulva* is fed throughout the grow-out facilities, along with formulated feed—and in many farms—wild-harvested kelp (*Ecklonia maxima*).

Gracilaria has proved more difficult to grow than *Ulva* in local land-based systems and is grown in tanks with aeration, whereas the *Ulva* is grown in ca. 30 m-long, D-ended 'paddle raceways'. Other algae growing on the *Gracilaria* (epiphytes) can be a problem, and in at least one farm the *Gracilaria* seed material is manually cleaned before re-stocking.

Two local commercial abalone farms were designed specifically as integrated abalone/*Ulva* systems, using the *Ulva* to remove most of the ammonia from effluent water leaving the abalone tanks, enabling recirculation of 50% of the original effluent water (see Figure 8). These farms have been operating successfully for around 10 years. This bioremediation by the seaweed (Checa, et al., 2024) enables large-scale electricity cost savings (up to 40% estimated) by reducing water pumping costs (Bolton, Robertson-Andersson, Shuuluka, & Kandjengo, 2009). It also has other benefits, with nutrient content (especially nitrogen) being significantly reduced in the final farm effluent returning to the sea, and a potential to run the farm on 100% recirculation for 3—4 days in the event of a Harmful Algal Bloom at sea, which can seriously affect abalone output (Bolton, Robertson-Andersson, Shuuluka, & Kandjengo, 2009; Pitcher, et al., 2019). Production manuals from the ASTRAL project, incorporating all this information, have been made available to the public (<https://www.astral-project.eu/training-education-materials>).



Figure 8: *Ulva* cultivation in paddle raceways on abalone farms

Photo credits: Viking Aquaculture

During 2021, the South African Kelp Farming Project was launched with financial support from UK International Development via the FCDO, in collaboration with the DFFE and implemented by BSASA. Phase 1 (Pre-feasibility study) indicated potential viability of integrated at-sea cultivation of three kelp species (*E. maxima*, *L. pallida* and *M. pyrifera*) (BSASA, 2022). Geospatial analysis was used to identify nine potentially suitable areas for kelp farming along the west coast of South Africa. As illustrated in Figure 9, two of these areas (in St Helena Bay and Saldanha Bay) fall within the Velddrif-Saldanha Aquaculture Development Zone (ADZ) (Lück-Vogel, et al., 2024), which is one of eight marine ADZs identified during a Strategic Environmental Assessment for aquaculture in South Africa (DEFF, 2019).

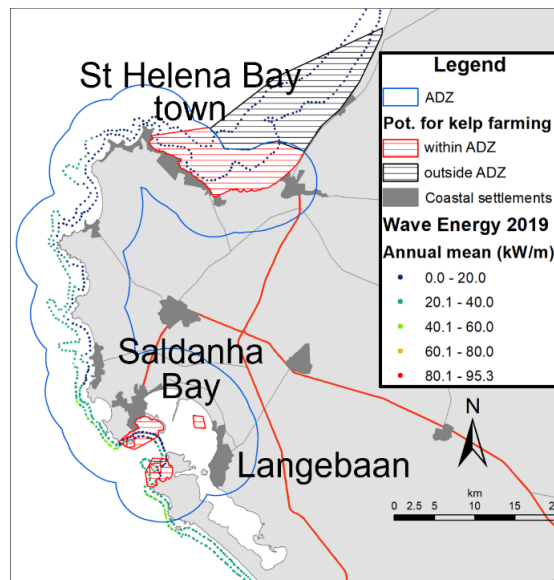


Figure 9: Areas within Velddrif-Saldanha ADZ with potential for kelp farming

Source: (Lück-Vogel, et al., 2024)

Phase 2 of the South African Kelp Farming Study, also funded by the UK International Development via the FCDO, commenced in 2022, with laboratory and at-sea cultivation trials of the same three kelp species in Saldanha Bay. As part of the project, a comprehensive kelp market and value chain analysis was conducted (BSASA, 2023). Project reports and publications are available through the PSSA website (<https://www.phycologysa.co.za/kelp-farming-project>). Phase 2 of the project will be completed in 2025.

Similar research on kelp farming is being undertaken elsewhere. Kelp Blue is an international company that aims to establish 6 500 ha of large-scale offshore *M. pyrifera* farms at four locations, including Namibia, Alaska, Chile and New Zealand. In Namibia, they have successfully established the technology to grow kelp on submerged rope systems, with a 3 500 t capacity processing facility that can convert kelp biomass into products such as biostimulants, packaging and other products (<https://www.kelp.blue/>).

South African seaweed species with potential for future aquaculture, and potential products, are described in Table 7. The list includes species that have been cultivated (experimentally or commercially) in the past, species that are currently subject to cultivation trials elsewhere (such as *Ecklonia radiata*), and species that are currently being cultivated on an experimental scale in South Africa (*E. maxima*, *L. pallida* and *M. pyrifera*). Carrageenophytes were collected in the past, and carrageenan has many applications such as the cosmetics industry, where it is used as a thickening or gelling agent (<https://www.cargill.com/personal-care/texturizers/carrageenans-old>).

Table 7: South African seaweed species with possible future aquaculture potential

Species	Potential product	South African occurrence	Notes
<i>Gracilaria gracilis/Gracilariopsis longissima</i>	Agar/other chemicals, feed for juvenile abalone, various products e.g. food and biostimulants, nutraceuticals etc.	South African west coast	At-sea growth trials were successful, current on-land cultivation in tanks is successful; agar of acceptable quality to Japanese market

Species	Potential product	South African occurrence	Notes
<i>Ecklonia maxima</i> and <i>Laminaria pallida</i>	Abalone feed, various other products such as biostimulants, nutraceuticals, cosmeceuticals, bioplastics, food products alginate/other chemicals, etc.	South African west coast	These species are currently tested in laboratory and sea-based growth trials on the west coast
<i>Porphyra/Pyropia</i>	Human food ('nori')	Likely South African species on west coast	Large, profitable industry in East Asia; local species harvested and used in human food products
<i>Ulva</i> spp.	Abalone feed, Human food products	West, southwest and southeast coast	This species is already harvested and used in human food products; current on-land cultivation in ponds is successful
<i>Ecklonia radiata</i>	Kelp (many potential uses)	Patchy distribution on south and east coasts	Large-scale cultivation experiments ongoing in Tasmania/New Zealand
Gigartinaceae	Carrageenan (especially λ)	Several species of <i>Gigartina</i> , <i>Sarcothalia</i> , <i>Chondracanthus</i>	Related to Irish Moss (<i>Chondrus crispus</i>) cultivated in N. Atlantic
<i>Pachymenia</i>	Carrageenan	Three species on west coast (including former <i>Aeodes orbitosa</i>)	<i>P. orbitosa</i> has been suggested before as a carrageenophyte
<i>Hypnea</i>	Carrageenan	Harvest of <i>H. spicifera</i> ? Cultivation of smaller species (both south coast)	Previous studies on <i>H. spicifera</i> . Cultivation of other species in e.g. Brazil
<i>Asparagopsis</i> spp.	Cattle feed additive	Both species present, but introduced and currently illegal to cultivate	Rapidly growing industry to prevent methane release (esp. Australia).
<i>Gelidium</i> spp.	Agar	<i>G. pristoides</i> collected from wild: cultivation of <i>G. vittatum</i> , others?	Unable to grow <i>Gelidium pristoides</i> , but subtidal species not investigated?
<i>Macrocystis pyrifera</i>	Kelp (many potential uses)	Limited distribution on southwest coast	Large-scale cultivation experiments ongoing in Namibia/Chile; cultivation experiments ongoing in South Africa

3.3 LOCAL INSIGHTS

One of the project objectives included the documentation of local insights regarding the cultivation of seaweeds, including local and indigenous knowledge in relation to future seaweed production. Such insights were obtained during three in-person workshops held in Saldanha Bay, Velddrif and St Helena Bay, and during an online workshop using an MS Teams platform. The results of interactive discussions during the three in-person workshops are discussed in detail in [Appendix B: Community Workshop Report](#).

3.3.1 Introduction to Seaweed Opportunity Workshops

Most attendees came from the traditional fishing communities of the coastal region including Saldanha Bay, Langebaan, Paternoster, St Helena Bay, Velddrif, and Mamre. Many referred to seaweed collectively as “bamboes” (bamboo/kelp), and to *Gracilaria* as “see gras” (seagrass). Their responses reflected widespread local and indigenous uses of seaweed in the past, for food, health, garden, agricultural and other applications. Popular uses included the wrapping and cooking of seafood in seaweed (which enhanced the flavour), using seaweed as a soil conditioner or fertiliser, and using dried sea bamboo (kelp) as firewood. Seaweed was also popular in health remedies (for skin problems, cuts and burns, inflammation, etc.). Furthermore, seaweed played an important role in their quality of life. Children used seaweed in their daily lives as make-believe hair and food, and as slides. Locals also knew the environmental value of seaweed, for example as a home for other species such as crayfish.

The issue of seaweed concessions is a point of contention for many community members, especially the Small-scale Fisheries Co-operatives that received concessions for *Ulva*, *Porphyra* and *Gracilaria* in Concession Area 11. Many participants admitted that they did not know what a seaweed concession or seaweed cultivation is. Some also thought they were getting concessions for kelp, which could not happen because there were already 15-year kelp concessions underway in the relevant areas. Those who did, identified regulatory issues and socio-economic benefits as the most important negative and positive aspects to development of both pathways to biomass access. Participants identified the benefits of seaweed as environmental, food, health and socio-economic. The potential future uses identified were mostly food- and health- related. Participants’ greatest expectations with regards to the development of the seaweed market and value chain were economic development and the development of sustainable businesses.

3.3.2 Online workshop

An online workshop was held on 6 September, with 49 participants from a wide range of local and international stakeholders. The purpose of the workshop was to provide feedback regarding the project, including preliminary observations from the seaweed value chain and market analysis and the workshops, and to obtain further insights from stakeholders, as described below.

Production and market development:

- ⇒ Seaweed has high moisture content, needing huge volumes, with high drying costs. Manufacturers may not be willing to pay 5–6 times more for farmed seaweed
- ⇒ The South African Kelp Farming Project, if piloted on a larger scale, could be used to determine financial/market feasibility of kelp farming, including production capacity along the coast
- ⇒ Factories need to be closer to harvesting areas; In the Northern Cape, distances are a problem
- ⇒ Seaweed standards are important; SADC and the Global Seaweed Coalition are working on standards, and the South African Government is working with the SABS to develop food safety standards.

Enterprise development and education:

- ⇒ A central knowledge repository (e.g. about regulatory issues, harvesting and aquaculture) is important. The Phycological Society of Southern Africa (PSSA) website is a good starting point (<https://www.phycologysa.co.za/>)
- ⇒ Enterprise development, skills development, business development and education are important and need to be championed.

Seaweed industry strategy development:

- ⇒ The current concession holders need to remain part of the discussions and development of the seaweed industry
- ⇒ The African Union Development Agency-New Partnership for Africa's Development (AUDA-NEPAD) is identifying gaps for micro and macro algae across Africa, and advises a cautionary, scientific evidence-based approach with more value chain studies (<https://www.nepad.org/>)
- ⇒ The World Bank is working with South Korea on the development of their seaweed industry and is ready to support South Africa to become a big player. This could include a visit to South Korea to see how they could assist in a practical way and copy what works. This may require a Seaweed Strategy for South Africa.

3.4 CURRENT SIMPLIFIED SEAWEED VALUE CHAIN

The current seaweed value chain, based mostly on the wild harvesting and collection of seaweed, is illustrated in Figure 10. The seaweeds that are exploited include *E. maxima*, *L. pallida*, *G. pristoides*, *Porphyra/Pyropia* spp., *Ulva* spp. and *G. gracilis*. *Ulva* and *Gracilaria* are cultivated on abalone farms and are not sold but fed to abalone on the farms. In addition, seaweed products in various forms from dried, packaged food products (e.g. nori (*Porphyra*) sheets) to nutraceutical products (e.g. kelp tablets) are imported and distributed to consumers.

Raw material production is mostly based on harvesting of living biomass, or collection of washed-up material. Suppliers include labour, equipment such as boats, and transport. The DFFE is responsible for the regulation and management of harvest and collection of raw materials in terms of the Marine Living Resources Act of 1998 (MLRA), the 2012 Policy for the Small-scale Fisheries Sector in South Africa (PSSFS), and the 2015 Policy on the Allocation and Management of Commercial Fishing Rights in the Seaweed Fishery (Seaweed Fishery Policy: 2015). Commercial or small-scale seaweed rights holders can harvest or collect raw material from twenty-three demarcated areas along the coastline. Aquaculture (including seaweed grown on aquaculture farms) is regulated in terms of the MLRA and various other relevant legislation relating to environmental management, plant and animal management, processing and manufacturing of various products, etc.

Primary processing includes the cleaning and stabilisation of fresh material, drying, sorting, milling and grading. Secondary processing includes further processing such as manufacturing of feed pellets, plant biostimulants and other products. This could take place in South Africa, or in the case of exported materials, in other countries. Some seaweed rights holders are vertically integrated and own their own processing facilities. Regulation includes various legislation related to the manufacturing of products, such as the Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act of 1947, etc. Distribution could be done by seaweed rights holders, processing companies or independent parties. Various companies are involved in the importation of products containing seaweed as an ingredient.

Currently, the main markets or consumers of seaweed products in South Africa are farms that utilise fresh kelp for abalone feed; wholesale or retail companies that sell seaweed-derived products such as food and nutraceuticals (including online and specialty shops, restaurants and food outlets, the agriculture and horticulture industry using biostimulants and the global colloid industry that extract phycocolloids (such as alginate and agar). Phycocolloids are amongst the seaweed ingredients and products imported into South Africa and sold through wholesale and retail outlets.

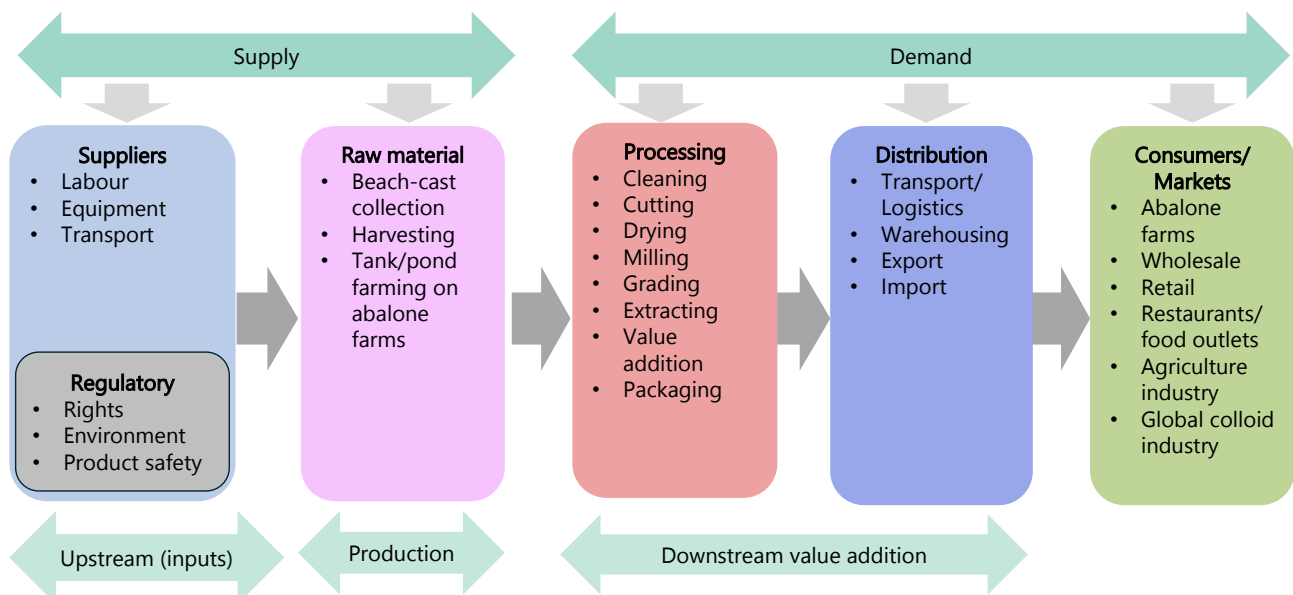


Figure 10: Current simplified South African seaweed value chain

GAPS: Several gaps and inefficiencies in the value chain are limiting the expansion of the industry. Some were identified during a kelp value chain study (BSASA 2023) and are included in the list as follows:

- ⇒ Lack of a food-grade processing facility in the Western Cape
- ⇒ Insufficient supply to the niche restaurant market
- ⇒ Inconsistent supply across the industry and difficulty in accessing raw product
- ⇒ No commercial seaweed cultivation other than on abalone farms.

CHALLENGES:

The seaweed industry is largely based on the harvest and collection and drying of commoditised biomass (raw dried seaweed), which are finite resources. Although there have been several studies and trials on cultivation of commercially important seaweed species over the years, there is still no commercial seaweed aquaculture in South Africa, other than on abalone farms (who do not sell their seaweed into the market).

Beach-cast collection of *G. gracilis* stopped in the late 2000s due to the decline in washed-up material, which made exploitation of the resource uneconomical. Although several species of *Gelidium* have historically been harvested from five Seaweed Rights Concession Areas, current collection mostly takes place from only one of these (Area 1). This is because four of the areas have little available *Gelidium* and poor transport infrastructure (Rothman M. D., Anderson, Kandjengo, & Bolton, 2020). Without sufficient biomass of these two seaweed groups, the establishment of an agar manufacturing facility in South Africa therefore remains economically unviable.

Historically, for people outside the value chain, it is difficult to obtain access to information about the seaweed industry. Typically, one had to contact several officials and possibly complete a Promotion of Access to Information Act (PAIA) form to request access to information. In 2024, DFFE updated its website, which makes access to general information easier (<https://www.dffe.gov.za/>).

The regulatory environment for seaweed harvesting and collection remains difficult. As a result of the PSSFS, several Seaweed Rights Concession Areas previously allocated to commercial companies

have been set aside for exploitation by small scale fishing co-operatives from coastal communities. During 2024, the process of allocation was completed when several co-operatives in the Western Cape received rights to exploit specific seaweed species in Concession Areas as part of a "basket" of species allocated to each co-operative.

OPPORTUNITIES:

The global new and emerging applications for seaweed have led to a growing enthusiasm in seaweed utilisation and cultivation in 'new geographies' i.e. everywhere in the world outside of East Asia. This 'seaweed revolution' is described and actively promoted by organisations such as the Global Seaweed Coalition (<https://www.safeseaweedcoalition.org/>). This enthusiasm has spread to South Africa as well. The success of the abalone aquaculture industry, global market opportunities for biostimulants and new and emerging applications for seaweed (e.g. bioplastics) have led to increased interest in the cultivation of seaweeds, and exploitation of additional species with commercial potential.

The volume of seaweed that can be sustainably harvested and collected from Concession Areas is finite. Any significant expansion in markets may require cultivation of seaweed at sea or on land. *Gracilaria* cultivation experiments undertaken in Saldanha Bay and St Helena Bay on the west coast in the 1990s were successful. The technology for integrated production of *Ulva* in paddle raceways and of *Gracilaria* in tanks on abalone farms is well understood. Currently, an at-sea cultivation trial of three kelp species is underway in Saldanha Bay. The technologies for cultivation of a few species of South African seaweed species are, therefore, already well understood, or under investigation.

We have a number of species of *Porphyra/Pyropia* in South Africa (Reddy, Clerck, Leliaert, Anderson, & Bolton, 2018). The main biomass of *Porphyra* at the top of the seashore on the west coast is composed of *Porphyra capensis*, and it is likely that most '*Porphyra*' collected is of this species. This material is generally large and often appears blackish/brownish. Lower on the seashore are a number of other species, which are generally more reddish/purple. A common, large west coast species is *Pyropia saldanhae* (Reddy, De Clerck, Leliaert, Anderson, & Bolton, 2020).

While wild stocks are finite, there are processing and value addition opportunities within this resource, including building value chains for seaweed species newly allocated to small scale co-operatives. Value addition opportunities can be trialled with wild harvest amounts before looking at increasing production through farming. This will require a good understanding of the sustainable harvesting limits for each of the species allocated, and cooperation amongst co-operatives that have been allocated concessions within the same concession area.

Market opportunities for farmed kelp include biostimulants, animal feeds, nutraceuticals and cosmeceuticals, bioplastics and fabrics, the restaurant and local food market trade, and exploration of multiproduct development (BSASA, 2023).

Other species with future aquaculture potential include:

- ⇒ *Porphyra/Pyropia* (human food)
- ⇒ *Ecklonia radiata*, *Macrocystis pyrifera* and *Laminaria pallida* (kelp has many uses; e.g. much of the European kelp industry (e.g. Brittany, Norway) is based on natural stocks of *Laminaria hyperborea*)
- ⇒ Gigartinaceae, *Pachymenia*, *Hypnea* (carrageenan)
- ⇒ *Asparagopsis* spp. (cattle feed additive)
- ⇒ *Gelidium* spp. (agar).

There is also interest in the cultivation of *Gracilaria*, kelp and eucheumatoids for export to Asian markets (Ohno, Doi, & Ohno, n.d.). Eucheumatoids are grown in tropical seas, and it is very unlikely that sites can be found in South Africa where these (species of *Eucheuma*, *Kappaphycus*) can grow, and where regulations would permit aquaculture of the required introduced material. Most of the fringe tropical coastline of South Africa (north of St Lucia) is in the isiMangaliso Wetland Park, a large marine conservation area.

4 POTENTIAL FUTURE SEAWEED VALUE CHAIN

The current seaweed value chain, based mainly on wild-harvest and collection of biomass, does not yet include many of the activities or role players required for seaweed aquaculture. For example, there are various knowledge generators and industry influencers involved in research and development initiatives, aimed at establishing a sustainable commercial seaweed aquaculture industry. Figure 11 illustrates a potential future, expanded value chain that incorporates all aquaculture-related research, farming, processing, value addition, product and market development, distribution, and other activities and role players.

Research and development of production and new products (uses and processes) need to go hand in hand to expand the wider seaweed industry. Seaweeds have traditionally been contributors to much broader, global industries, for example human and animal feed industries, colloids, agricultural products etc., where seaweeds are a beneficial component. The existing South African seaweed industry is a good start to allow expansion in the various areas. For example, the World Bank report (2023) predicts that biostimulants are a large emerging seaweed market, whereas a globally successful biostimulant has been produced locally from South African kelp since the 1970s. Similarly, animal aquaculture feed is a large emerging use of seaweeds, and the South African abalone aquaculture industry has been carrying out research and feeding seaweeds (both harvested kelps and aquacultured *Ulva* and *Gracilaria*) since the industry began in the 1990s.

There is, thus, a good record of innovation in seaweed uses and products. *Ulva* grown on South African abalone farms is one of the largest examples, globally, of the aquaculture of green seaweeds (Hofmann, et al., 2024). The current availability of seaweeds is limited by resource availability, and although the commercial value could be increased e.g. through increased value addition/processing (and made more equitable), to produce a large seaweed industry in South Africa will eventually require aquaculture.

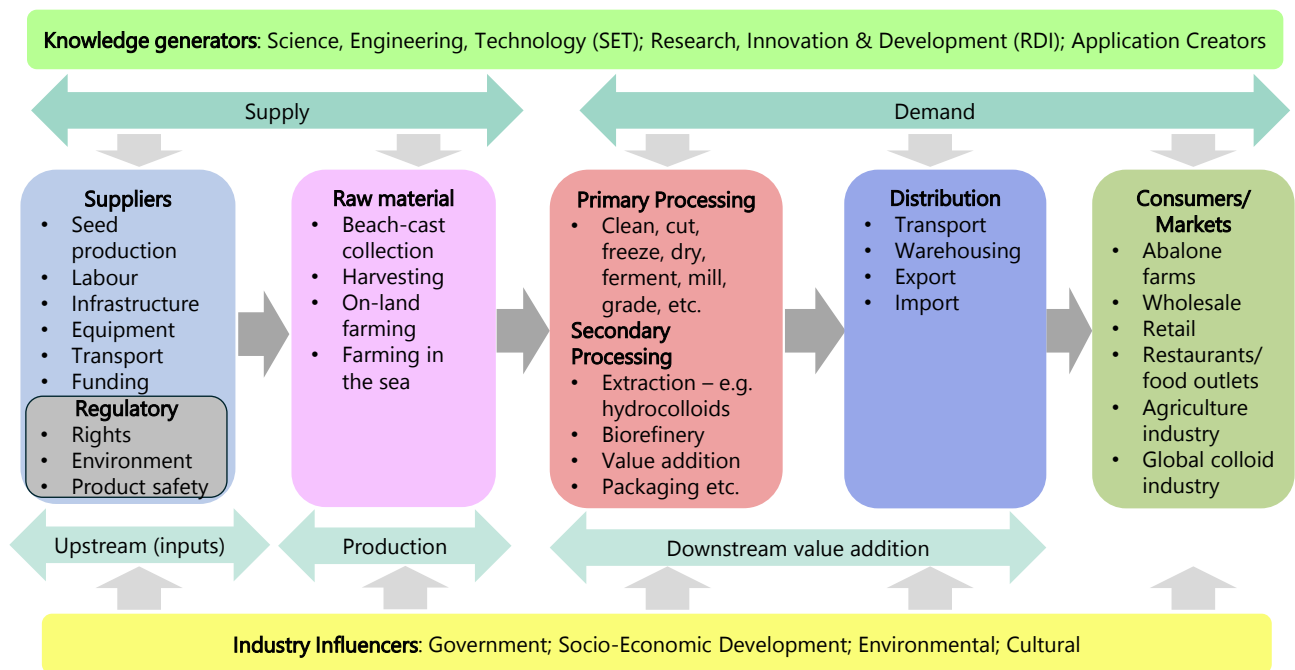


Figure 11: Potential future South African seaweed value chain

4.1 KNOWLEDGE GENERATORS

On both global and local scales, research into the benefits, applications, valorisation and cultivation of seaweed increased over the last few years. In South Africa, several collaborative or organisation-specific projects are ongoing to generate the required scientific, engineering and technical knowledge required to expand existing and build new seaweed value chains (see Figure 12). These projects may include Higher Education Institutions (HEIs), Research Councils, private companies, government, development agencies, non-profit organisations and others. Knowledge generators include research institutions, industry, government departments and development organisations that conduct research such as the conservation and sustainable utilisation of seaweed resources, development of new products from seaweeds, seaweed aquaculture etc. Associations such as the Phycological Society of Southern Africa (PSSA) play a crucial role in the coordination and dissemination of research results amongst the research community and wider audiences. There are good working relationships between industry, academia and government in many collaborative projects in South Africa, which bodes well for further development of the industry.



Figure 12: Knowledge generators in the seaweed value chain

The Seaweed Project at Stellenbosch University (<https://www.eng.sun.ac.za/awesome-seaweeds-researched-in-ambitious-collaborative-project/>) is a collaborative project between the Department of Process Engineering, a private company—CMD Industries and the Cape Peninsula University of Technology (CPUT). The project's aims are to explore how to recover different high-value and health-promoting compounds found in kelp (e.g. fucoidan, laminarin and alginate) in an environmentally friendly way, and to determine how to incorporate these compounds into existing foods.

The International Joint Laboratory (IJL) LIMAQUA (<https://en.ird.fr/project-limaqua-african-interdisciplinary-laboratory-sustainable-nutrition-sensitive-marine>) is a collaboration between multiple French and South African research institutions, bringing together an interdisciplinary team of scientists. The project aims to tackle nutritional and sustainability challenges of marine aquaculture and lay the foundations of a regional centre of excellence in sustainable, nutrition-sensitive marine aquaculture. *Gracilaria*, farmed *Ulva* and three South African kelp spp. were included in a baseline survey to characterise the nutritional value of aquatic species that are currently farmed or considered as aquaculture candidate species. The objective was to assess the contribution of these species to the nutritional needs of South Africans and to identify nutritional and functional ingredients for human consumption and for animal feeds. The GDRI-Sud AfriMAQUA project (<https://en.ird.fr/project-afrimaqua-sustainable-marine-aquaculture-africa>) brings together research teams from various African countries to exchange knowledge, pool research efforts and strengthen research capacity in order to develop marine aquaculture in a sustainable manner in Africa. Both projects are funded by the French National Research Institute for Sustainable Development (IRD), with additional funding provided by the National Research Foundation (NRF).

The All Atlantic Ocean Sustainable, Profitable and Resilient Aquaculture (ASTRAL) Project (<https://www.astral-project.eu/>) is a European Union Horizon 2020 collaboration focused on integrated multi-trophic aquaculture (IMTA) farming in the Atlantic area. The South African partners are a collaboration between the University of Cape Town, DFFE and Viking Aquaculture, and the IMTA research is conducted at the DFFE marine aquaculture research aquarium and Buffeljags abalone farm on the Cape South Coast. The seaweed species grown in this system includes sea lettuce (*Ulva*

lacinulata), with abalone and sea urchins (*Tripneustes gratilla* and *Parechinus angulosus*). The ASTRAL project will release cultivation manuals for all species involved (they are already written), and the local kelp project is also working on something similar for our kelps. Dissemination is generally integrated in these projects. The problem is whether the skills and commitment are available to take advantage of this information.

The AquaVitae Project (now finished), was a sister project of ASTRAL, also EU funded, and coordinated by NOFIMA (Norway). The project investigated land- and sea-based IMTA value chains in various countries, including South Africa. There were numerous studies involving seaweeds, including cultivation trials for *Gracilaria*, as well as incorporation of *Ulva* in formulated feed for abalone. Partners included Rhodes University, Wild Coast Abalone (RSA), Marifeed Ltd. (RSA), Universidad de las Palmas de Gran Canaria and France Haliotis (Spain and France), Universidade Federal de Santa Catarina and Trevisan (Brazil).

<https://aquavitaeproject.eu/value-chains-case-studies/ii-integrated-multi-trophic-aquaculture-imta-land-based-and-sea-based-new-species-and-systems/#1566566507637-f8b311eb-fab3>

The South African Kelp Farming Project, funded by UK International Development via the FCDO and implemented by BSASA, commenced in 2022. The project aims to investigate the feasibility of commercial cultivation of three species of indigenous kelp (*E. maxima*, *L. pallida* and *M. pyrifera*) along the west coast of South Africa. The Kelp Farming project will release cultivation manuals for all species involved. <https://www.phycologysa.co.za/kelp-farming-project>

The Kelp Scientific Collaboration (KSC) was set up in 2024 as a Public-Private-Partnership (PPP) to promote the importance and value of the Great South African Kelp Forest and support its long-term sustainability through science, education and collaborative research. The KSC is directed by a Steering Committee, and its members are drawn from key players in the market, industry, regulatory, environmental protection agencies and universities.

The Global Seaweed Coalition (GSC) is instrumental in the development of a seaweed industry that provides safe products, safe working conditions and environmental protection, and to help the seaweed sector make a significant contribution to the United Nations' SDGs. GSC also provides funding to sector-building projects to accelerate growth in the industry, from cultivation through processing to new product development. <https://www.safeseaweedcoalition.org/>.

There are various international organisations contributing to the body of knowledge and providing support to the seaweed industry. The World Bank Group (WBG) promotes the development of sustainable and responsible aquaculture through its AqualInvest Platform, financed by PROBLUE (<https://www.worldbank.org/en/topic/agriculture/brief/the-aquainvest-platform>). WBG also published a global seaweed market report in 2023, detailing new and emerging seaweed market segments. The Scottish Association for Marine Science (SAMS) has specialist expertise in aquaculture and is one of the ASTRAL partners (<https://www.sams.ac.uk/>). GreenWave is a global network of regenerative ocean farmers that provides technical, market and business support and training to seaweed farmers (<https://www.greenwave.org/>).

CHALLENGES:

- ⇒ Coordination of efforts can be difficult where multiple role players are involved in similar initiatives
- ⇒ Dissemination of results for practical application

- ⇒ Availability of entrepreneurs in the value chain with the required skills to utilise the available knowledge
- ⇒ Research and development of a new species in aquaculture can be a long process. Initial stages may be externally funded by research/government agencies, but the transition to a commercial operation is often long and difficult.

OPPORTUNITIES:

- ⇒ The Saldanha Aquaculture Development Centre (SAquaDC), a collaborative initiative, is in the process of being established, with the aim to provide an integrated technical and business support mechanism to develop aquaculture enterprises and the industry in the Velddrif-Saldanha Aquaculture Development Zone
- ⇒ Numerous examples of external funding and expertise providing opportunities for scientists:
 - ◆ Two EU projects, UK International Development project, five years of IRD projects, and the UNDP/Japan interest
 - ◆ These projects provide opportunities for scientists and practitioners, and the expansion of the body of knowledge about seaweeds and their cultivation
- ⇒ The existence of local seaweed industry and aquaculture industry professionals (these in great demand around the world)
- ⇒ The 'Seaweed Revolution' which is envisaged and predicted in the west (Global Seaweed Coalition, as well as the World Bank Report (2023)). There is overwhelming media attention on seaweed potential over the last few years.

4.2 SUPPLIERS

A strong base of suppliers addressing the needs of the seaweed sector is key to growth. The various suppliers required to support the seaweed value chain are set out in Figure 13.

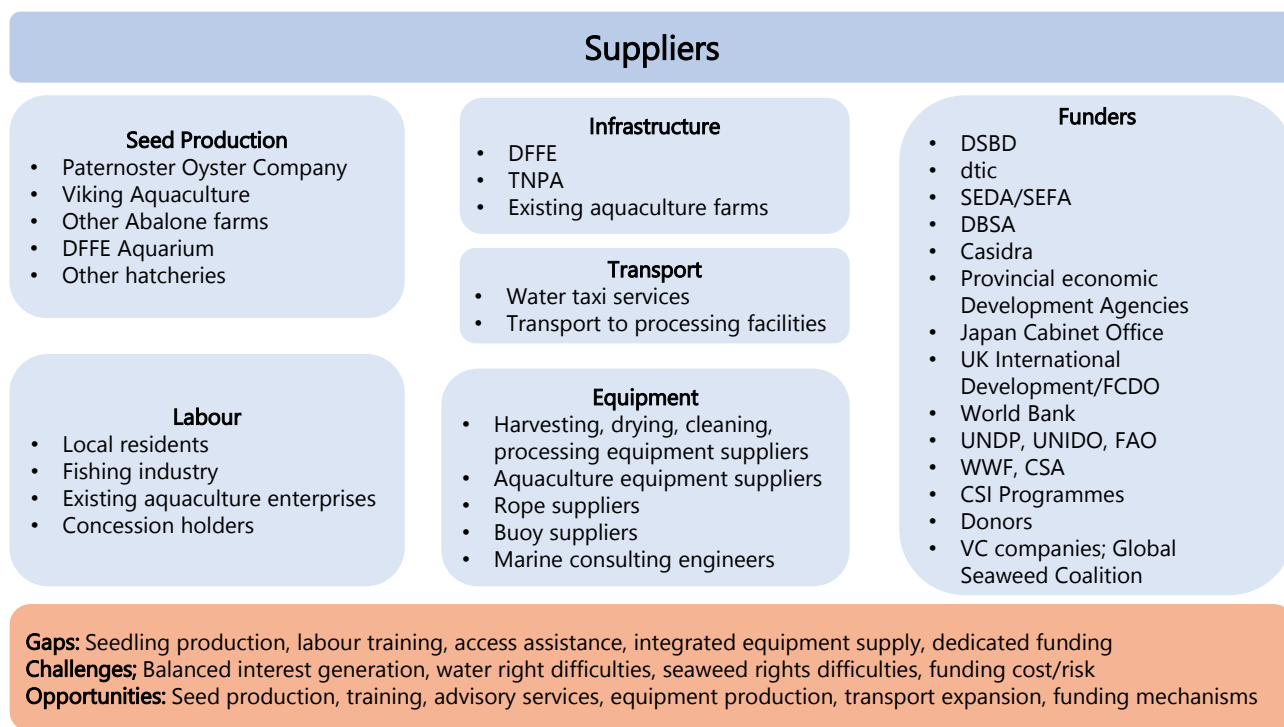


Figure 13: Suppliers in the future South African seaweed value chain

The main inputs are:

- ⇒ **Seed Production:** Sporelings and thalli are the main raw material input for seaweed aquaculture. There are no dedicated nurseries/hatcheries focusing on seaweed. The DFFE Aquarium and Paternoster Oyster Company have the capability. Viking Aquaculture has its own hatchery for the kelp it intends to grow as abalone feed. Some abalone farms undertake vegetative thalli reproduction of *Gracilaria* and *Ulva* for abalone feed purposes. There is no seaweed biobank (or any algae culture collection) in Africa; this could be a risk in the case of die-off of one of the economically valuable seaweeds.
- ⇒ **Labour:** Labour is generally sourced from the surrounding areas. Beach cast collection and harvesting do not require special skills. There is not much experienced labour available for seaweed aquaculture operations. However, fishermen and labour experienced in other sea aquaculture could easily be trained. It is often neglected to train labour in seagoing skills as provided by the South African Maritime Safety Authority (SAMSA).
- ⇒ **Infrastructure:** Other than general infrastructure such as transport, beach cast collections and harvesting do not require specific infrastructure. Water space is the key infrastructure required for coastal seaweed aquaculture. Generally, access to the coast is governed by the DFFE. In the case of ports, the water spaces are governed by the Transnet National Ports Authority (TNPA). Existing aquafarms can provide seedstock as they already have systems of seawater pumping running.
- ⇒ **Equipment:** Beach cast collections and harvesting make use of specialised equipment in some cases, e.g. equipment to remove sand from beach cast seaweed (turning, elongated cages with motor belt drive). Some local companies (Aquaculture Innovations, Aquaponics Direct, Ecotao) supply aquaculture systems or sub systems. However, none are focused on seaweed, as the industry is very small at this stage. Much of the equipment used in seaweed aquaculture systems

is purpose made by the individual farmers/entrepreneurs, using supplies from established commercial concerns that supply their products into the broader market. For seaweed, the most notable suppliers of such inputs include Southern Ropes, Ropes for Africa, Engineering supplies. Marine Buoys, African Marine Services, Anchor industries, Pioneer Plastics, RotaTank, BOATSA and a selection of timber merchants. Saldanha Bay Diving provides the inputs (chains, blocks etc.) for anchoring rafts and longlines typically used in seaweed aquaculture. The services of marine engineers may be used when designing seaweed aquaculture facilities, especially the case for offshore: Potential suppliers of these services include PRDW, Enuvo, MarineTech, Beckett Rankine, and SA institute of Marine Engineers and Naval Architects

- ⇒ **Transport:** Where harvesters and farmers do not own, have direct access to sea craft, or have a service contract, they are dependent on 'water taxi services' to access their farms. Waypoint Marine provides this service in Saldanha Bay, and charges at an hourly rate.
- ⇒ **Funding:** No specific or dedicated funding mechanisms have been identified for the seaweed value chain. Potential funders include the Department of Small Business Development, Department of Trade, Industry and Competition, Small Enterprise Development/Finance Agency (the two agencies are in the process of merging), Development Bank of SA, Casidra and other provincial economic development agencies. The international interest in seaweed should not be forgotten, e.g. World Bank, UNDP, UNIDO, FAO, WWF, GIZ, UK FCDO, GSC etc. Once the industry has been established, private donors, CSI programmes and venture capital companies could also be interested.

GAPS: Moving from mainly collection and harvesting into farming as a relatively new development with a view to developing a vibrant value chain highlights a number of gaps:

- ⇒ Shortage of hatchery/nursery capacity
- ⇒ Neglect of technical and safety training for labour
- ⇒ Lack of advisory services for accessing water rights
- ⇒ No seaweed-specific equipment and system suppliers
- ⇒ A lack of dedicated funding mechanisms.

CHALLENGES: The main challenges include:

- ⇒ Generating interest in new activities in a balanced manner that stimulates sufficient interest but avoids run away enthusiasm with visions of easy success
- ⇒ A lack of clarity on water rights authorities in some areas, e.g. St Helena Bay, and on rights access to seed material (e.g. kelp sorus and *Gracilaria* seedstock)
- ⇒ Funding. The costs of setting up a significant seaweed cultivation facility are high, and it is a relatively new activity, with risks that could discourage potential funders.

OPPORTUNITIES: The development of the seaweed value chain should unlock a number of opportunities in the supply side:

- ⇒ Hatcheries/nurseries
 - ◆ Sales opportunities for the abalone farms currently undertaking these operations
 - ◆ The development of new local operations with the assistance of the DFFE, or the current producers
- ⇒ Labour
 - ◆ Establishment of a technical training facility aimed at meeting the specific needs of the sector
 - ◆ Provision of seafaring skills training aimed at improving worker safety and worker development
- ⇒ Infrastructure
 - ◆ The establishment of services aimed at facilitating the access to water rights, as well as other licensing issues identified in the Regulatory section
- ⇒ Equipment
 - ◆ For current aquaculture equipment companies to expand into seaweed

- ◆ The establishment of local specialist seaweed equipment and system suppliers
- ⇒ Transport
 - ◆ Expansion of existing operations
 - ◆ Establishment of new capacity
 - ◆ Establishment of value-added services
- ⇒ Funding:
 - ◆ Establishment of professional feasibility study and business planning services
 - ◆ Establishment of dedicated funding mechanisms.

4.3 PRODUCTION OF RAW MATERIALS

Currently, raw materials are mostly produced from indigenous seaweeds, including kelp (*E. maxima* and *L. pallida*), *Gelidium* spp., *Porphyra/Pyropia* and *Ulva*. Kelp species contain alginate, a commercially valuable colloid. For all species the source methods include the harvesting of living biomass from standing stock (*E. maxima*), collection of wash-ups from the shore (*E. maxima* and *L. pallida*), or picking of biomass from rocks by hand (*Gelidium*, *Ulva* and *Porphyra* spp.) (Figure 14). *Gracilaria* used to be collected as beach-cast material in Saldanha Bay/St Helena Bay until the late 2000s, when collection stopped due to a substantial decline in washups. *Ulva* and *Gracilaria* are also cultivated in land-based aquaculture systems on abalone farms, to be used as abalone feed. The raw material component of the seaweed value chain is illustrated in Figure 14. One of the abalone farms (Abagold) is about to launch a venture covering the commercial uses of their farmed seaweeds (S. Halse, pers. comm).

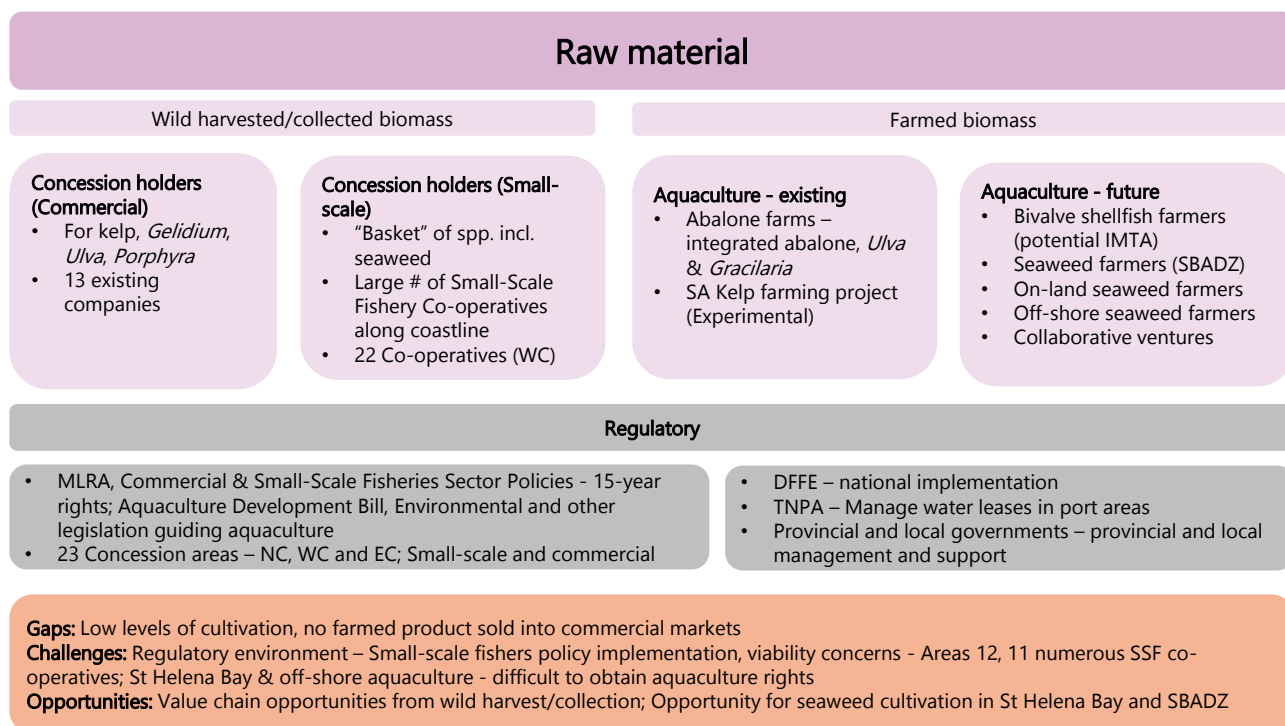


Figure 14: Production of raw materials in the seaweed value chain

Commercial seaweed resources in South Africa can be harvested or collected according to a system of 23 Seaweed Rights Concession Areas between the Northern Cape, Western Cape and Eastern Cape (Figure 15). These resources are managed in terms of the MLRA, the Seaweed Fisher Policy: 2015 Policy, and the PSSFS, administered by the DFFE. Currently, commercial seaweed fishery rights are allocated for 15 years. Within each Concession Area, multiple concession holders may be allocated

rights for the exploitation of specific types of seaweed. Small-scale fishing rights are awarded for the remaining period of the long-term rights allocation period in the same area.

Areas 15 to 19 are within the Northern Cape, and areas 1, 20, 21, 22 and 23 within the Eastern Cape (Figure 15). Concession Areas 2 to 13, part of Areas 1 and 14, and Area 17 fall within the Western Cape (Figure 16). Since 2016, Small-scale Fishery Co-operatives have been set up in terms of the PSSFS to recognise and protect the rights of small-scale fisher communities. These co-operatives received rights to “baskets” of species including fish, shellfish and seaweeds, that could be exploited within allocated Concession Areas.

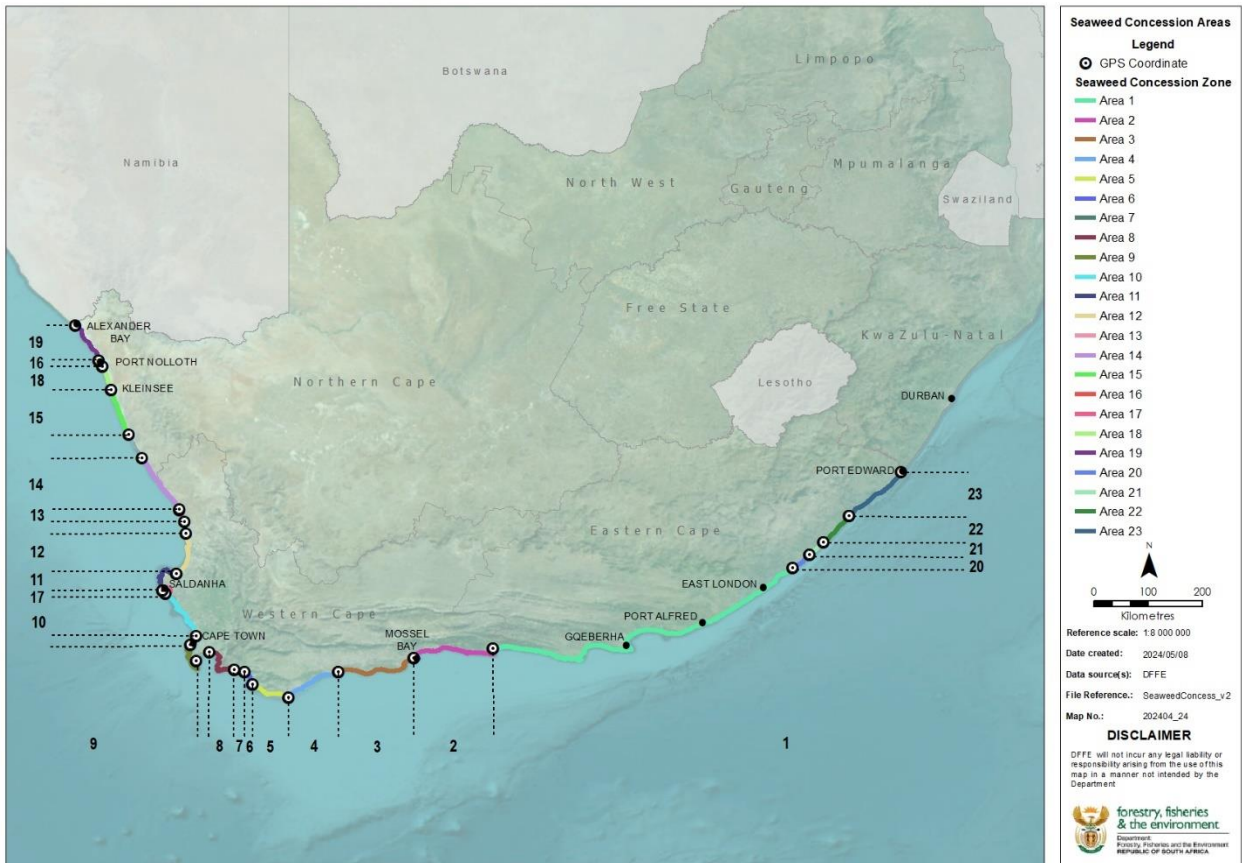


Figure 15: South African seaweed concession areas

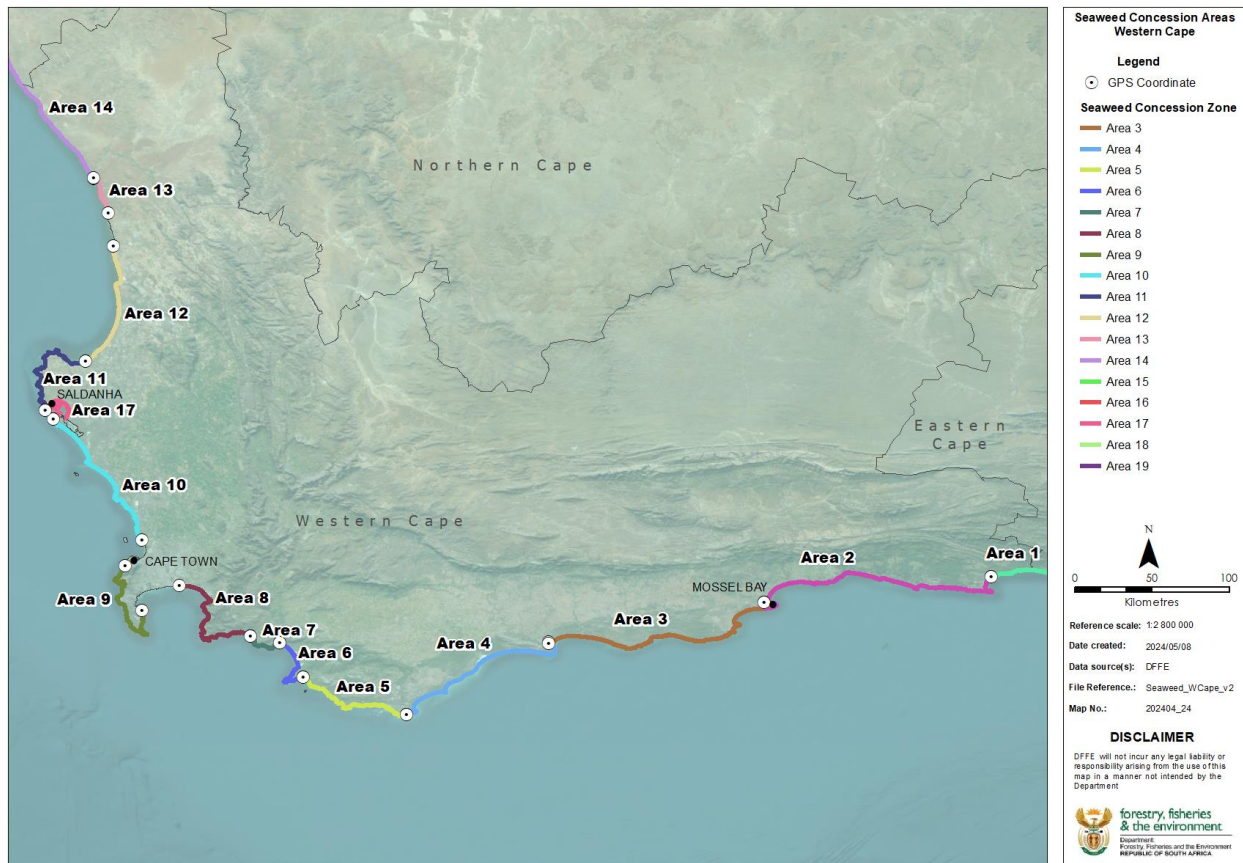


Figure 16: Western Cape seaweed concession areas

In 2024, 29 Small-scale Fishery Co-operatives in ten Concession Areas in the Western Cape received concessions for different species of seaweed as part of their "basket" of species. The seaweed species include kelps *E. maxima* and *L. pallida* (drift/wet/dry, in Concession Areas 5 and 8), *Gelidium*, *Ulva*, *Porphyra* and *Gracilaria*. Some of these concessions overlap with commercial concessions in the same Concession Areas, as set out in Table 8. In some Concession Areas, multiple co-operatives received concessions for the same species. As an example, in Area 11, eight co-operatives have rights to collect *Gracilaria*, *Ulva*, and *Porphyra*. The coveted right for harvesting and collecting *E. maxima* and *L. pallida* in this Concession Area had been previously allocated to one commercial company, with a validity period of 15 years. This has caused considerable uncertainty and unhappiness amongst the Small-scale Co-operatives.

The quantities of beach-cast *Gracilaria* in Concession Area 17 has dwindled to the extent that no commercial collection has taken place since the late 2000s, and only sporadic beach-casts have been observed in Area 12 (north of the Berg River mouth) (Rothman M. D., Anderson, Boothroyd, Kemp, & Bolton, 2009). For *Ulva* and *Porphyra*, no harvest data has been submitted to the DFFE for at least four years, and it is not yet clear how much biomass can be sustainably and economically harvested by the multiple co-operatives that have received concessions.

Table 8: Small-scale and commercial seaweed concession holders in the Western Cape (2024-2025 fishing season)

Source: DFFE

Concession Area	# of Small-scale Concession Holders	Species allocated	# of Commercial Concession Holders	Species allocated
1	-		1	<i>Gelidium</i>
2	2	<i>Gelidium</i>	-	
3	2	<i>Gelidium</i>	-	
4	2	<i>Gelidium</i> , mixed beach-cast	-	
5	2	<i>E. maxima</i> ; <i>L. pallida</i>	-	
6	2	<i>Ulva</i> , <i>Porphyra</i>	1	Kelp
7			2	Kelp, <i>Ulva/Porphyra</i>
8	6	<i>E. maxima</i> , <i>L. pallida</i> , <i>Ulva</i> , <i>Porphyra</i>	-	
9	-		1	Kelp
10	-		2	<i>Ulva/Porphyra</i> , Kelp
11	8	<i>Gracilaria</i> , <i>Ulva</i> , <i>Porphyra</i>	1	Kelp
12	2	<i>E. maxima</i> , <i>L. pallida</i> , <i>Gracilaria</i> , <i>Ulva</i> , <i>Porphyra</i>	-	
13	1	<i>Ulva</i> , <i>Porphyra</i>	1	Kelp
14	2	<i>Ulva</i> and <i>Porphyra</i>	1	Kelp
17	-		-	
Total # of concession holders	29		10	

Aquaculture presents a potential solution for the production of sufficient quantities of seaweed species with commercial potential. Aquaculture is managed in terms of the MLRA, environmental legislation and other legislation guiding aquaculture in seawater space (e.g. in port areas). An Aquaculture Development Bill is currently underway but has not yet been promulgated. Several abalone farms are farming seaweed as feed, including Viking Aquaculture (*Ulva*, *Gracilaria* and *Macrocystis* (the latter on an experimental basis)), Wild Coast Abalone (*Ulva* and *Gracilaria*), Irvine and Johnson Cape Abalone (*Ulva*) and Abagold (*Ulva*).

A Strategic Environmental Assessment (SEA) resulted in the identification of eight marine aquaculture development zones along the South African coast, including the Veldrif-Saldanha marine Aquaculture Development Zone (ADZ) (DEFF, 2019). Within this ADZ, only Saldanha Bay received environmental authorisation for aquaculture in four demarcated areas totaling 884 ha. These areas (known as the Saldanha Bay ADZ) are located in Small Bay, Big Bay, Outer Bay North and Outer Bay South (DAFF, 2017).

Further north, the Port Owen and St Helena Bay harbours are managed by SAMSA, the Maritime Safety Authority. Someone wanting to lease water space in these areas, would have to pay for an environmental impact assessment (EIA) as open water aquaculture is a potential hazard to shipping.

GAPS: The production of seaweed by cultivation is still relatively low; seaweed cultivated on abalone farms are not sold into the market

CHALLENGES: The regulatory environment is challenging:

- ⇒ Implementation of the PSSFP raised concerns about the economic viability of the Concession Areas for small-scale use
- ⇒ It is considered difficult to obtain seaweed concessions or aquaculture rights
- ⇒ In St Helena Bay, EIAs will be required before aquaculture can be considered.
- ⇒ Eight small-scale fishing co-operatives have been allocated rights to harvest or collect *Ulva*, *Porphyra*, and *Gracilaria/Gracilariopsis* in **Area 12** (including St Helena Bay/Velddrif) and **Area 11** (including Paternoster); Small quantities of *Ulva* are currently harvested for human food products; however, the co-operatives will need to work together and cooperate with each other to ensure sustainable utilisation of the resource. In addition, only sporadic washups of gracilarioids have been recorded in Area 12 in the past.
- ⇒ **Area 17** (including Saldanha Bay) represents value opportunities based on collection of *Gracilaria* for entrepreneurs from local communities, however, the resource has not been commercially exploited since the late 2000s due to declined quantities of washups.

OPPORTUNITIES:

- ⇒ There are opportunities to cultivate seaweed in St Helena Bay and the Saldanha Bay ADZ; *Gracilaria* cultivation trials were successful in both bays; and experimental cultivation studies of three kelp species are currently taking place in Saldanha Bay.

4.4 PROCESSING

Currently, the three main applications for kelp are as abalone feed (where fresh kelp blades are used to feed abalone), manufacturing of biostimulants and liquid fertilisers (where fresh kelp plants are used to extract natural plant biostimulants), and manufacturing of hydrocolloids (where dried seaweed is exported for the extraction of alginate and agar). Other applications include local manufacturing of formulated abalone feed (using fresh or dried kelp), and local manufacturing of biostimulants and liquid fertilisers using dried kelp. The total volume of kelp biomass used in the industry in 2023 was estimated at 24 245 t fresh weight equivalent, with a raw market value for the seaweed of roughly ZAR 56.5 million (BSASA, 2023). The processing of seaweed is illustrated in Figure 17. An increase in the production of fertilisers from seaweed will need formulation assistance (possibly available from the European Union) to produce well balanced products. This is a challenge and presents an opportunity—if the products can be produced at low cost and used in local agriculture.

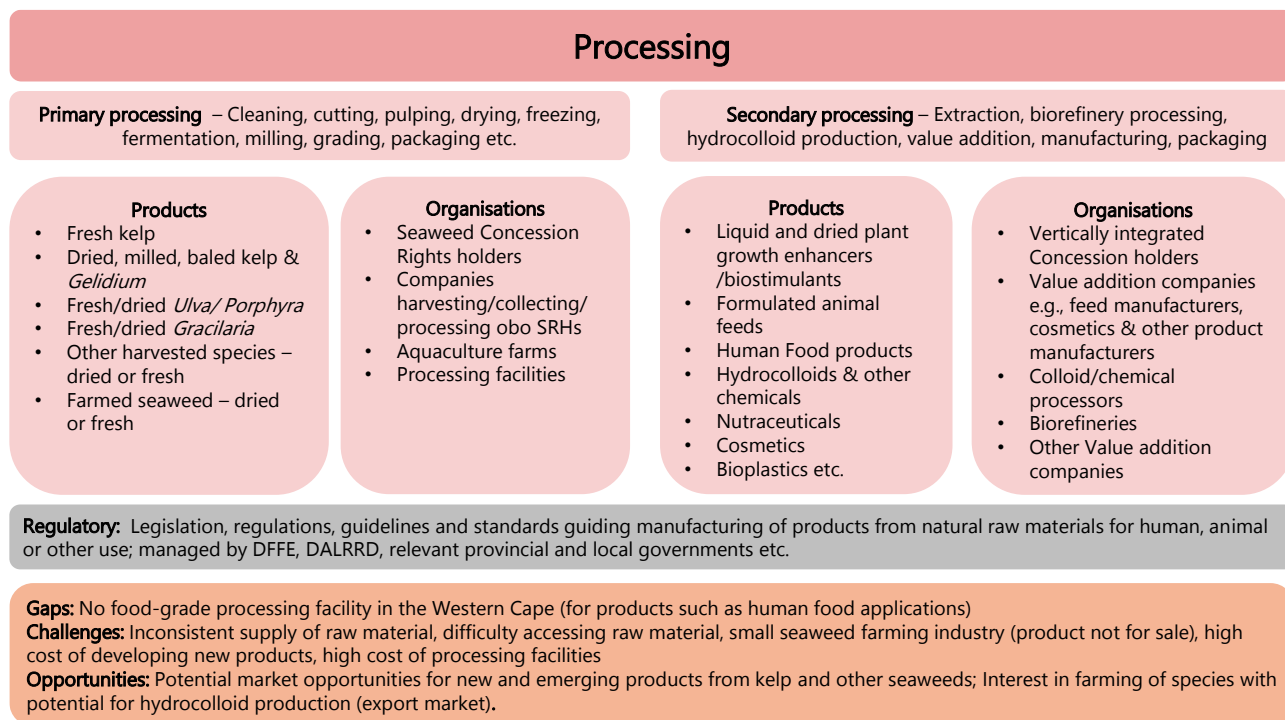


Figure 17: Processing of seaweed products in the value chain

Primary processing of seaweed biomass depends on the intended market for the seaweed and could include cleaning, cutting, drying, milling, and baling/packaging. Kelp blades intended for abalone feed (mostly *E. maxima*), are harvested from boats at low tide. Either the heads are cut off, or the fronds are cut in such a way that the first 30 cm are left intact, to allow the plant to regrow. Kelp fronds are delivered fresh to the abalone farm, weighed, and cut into smaller pieces to supply to the abalone as feed. Kelp collected as beach-cast material is mostly dried and milled and exported for alginate extraction. *Gelidium* is a source of agar, a commercially valuable colloid with food, cosmetic and industrial uses. It is harvested, dried, cleaned, graded and baled for export. *Ulva* and *Porphyra* are harvested, cleaned, pulped (*Porphyra*), and dried, before use in human food products. The organisations involved in primary processing include seaweed concession rights holders (e.g. Taurus Cape Chemicals), subcontractors to rights holders, and aquaculture farms.

Kelpak and Afrikelp have specific permission to harvest kelp (mostly *E. maxima*) used for the production of liquid plant growth stimulants by SCUBA diving. Complete plants are harvested, and the stipes are also used. Afrikelp's permission is for a specific area in their concession. The fresh plants are delivered to the manufacturing plant, sorted, where the best quality plants are selected, cut, and mechanically processed to extract the liquid. Secondary processing, therefore, includes extraction and production of value-added products. The waste products are sold for manufacturing of products such as special compost.

With increased seaweed production through aquaculture, more products could be produced through primary and secondary processes, including local hydrocolloid production, biorefinery production and other value addition processes. However, a commercially viable alginate plant needs much more kelp than is currently available. The large international colloid companies also mix and match phycocolloids from different species/sources for specific uses, which would not be possible in an extraction plant based solely on local material. It also takes substantial investment to develop new products. As an example, the formulation and development of one product intended for the cosmetics market could cost about R200 000.

Processing is regulated through legislation, guidelines and standards ensuring the safety of products for human, animal or other use.

GAPS: Although there are aquafeed manufacturers and animal feed manufacturers, there is no food-grade seaweed processing facility (for other products such as human food products) in the Western Cape (BSASA, 2023).

CHALLENGES

- ⇒ To produce products that compete in the global market requires substantial capital investment, that could range from ZAR 30 million to ZAR 100 million (BSASA, 2023)
- ⇒ High value products needed for viable seaweed aquaculture, and cost of product development is high
- ⇒ Inconsistent raw material supply, difficulty accessing raw material, making investment in processing facilities difficult
- ⇒ Established interests and high costs of setting up processing facilities make it difficult to ensure that local and indigenous residents are able to benefit from this part of the value chain.

OPPORTUNITIES

- ⇒ Potential market opportunities for new and emerging products from kelp
- ⇒ Interest in kelp farming for abalone feed
- ⇒ Interest in farming of species with potential for hydrocolloid (e.g. agar) production.

4.5 DISTRIBUTION

Distribution entails the movement of the seaweed and processed seaweed products from the producers and importers to markets such as wholesalers, retailers and exporters. After primary and secondary processing, the products are distributed to market via distributors or exporters (Figure 18). These could be the same organisations as the manufacturers, or separate specialist companies. For example, Elim Fertilisers is a specialist company in the agricultural fertiliser field, and they are the distributors for Afrikelp and other brands in South Africa, whereas Kelp Products International distribute their own product (Kelpak) globally. In comparison, abalone farmers use international seafood distributors to sell their abalone.

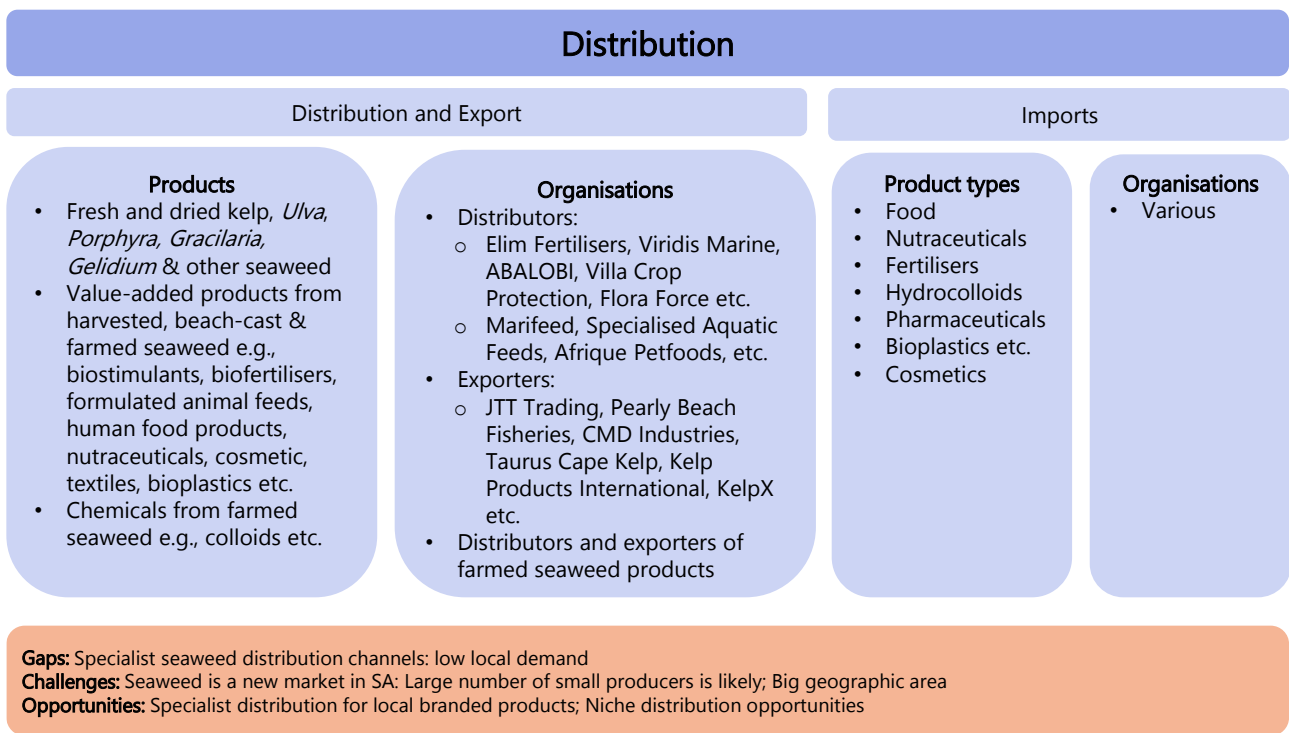


Figure 18: Distribution of seaweed products in South Africa

There are also a number of companies importing or distributing imported seaweed-based products into South Africa. Examples of products and organisations (not an exhaustive list) are provided in Figure 19. These products are not based on indigenous seaweeds. The products are distributed to markets in South Africa, including retail and speciality shops.

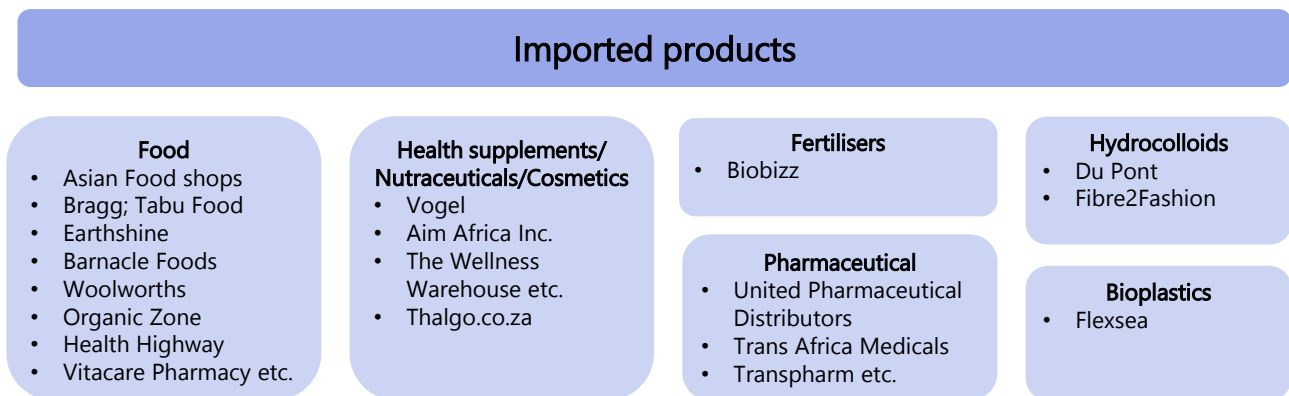


Figure 19: Examples of products and role players involved in distribution of imported seaweed products

Distribution is a key and an integral part of the value chain. It should be stressed that the development of the seaweed value chain will give rise to many opportunities in various aspects of distribution:

- ⇒ Transport and logistics
- ⇒ Warehousing
- ⇒ Exports
- ⇒ Imports.

Effective distribution is a major aspect needed to ensure the growth of the local seaweed industry. A collaborative approach would be an efficient mechanism, especially for the small producers who may not have a strong brand or are unable to offer the benefits of economies of scale. This is also the

case on a global scale, where distribution was identified as a gap that needs more startups, to enable seaweed producers to sell their crops at market value (Hermans, 2021).

However, the specific opportunities are not yet discernible as they are linked to the specific products. For example, if new fertiliser products are developed, these will have to be different products, with formulations that are different from existing products, otherwise they can only compete on price.

GAPS:

- ⇒ Seaweed distribution channel for small producers
- ⇒ Local demand for seaweed products

CHALLENGES

- ⇒ Seaweed is a new field with limited local demand at present; it will take time to reach significant volumes
- ⇒ Potentially a large number of small producers. It may be difficult to unify them under a single brand/identity
- ⇒ Large geographic area represents high distribution costs.

OPPORTUNITIES

- ⇒ Establishment of a specialised locally branded seaweed distribution channel. These may involve the current players, collaborations and partnerships as well the development of new distributors, covering all aspects of distribution
- ⇒ Niche distribution opportunities, linked to specific products and markets.

4.6 CONSUMERS/MARKETS

Markets are the final destination for raw, processed and finished goods. The market sectors are illustrated in Figure 20.

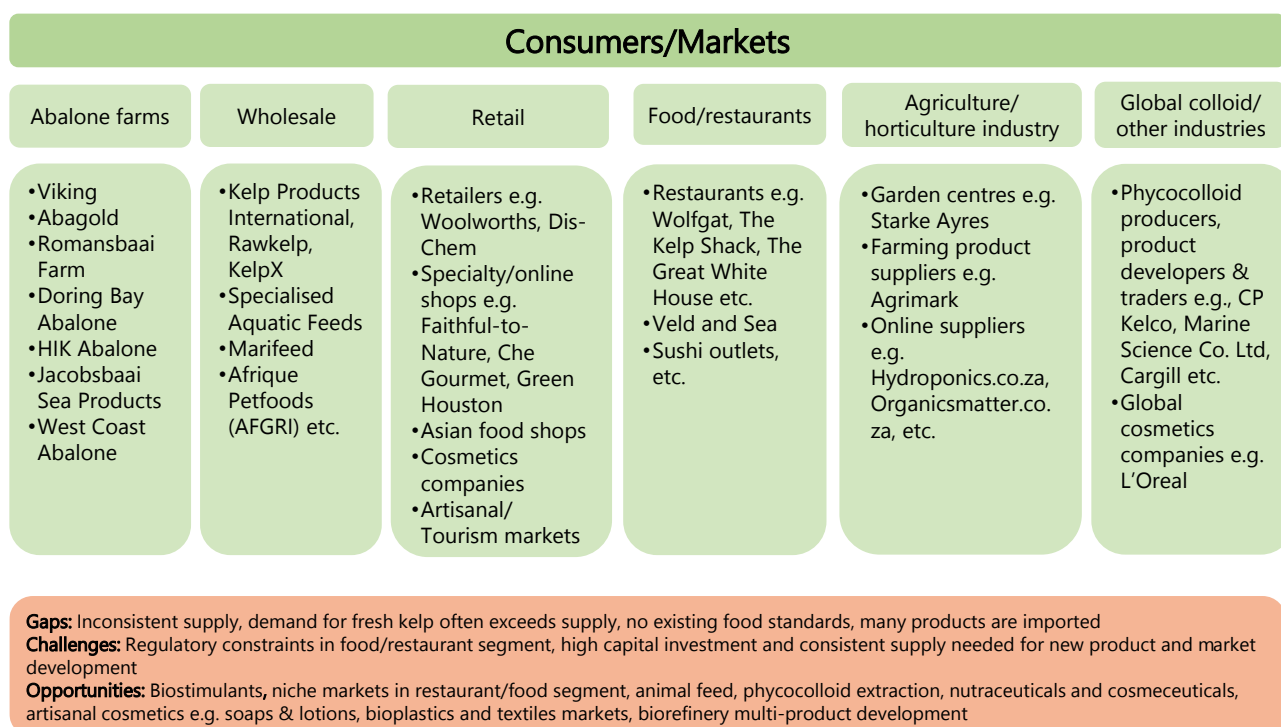


Figure 20: Consumers/markets in the seaweed value chain

Seaweed could be sold into existing and new local and global markets depending on the products:

- ⇒ Abalone farms:
 - ◆ There are about 16 operational abalone farms in South Africa, most of which are located in the Western Cape
 - ◆ These farms use fresh kelp, *Ulva* and *Gracilaria*, and formulated abalone feed, some of which contain seaweed
 - ◆ Farmed kelp, *Ulva* and *Gracilaria* could be sold to abalone farms.
- ⇒ Wholesale:
 - ◆ Some seaweed value addition companies do not use distributors, and sell their products to retailers
 - ◆ Current products include liquid plant biostimulants and formulated animal feed
 - ◆ As more products are developed, more opportunities for wholesale market will become available
- ⇒ Retail:
 - ◆ Retail companies sell seaweed products to the general public
 - ◆ These companies are easily accessible to the public and products are normally well known or marketed
 - ◆ Online or specialty shops typically sell niche or specialty products that are not widely available or known
 - ◆ All 'Asian food shops' contain a variety of imported seaweed food products
 - ◆ Nonregulated cosmetic products such as soaps, lotions and shampoos could be sold through artisanal or tourism/hospitality markets and industry. As an example, in Tanzania and Zanzibar seaweed soap production supports a number of women-led coastal community groups and provides additional income. It is not large, but has local impact.
- ⇒ Food/restaurant outlets:
 - ◆ There are some restaurants and food outlets that have started putting seaweed on their menus (e.g. Wolfgat in Paternoster). In addition, sushi containing 'nori' (*Porphyra*) is a popular dish in many South African restaurants, and retailers such as Woolworths even sell sushi as ready-made food. This familiarity can be capitalised on to expand local intake of seaweed food products, if consistent supply can be achieved.
- ⇒ Agriculture/horticulture industry:
 - ◆ Biostimulants and fertilisers containing seaweed are already sold into local and international markets. This market holds promise as consumers become more aware of the potential crop and soil improvement benefits of seaweed.
- ⇒ Global colloid industry:
 - ◆ There is an established global hydrocolloid industry that includes colloids from seaweeds, such as agar, alginate and carrageenan, and South African seaweed is exported for extraction of agar and carrageenan. There is potential for farmed seaweed to be sold into this market.

As the seaweed chain is developed further, it is expected that more products and market segments will become available.

GAPS: Further development of market segments is affected by several issues:

- ⇒ Supply of raw materials is inconsistent
- ⇒ Demand for fresh kelp for abalone feed often exceeds supply
- ⇒ There are no existing food standards, especially for seaweed intended for human consumption
- ⇒ Many seaweed products available in the market are imported.

CHALLENGES: The following challenges need to be addressed:

- ⇒ Regulatory constraints cause illegal harvesting of most seaweed in the restaurant and food segment
- ⇒ The development of new products for new or existing markets requires high capital investment, and consistent supply.

OPPORTUNITIES: There are significant opportunities for development of seaweed markets:

- ⇒ Biostimulants and liquid fertilisers

- ⇒ Niche food/restaurant markets
- ⇒ Supply of seaweeds from which hydrocolloids can be extracted
- ⇒ Nutraceuticals and cosmeceuticals
- ⇒ Bioplastics and textiles
- ⇒ Biorefinery multi-product development.

4.7 INDUSTRY INFLUENCERS

Industry influencers include the government (national, provincial and local) responsible for the sustainable and equitable development of the seaweed industry and aquaculture, organisations involved in socio-economic development including seaweed utilisation, environmental organisations and community/cultural organisations.

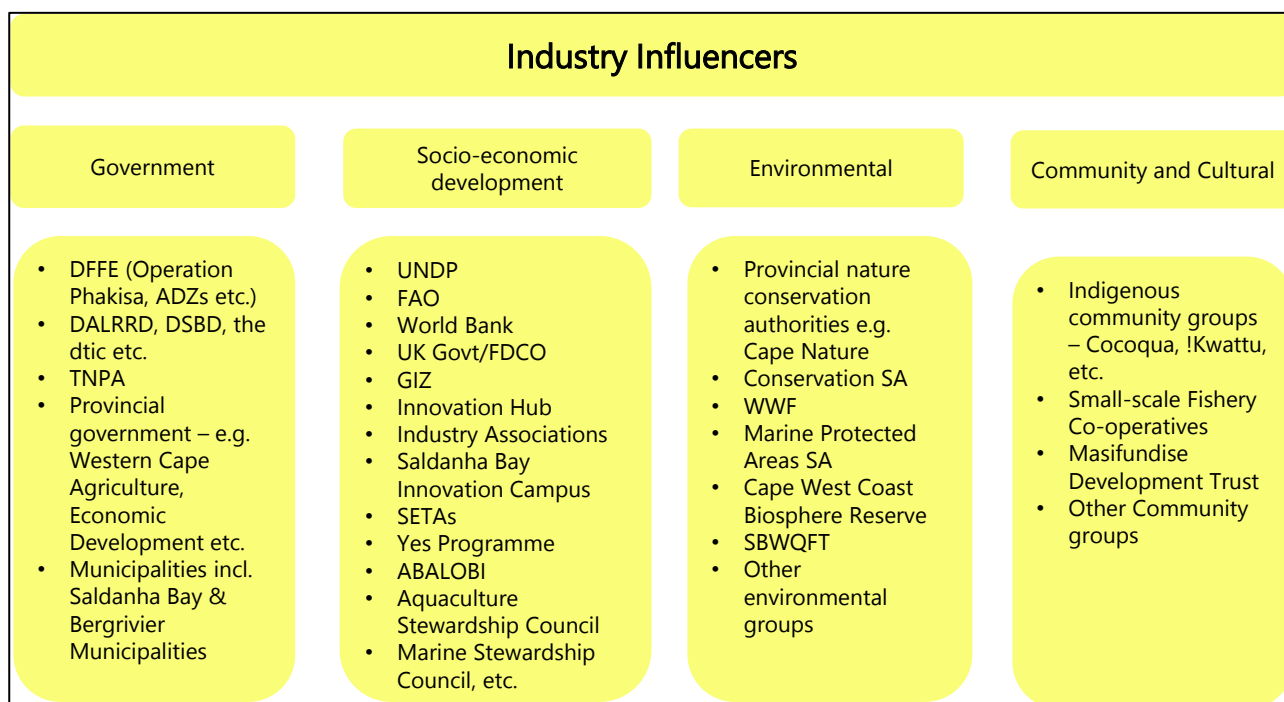


Figure 21: Role players influencing the development of the seaweed industry

As illustrated in Figure 21, the whole seaweed value chain is also affected by the interests and actions of a multitude of organisations and interest groups found in various sectors of society:

- ⇒ Government
 - ◆ The DFFE is the national key government department as the seaweed industry falls within its domain
 - ◆ Other national departments that have an interest in the commercial aspects such as the Department of Small Business Development (DSBD) and the Department of Trade, Industry and Competition (DTIC)
 - ◆ Provincial departments of agriculture are typically the home for aquaculture extension and development services. This includes provincial development agencies such as Wesgro in the Western Cape.
 - ◆ Municipalities that house seaweed activities and enterprises
- ⇒ Socio economic development
 - ◆ International organisations that are actively involved in seaweed and aquaculture projects in Africa, such as UNDP, FAO, World Bank, UK FCDO, GIZ, GSC, WWF (<https://www.worldwildlife.org/industries/farmed-seaweed>).
 - ◆ South African development organisations that could either contribute to and/or benefit from opportunities such as The Innovation Hub, Industry Associations e.g. BSASA (Bivalve Shellfish Farmers

Association), AFASA (Abalone Farmers Association), various SETAs and development structures like the YES Programme and ABALOBI

- ◆ Certification bodies such as the Aquaculture and Marine Stewardship Councils

⇒ Environmental Organisations with an interest in ensuring and maintaining a balance between the development of the value chain and the environmental aspects such as Conservation South Africa, WWF, Marine Protected Areas SA, the Cape West Coast Biosphere Reserve, and Saldanha Bay Water Quality Forum Trust (SBWQFT)

⇒ Community and cultural organisations including:

- ◆ Indigenous community groups such as the Cochoqua, and !Kwattu
- ◆ The Small-scale Fishing Co-operatives established as part of the roll-out of the PSSFS
- ◆ Local development organisations e.g. Masifundise Development Trust.

5 POTENTIAL MARKET OPPORTUNITIES IN THE WESTERN CAPE

5.1 INTRODUCTION

As set out in Chapter 2 of this document, there are many views on the size of the seaweed market, and its potential growth. This report follows a conservative approach and views the market growing from U\$17 billion in 2021 to U\$27.8 billion in 2030. The projected growth is supported by a long history of market growth, increasing demand for existing products, additional new markets and applications developing over time—as well as a growing awareness of the benefits of seaweed.

Asia still accounts for most production, but according to Phyconomy, Europe has the most seaweed startups each year, and Africa the least. It is important to note that internationally investments in seaweed are focused on processors and vertically integrated grower/processors, rather than on cultivation as a standalone activity (Hermans, 2023). This is largely attributable to high labour costs in developed economies.

This provides a potential opportunity for South Africa and the Western Cape to develop an efficient and cost-effective seaweed industry, based on a collaborative approach to ensure vertical integration within the industry, and not only at company level. This could potentially provide access to markets for:

- ⇒ Semi-processed products based on value for money
- ⇒ Processed products for niche value added products
- ⇒ New products and applications as they develop.

As most of the collection and harvesting rights are already allocated, accessing these new opportunities would depend on improving efficiency at an industry level and the introduction of cultivation of species that exhibit a market demand.

5.2 POTENTIAL AND FEASIBLE PRODUCTS

5.2.1 Market opportunities for kelp products

Potential market opportunities from South African kelp species are described in Table 9. Bioplastics, fabrics and construction materials could be considered in the long term, if large amounts of biomass with a high consistency and low cost can be produced.

Table 9: Potential market opportunities from South African kelp species

Species:	<i>Kelps -Ecklonia maxima, Laminaria pallida, Macrocystis pyrifera, Ecklonia radiata</i>				
Broad application	Primary product	Existing/potential client/s	Secondary product	Potential client/s	Potential for market uptake
Human foods	Fresh and dried kelp blades/stipes in sheet, flake or powder form	Restaurants (Wolfgat, The Kelp Shack, The Great White House etc.)	Ingredients in dishes; Artisanal foods (Kelp noodles, pickles, jams, chutneys etc.)	Retail (Woolworths, Spar, Asian shops, formal & informal markets), more restaurants	Small and artisanal, good quality required, lots of "waste"; requires market development, awareness etc.

Species:	<i>Kelps -Ecklonia maxima, Laminaria pallida, Macrocystis pyrifera, Ecklonia radiata</i>				
Broad application	Primary product	Existing/potential client/s	Secondary product	Potential client/s	Potential for market uptake
Aquaculture feed	Fresh blades	Aquaculture farms	Value-added (fermented) product using bacteria for better bioavailability	Aquaculture, pet food/ companion pet markets	High; Value-added aquaculture/ pet foods, needs a distributor with good sales staff
Hydrocolloids	Alginic acid/ alginate	Overseas companies	FDA-approved food ingredient used as emulsifier, thickener, stabiliser in applications e.g. food, cosmetics, pharmaceuticals etc.	Overseas extraction; South African production not sufficient for local extraction	Subject to global market trends. Large global industry, mature market, hard to break into; competing with low cost (e.g. Chinese) producers
Biostimulants	Regional production of agricultural biostimulants	Sold locally and exported to more than 100 countries, worldwide	Remaining solids after processing sometimes used in compost. Being tested as cattle feed additive.	The agriculture industry (current and rapidly growing component)	High. Low-cost extraction technologies available; could produce single or blended species extracts
Animal feed additives	Currently small-scale, selling dried kelp	Agriculture industry	Possible potential for biorefinery (several products from same material)	Local and overseas feed manufacturers	High in the future; will need energy-efficient drying technology
Pet food	Not currently in SA, overseas	Pet food industry	Biorefinery potential. Blending, fermentation to increase protein content and efficacy	Local and overseas feed manufacturers	Predicted global increase. Health benefits of small amounts.
Nutraceuticals, cosmetics	Products containing seaweeds for their wellness and cosmetic properties;	Local and global manufacturers;	Product/s to test on various skin models	Local and global traditional cosmetics companies (act as supplier)	Large market opportunity in medium term; High research, development & marketing costs
	Artisanal cosmetics - soaps/ creams etc.	Hospitality/ tourism industry	Non-regulated products that do not require high levels of testing and costs	Local tourist and hospitality industry	Medium. Dependent on tourism and hospitality markets

In the aquaculture feed, animal feed additives and pet food/companion pet markets, there is a move towards utilising the specific benefits of seaweeds (e.g. for improved gut health), and using proprietary blends of brown, red and green seaweed in species-specific formulations. The use of processing steps such as fermentation (using bacteria) could improve bioactivity and product quality. However, these applications require specialist knowledge (e.g. about processing and blending) and technically knowledgeable sales staff. The Ocean Harvesters Technology and Seaweed Company “models” are based on buying dried seaweeds, (red, brown and green) and making proprietary blends (tested in animal trials). These trials are expensive, but blends can be varied depending on fish, shrimp and production or companion animals. Technologies for drying of kelp to produce the basic kelp meal, include fluidised bed driers (expensive) and tunnel type systems using solar panels (for which sponsorship may be available).

To access the hydrocolloid market, a biorefinery approach could be considered. In this case high-value compounds such as fucoidans, mannitol and pigments could be removed first, alginate extracted as a by-product from the remaining fibre (using microbial hydrolysis or fermentation), and the waste streams further valorised to extract maximum economic value from the same crop. If this is done at a pilot scale, samples from each product line could be sent to potential markets to evaluate viability. This approach will need capital for infrastructure and skilled staff such as chemical and process engineers in the design and operation stages. Consulting companies could be contracted, but this will come at high cost.

Biostimulants were flagged in the World Bank Emerging Markets Report (2023) as a good short-term market opportunity. There are already various companies in South Africa producing agricultural biostimulants, e.g. Kelpak, Afrikelp and others. Kelp Blue in Namibia has developed a product (Stimblue) based on farmed *Macrocystis pyrifera*.

GreenWave (<https://www.greenwave.org/>) developed a low-cost extraction process to produce a biostimulant and may be able to assist new entrants in this industry. Potential products could include single extracts of two or three types of kelps, *Gracilaria* and combinations of these tested in standard bioassays to see if there are synergies. This would provide an indication of the viability of co-extraction and/or single extracts and then a blended product. This would be a technical sell, but a low-cost product could find a home in crops such as grape and broad acre crops such as maize in South Africa. Blends of species will provide a point of differentiation and the possibility of not having to compete on price. However, the costs of demonstration and field trials are not insignificant. There is interest from a local company in buying farmed kelp and setting up its own facility for biostimulant production (using its own recipe and intellectual property).

Nutraceuticals and cosmetics are long-term opportunities, requiring considerable research, development and marketing (at huge costs) to become a market leader. There are already products in the market based on *E. maxima* extracts, e.g. Dermikelp® products for the treatment of eczema, psoriasis and dermatitis. A potential option for new entrants would be to develop traditionally inspired cosmetics and approach the bigger companies to act as a supplier to them. This could work if a “story” about local communities and traditional knowledge is first developed, followed by development of a product with some efficacy that can be tested in various skin models.

Kelp has low protein content, and it is not clear whether there is an economic case for alternative proteins using macroalgal biomass. The pharmaceuticals market is very long term. It may be best to try the home remedy market first, get a revenue stream and then invest in ever more detailed research and development.

5.2.2 Market opportunities from *Gracilaria*

Table 10 sets out the potential opportunities of South African Gracilarioids. Globally, tropical species of *Gracilaria* are commonly known as edible seaweed, called ogonori in East Asian countries.

Using a biorefinery approach, carbohydrates (e.g. agar) could be removed, leaving a high protein remainder, from which other useful functional components could be extracted. Red seaweed, especially cultivated, is now being used extensively for biostimulants. India and Brazil are good examples, and their products find ready markets in countries of production. Fairly low technology grinding and separation of “sap” from fibre is used. The fibre can be used as “bagasse” for cooled extraction of high-value compounds. Potential products include single extracts of Gracilarioids, or combinations with brown seaweed for testing in standard bioassays. GreenWave (<https://www.greenwave.org/>) may be able to assist with a low-cost extraction technology. Blends of brown and red seaweeds can provide propriety differentiation. In South Africa, a local company (Kelpak) uses a patented cold extraction technology in which plant hormones are the main critical components extracted from kelp.

As is the case with kelp, nutraceuticals and cosmetics are long-term opportunities. A proposed option is to develop a local “story” (perhaps based on local/traditional lifestyles or communities), develop a product that can be tested across various skin models, and then approach a bigger company to become a supplier. Sea Laria (<https://sealaria.com/>) is a marine biotechnology company in Israel that developed a proprietary gelatinised formula for health care and pharmaceutical applications, from pond-farmed *Gracilaria*.

There is interest from a local seaweed export company in buying and exporting dried farmed *Gracilaria* in future (as part of off-take agreements with seaweed farmers). There is also interest from Japanese companies (e.g. Marine Science Co. Ltd - <https://marine-science.co.jp/english>) to buy farmed *Gracilaria* for agar extraction.

Table 10: Potential market opportunities from South African Gracilarioid species

Species:	<i>Gracilaria gracilis/Gracilariopsis longissima</i>				
Broad application	Primary product	Existing/potential client/s	Secondary product	Potential client/s	Potential for market uptake
Human foods	Is eaten elsewhere		Artisanal food products (pickles, noodles) etc.	Potential overseas	Currently low
Aquaculture feed	Fresh feed for juvenile abalone in aquaculture	Abalone farms		Animal aquaculture farms	Minor currently
Hydrocolloids	Agar	Has been partially extracted locally in the past	Chemicals e.g. protein and agar. Agar has food, pharmaceutical, industrial, applications	Current large overseas markets; interest from Japanese companies in farmed <i>Gracilaria</i> for agar	Agar was processed in Southern Africa in the past; current large global market

Species:	<i>Gracilaria gracilis/Gracilariopsis longissima</i>				
Broad application	Primary product	Existing/potential client/s	Secondary product	Potential client/s	Potential for market uptake
Biostimulants	Not currently, locally?	Not tested locally	Fairly low tech grinding and separation of "sap" from fibre; Fibre is used as "bagasse" for cooled extraction	Agricultural/horticultural markets	High. Low-cost extraction technologies available; could produce single or blended species extracts
Animal feed additives	Experimental			Animal feed companies	Experimental
Pet food	Experimental			Pet feed companies	Experimental
Nutraceuticals	Products containing seaweeds for their wellness and cosmetic properties.	Local and global manufacturers	Product to test on various skin models	Local and global traditional cosmetics companies (act as supplier)	Large market opportunity; high research, development & marketing costs

5.2.3 Potential market opportunities for products from *Ulva*

Potential market opportunities based on *Ulva* species are described in Table 11. Locally, food products such as "Sea lettuce salt" are produced on a small scale. Other human food products can be developed; however, it takes time and investment to develop and bring products to market. In cultivation, *Ulva* can produce higher levels of protein than in nature.

Green seaweeds are not traditionally known as contributors to the hydrocolloid industry. However, ulvans (sulphated polysaccharides) from green algae such as *Ulva* spp. exhibit a variety of biological activities. Ulvan-based hybrid materials can be designed for tailor-made, high-value applications such food, feed, cosmetics, and bio-fertilisers. As an example, Seaweedland in the Netherlands (<https://seaweedland.com/>) grows *Ulva* and other seaweed on-land and develops high-value applications for different markets. In France, Olmix (<https://olmix.com/>) is a significant producer of biostimulants. They specialise in the development, production and distribution of bio-sourced solutions for livestock and crop farming. Olmix produces biostimulants using blends of red and green seaweeds, such as *Ulva*.

Companies such as Ocean Harvest Technology (<https://oceanharvesttechnology.com/>) and The Seaweed Company (<https://www.theseaweedcompany.com/>) hope to catalyse a transition to sustainable agriculture and food solutions by offering innovative seaweed farming and product development solutions. Their products include proprietary blends of red, brown and green seaweed for the food, feed and agriculture industries.

Nutraceutical product development based on *Ulva* is in an experimental stage, and *Ulva* in alternative proteins is being tested elsewhere (Hofmann, et al., 2024).

Table 11: Potential market opportunities from South African *Ulva* species

Species:	<i>Ulva</i>				
Broad application	Primary product	Existing/potential client/s	Secondary product	Potential client/s	Potential for market uptake
Human foods	Live or dried seaweed	Local small-scale food additive		Restaurants	Currently mostly in Asia. Being tried widely in Europe and elsewhere
Aquaculture feed	South Africa one of world's largest producers for aquaculture feed (abalone farms)	Abalone farms		Animal aquafarms and feed producers	High
Hydrocolloids	Ulvans — sulphated polysaccharides	Specialist R&D and product development companies	Health, cosmetics and agricultural applications	Cosmetics/nutraceutical companies, agricultural industry	Ulvans have high value opportunities; strains for high yielding cultivars can be selected
Biostimulants	Ulva liquid from biorefinery processes used in biostimulants (France)	Specialist R&D and product development companies	Biostimulant with Ulva and red seaweed (Seamel) produced in France	Agricultural/horticultural industry	Olmix (France) produces a green/red biostimulant
Animal feed additives	Experimental in SA, proprietary blends of red, brown and green seaweed	Specialist R&D and product development companies	Species-specific and unique blends e.g. seaweed prebiotics	Livestock and aquaculture industries	Need specialist blending e.g. Ocean Harvest Technology
Pet food	Proprietary blends of red, brown and green seaweed	Specialist R&D and product development companies	Specific formulations to enhance pet gut health and digestive efficiency	Pet food industry	Need specialist blending— e.g. OHT and The Seaweed Company

5.2.4 Potential market opportunities for products from *Porphyra/Pyropia*

The potential market opportunities for *Porphyra/Pyropia* are described in Table 12. The market for human food products is currently mostly in Asia, and local producers have to compete with low-priced, imported nori products. The local market is under development but will require substantial investment in product development and marketing. South Korea was successful in developing the nori snack market and export their products globally, due to concerted efforts by their government and industry.

There is potential for use of *Porphyra/Pyropia* as additional biomass in blends for animal feeds and for supplements, especially as these species naturally have the highest protein content of seaweeds, commonly above 40%.

Table 12: Potential market opportunities from South African *Porphyra/Pyropia* species

Species:	<i>Porphyra/Pyropia</i>				
Broad application	Primary product	Existing/potential client/s	Secondary product	Potential client/s	Potential for market uptake
Human foods	Dried seaweed	Local small-scale food additive			Currently mostly in Asia (nori). Local market being developed
Aquaculture feed	Supplementary abalone feed	Abalone farms			Increased use will require aquaculture
Animal feed additives	Potentially good additional biomass for blends for feeds and supplements	Companies producing animal feeds and supplements	Specific feed formulations for improved animal health	Agricultural industry	Long term: <i>Porphyra</i> cultivation not low cost but can select strains for proteins and/or pigments

5.3 POTENTIAL BUYERS FOR PRODUCT CATEGORIES

Existing companies in the seaweed value chain in the Western Cape could represent potential markets for off-take of seaweed from concession holders and seaweed farmers. However, if new products are developed, new companies could be established, depending on what product is produced in South Africa, and where the markets are located.

Potential buyers for product categories are described in Table 13. This is not an extensive or comprehensive list of products or buyers and does not imply any commitments for off-take on the part of any potential buyer. New applications that are developed will see new buyers enter the industry.

Table 13: Product categories and potential buyers

Product category	Potential buyers
Human food products	<ul style="list-style-type: none"> ⇒ Retailers e.g. Woolworths, Spar, Asian shops, informal markets, online platforms, farm stalls ⇒ Restaurants e.g. sushi restaurants, high-end restaurants, food stalls
Aquaculture feed	<ul style="list-style-type: none"> ⇒ Aquaculture farmers e.g. Viking, West Coast Abalone etc. ⇒ Local aquatic feed manufacturers e.g. Marifeed ⇒ Overseas feed manufacturers e.g. Ocean Harvesters Technology
Hydrocolloids	<ul style="list-style-type: none"> ⇒ Local exporters e.g. Taurus Chemicals etc. ⇒ International hydrocolloid producers e.g. Marine Science Co. Ltd, Dupont Danisco, etc.
Biostimulants	<ul style="list-style-type: none"> ⇒ Biostimulant manufacturers e.g. Afrikelp etc. ⇒ Own distributors if developing a proprietary blend
Animal feed additives	<ul style="list-style-type: none"> ⇒ Local animal feed manufacturers e.g. Agrifood SA, etc. ⇒ Overseas feed manufacturers e.g. Olmix, etc.
Pet food	<ul style="list-style-type: none"> ⇒ Local pet food manufacturers e.g. Rawgold, Whiskas, Specialised Aquatic Feeds, etc.
Nutraceuticals, cosmetics	<ul style="list-style-type: none"> ⇒ Local manufacturers, salons and retailers e.g. The Body Shop, etc. ⇒ Tourism and hospitality industry (artisanal cosmetics e.g. soaps) ⇒ International companies and manufacturers e.g. L'Oréal, Cargill, Seaweedland, etc.

6 SUMMARY, DISCUSSION AND CONCLUSIONS

There is an existing seaweed industry in South Africa, dating from the 1950s. It is currently based mostly on wild harvesting and collection of seaweed, especially the kelp *E. maxima*. The value chain based on this species is very well developed, and new entrants find it difficult to enter this industry as the resource is finite and demand exceeds supply; also, there are currently no unallocated commercial concessions available. Other commercially valuable species are available in smaller volumes, or their exploitation is not commercially viable. Numerous Small-scale Fisheries Cooperatives received concessions for a 'basket' of species that include seaweed. However, in some areas including the Western Cape, these allocations are perceived to be economically unviable due to perceived low volumes or lack of viable markets. For the South African seaweed industry to grow significantly, mass cultivation of species with commercial value or potential, therefore, needs to be considered.

A substantial body of knowledge is already available that could form the foundation for further seaweed aquaculture development:

- ⇒ In the 1990s, *Gracilaria* was grown successfully during sea-based experiments in Saldanha Bay and St Helena Bay
- ⇒ The South African Kelp Farming Project is currently conducting laboratory (hatchery) and sea-based kelp cultivation experiments of three kelp species (*E. maxima*, *L. pallida* and *M. pyrifera*).
- ⇒ Various abalone farms are successfully growing *Ulva* in integrated farming systems, and *Gracilaria* in tanks, as feed for abalone
- ⇒ The Saldanha Aquaculture Development Zone has 884 ha of sea water space approved for aquaculture, including seaweed cultivation
- ⇒ Several offshore areas have been identified along the west coast as potentially suitable for kelp cultivation
- ⇒ There is substantial international and local interest in seaweed for use in food, feed, health, pharmaceutical, industrial and environmental applications (A Seaweed Revolution)
- ⇒ A kelp value chain study in 2023 identified the need for a food-grade processing facility in the Western Cape, and various market opportunities. It also identified inefficiencies such as an industry-wide supply inconsistency and lack of a kelp farming industry. A roadmap, premised on the successful development of kelp farming technologies, listed five key strategies to unlock opportunities for those interested in kelp farming in South Africa (BSASA, 2023):
 - ◆ Developmental/Regulatory Strategy—preparation of a regulatory framework for sustainable development of the kelp sector
 - ◆ Research and Development Strategy—ensure that the sector is found and diversified on the basis of strong R&D
 - ◆ Product-Market Strategy—promote use of kelp and focus on product and market development (including formation of a South African Kelp Industry Association)
 - ◆ Commercialisation Strategy—facilitate the development of the sector
 - ◆ Community Participation Strategy—private sector-led integration of coastal communities into kelp farming and the value chain, facilitated by the DFFE/Government.

The Roadmap proposed for the Kelp farming industry, and lessons learned from the South African Kelp Farming Project, provide a good foundation for the development of a South African seaweed farming industry.

A future seaweed value chain could include a wide range of downstream and upstream enterprise opportunities, based on farming of existing and additional species with commercial value, processing and manufacturing of a wide range of new seaweed-based products, and marketing and distribution

opportunities to existing and new markets and end consumers. The following should be taken into consideration:

- ⇒ Seaweed aquaculture and beneficiation is seen as a potential contributor to multiple SDGs, including decent work and economic growth, and reduced inequalities
- ⇒ The current seaweed industry is characterised by a few big players that have built their businesses over many decades and depends on a sustainable access process to seaweed resources. Care must be taken not to destroy existing industry and businesses, whilst expanding the seaweed value chain. However, future industry development must address past inequalities and ensure that entrepreneurs from historically disadvantaged coastal communities have the support required to become successful players in the value chain.
- ⇒ Past experiences of involvement of historically marginalised individuals and coastal communities in collaborative aquaculture projects highlighted how the nature of benefit sharing arrangements, institutional arrangements and power dynamics could influence the extent to which individuals and the greater community profit from such projects (Agiotis, 2023). Future aquaculture enterprise development programmes must, therefore, consider factors such as power dynamics, skills and knowledge transfer, mentoring and support, and effective benefit sharing arrangements.
- ⇒ The regulatory environment for seaweed resource access and cultivation is still daunting, despite efforts by Government to reduce red tape, and make information more accessible
- ⇒ Investigating the commercial viability of cultivation of any seaweed species will require substantial outlay of expertise, time and money into feasibility studies
- ⇒ The development of new seaweed-derived products and markets will also require considerable investment
- ⇒ Meaningful investment in education, skills development, incubation, and other enterprise development support will be required to assist entrepreneurs in the seaweed value chain
- ⇒ Seaweed does not exist in a vacuum. It coexists with other marine value chains such as fish, mussel and abalone farming, etc., and can be used for bioremediation of excess nutrients in integrated multi-trophic aquaculture (IMTA) with other species such as shellfish and sea urchins.

This report demonstrates that there is an opportunity as well as international interest in growing the SA seaweed industry, which is very small in comparison to the industry in East Asia. However, it is not a simple or trivial task to move from the current to an extensive world class industry, especially when considering the challenges of ensuring inclusive socio-economic development. The way forward should include:

- ⇒ An integrated effort to establish South Africa as a Seaweed force
- ⇒ Establishing cultivation of various species in line with market demands
- ⇒ Establishing various cultivation methods and practices (offshore, in-shore, land-based, laboratory-based, etc.)
- ⇒ Establishing processing facilities at various scales to suit market demands
- ⇒ Establishing standards, testing protocols and accredited test facilities
- ⇒ Developing the value chain, including small local enterprises, medium scale enterprises and big industries
 - ◆ SA seaweed branding
 - ◆ Provenance
 - ◆ Product development
 - ◆ Integrate circularity in the industry
 - ◆ Support services—suppliers, distributors, integrators
 - ◆ Local market development
 - ◇ Ongoing publicity of seaweed, health and environmental benefits and uses etc.
 - ◇ Promotion of traditional uses

- ◇ Promotion of seaweed as a sustainable food source
- ◇ Promote collaborative/co-operative approaches
- ◆ International market development
 - ◇ Promotion of the SA seaweed brand
 - ◇ Linkages with key international customers
 - ◇ Slick logistics (efficient port and export processing etc.).

7 RECOMMENDATIONS

The recommendations below are aimed at developing a strong vertically integrated industry that provides opportunities for all, thereby ensuring that the previously disadvantaged are not relegated to the menial and low value operations.

7.1 FOUNDATION

A disjointed ad-hoc approach will have a very limited impact, meaning that a well thought out and well-resourced integrative and inclusive sector approach is required, starting with:

- ⇒ Expanding on the excellent recommendations of the kelp value chain study (BSASA, 2023) regarding the kelp sector to include the broader seaweed industry:
 - ◆ Establishment of a credible Seaweed Industry Association that incorporates commercial and small-scale concession holders, seaweed farmers, and other organisations in the value chain. Preferably this should be achieved by repurposing/amalgamating/expanding brief of credible (track record) existing structures rather than another startup in the field. This is aligned with what was proposed in the kelp value chain study of 2023.
 - ◆ A national Seaweed Industry Development Strategy, vision and implementation plan, driven by the above Industry Association in co-operation with government, possibly based on a West Coast Seaweed Cluster approach.
 - ◆ Environmental Impact Assessment for the remainder of the Velddrif-Saldanha ADZ (including St Helena Bay) to determine approved areas for aquaculture (including seaweed).

The aim of undertaking these actions is to construct a solid and cohesive foundation for establishing and expanding all aspects of the seaweed value chain in future. This is key to the sustainability and inclusivity of the sector.

7.2 FOCUSED RD&I

Such a sector-based approach should be supported by the undertaking of focused research, development and implementation activities with a view to providing access to the whole sector:

- ⇒ Continued support for the SA Kelp Farming Project to proceed to Pilot phase, to test commercial feasibility of kelp farming
- ⇒ Experimental cultivation of kelp in one of the other areas approved for aquaculture in the Saldanha Bay ADZ (e.g. Big Bay or Outer Bay North)
- ⇒ Off-shore experimental cultivation of kelp in one of the areas identified along the west coast during Phase 1 of the SA Kelp Farming Project
- ⇒ Expansion of the UNDP project to include additional phases such as:
 - ◆ *Gracilaria* Feasibility study in Saldanha Bay ADZ to determine viability of various cultivation techniques (at-sea, on-land, vegetative and laboratory seeding), and test product in potential markets
 - ◆ *Gracilaria* pilot production
 - ◆ Testing of other *Ulva* species for constituents, food and feed desirability and aquaculture potential
 - ◆ *Porphyra* cultivation experiments – land-based hatchery and sea-based cultivation experiments
 - ◆ Additional community awareness workshops in Saldanha and other geographical areas
 - ◆ Development of products by entrepreneurs from local communities, that can be trialled and tested on a small scale in local markets
- ⇒ Investigating opportunities for circularity, including those based on linkages with other aquaculture and marine activities in the region
- ⇒ Undertaking additional research into:
 - ◆ Primary and secondary processing

- ◆ Product design.

The purpose of these activities is to underpin the successful cultivation of various species of seaweed to meet market demand. Initially a fledgling cultivation sector that develops and flourishes will be an indication of the effectiveness of the RD&I activities. The cultivation industry should also stimulate the development of value-added products, as well as support enterprises across the value chain.

7.3 ENABLING ENVIRONMENT

An enabling environment should be in place to ease the development of new seaweed companies, cultivation technologies, production processes, and product development:

- ⇒ Knowledge generation and transfer
 - ◆ Coordination and integration and dissemination of relevant research, development and innovation (RDI) initiatives. This is aligned with the online workshop recommendations and could include an online portal under the auspices of the proposed industry body.
 - ◆ Creating a platform to assist the existing knowledge base in the industry to transfer skills in various ways such as:
 - ◇ Workshops and discussion groups
 - ◇ Expert lectures
 - ◇ Development of guidelines and standard operating procedures (as currently being undertaken by the SA Kelp Project)
 - ◇ Development of courses to be presented at TVET colleges
 - ◇ Community outreach activities
- ⇒ Development of a supportive regulatory framework for sustainable development of the seaweed sector. This is again aligned with the recommendations from the kelp value chain study (BSASA, 2023). Without abdicating/neglecting the management of this sector, it is important to simplify the regulatory burden, especially for smaller businesses
- ⇒ Development of standards, testing protocols and the eventual establishment of local accredited test facilities
- ⇒ Incentives (national, provincial and municipal) directed at encouraging the cluster approach aimed at the establishment of enterprises in all aspects of the value chain:
 - ◆ Suppliers
 - ◆ Raw material
 - ◆ Processing
 - ◆ Logistics and distribution
 - ◆ Marketing
- ⇒ Support for undertaking feasibility studies and developing business plans
- ⇒ Establishment of shared processing facilities for the benefit of the sector.

The Seaweed Industry Association in partnership with government (DFFE, DSBD and the dtic) should take the lead in creating this environment to the benefit of all role players, with a special emphasis on ensuring inclusivity.

7.4 MARKET DEVELOPMENT

All successful businesses need to access sustainable market opportunities. This is particularly difficult for new entrants as their products are not well known. It is, therefore, recommended to create a West Coast Seaweed (and other marine product) identity/brand to stimulate a strong market presence and assist new members in their market entry. This would include:

- ⇒ Unified branding

- ⇒ A local story providing product provenance
- ⇒ Ongoing publicity regarding seaweed, its uses and benefits
- ⇒ Consolidated marketing efforts, providing access to:
 - ◆ Local west coast retail opportunities
 - ◆ Provincial and national wholesalers and retailers
 - ◆ Provincial and national seaweed industrial users
 - ◆ Export markets.
- ⇒ Establishing an efficient export processing help desk
- ⇒ Market intelligence.

Again, the Seaweed Industry Association in partnership with government (DFFE, DSBD and the dtic) should take the lead in creating this environment to the benefit of all role players, with an emphasis on vertical integration and circularity in the local industry to provide maximum impact.

7.5 ENTERPRISE DEVELOPMENT

Enterprise development support is critical in the effort to ensure inclusivity. A collaborative approach is required to redress the effects of past inequalities. Whilst there is often organisational fatigue regarding this aspect, it does not wipe out the need for continued vigor in this regard. It is proposed to establish a structured seaweed value chain incubation programme incorporating implementation based on the World Bank's "Global Aquabusiness Investment Guide", developed by Advance Africa (World Bank, 2024), which sets out to promote sustainable development of aquaculture as the world's fastest growing food sector. The enterprise development activities should include the following:

- ⇒ An outreach and education programme to teach seaweed entrepreneurs from coastal communities about the basics of seaweed, sustainable harvesting/collection and cultivation, potential applications and markets, value addition processes, and other aspects of the value chain
- ⇒ A technical support programme with experienced technical mentors supporting the development of enterprises across the value chain, including:
 - ◆ suppliers (e.g. nurseries)
 - ◆ raw material providers (e.g. seaweed concessionaires and farmers)
 - ◆ processors (e.g. processors and final product manufacturers)
 - ◆ distributors
- ⇒ A business development and support programme covering:
 - ◆ Business establishment
 - ◆ Business administration
 - ◆ Business leadership
 - ◆ Regulatory aspects
 - ◆ Assistance with business plans and finance applications
 - ◆ Business mentorship
- ⇒ A market development programme covering:
 - ◆ Marketing mentorship
 - ◆ Business intelligence
 - ◆ Access to opportunities, general marketing support
 - ◆ Identification and development of viable markets and product applications
- ⇒ Establishment of physical infrastructure and facilities to be utilised for industry development and support activities, including:
 - ◆ Small scale hatchery/nursery
 - ◆ Product development and testing laboratories
 - ◆ Small scale/pilot production equipment and facilities
 - ◆ Technology demonstrators
 - ◆ A bio-refinery pilot facility.

The incubation programme could be expanded to include other species such as mussels, oyster and abalone to promote integrative and circularity aspects. In addition, the role of the incubator could be expanded to include some of the other recommendations such as dissemination of research development and implementation outcomes.

7.6 HIGH LEVEL ROADMAP

A high-level roll-out plan (roadmap) is shown in Figure 22.

The recommendations are quite ambitious and far reaching. It is understood that it will take considerable time and effort to address all aspects. But this section serves to outline the vision of how an integrative and inclusive seaweed sector could be developed in the Western Cape, with the potential for roll-out to other local and international destinations.

Seaweed Sector Recommendations - Implementation Roadmap																								
Activity	Year																							
	2025				2026				2027				2028				2029				2030			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Foundation																								
Establish a sound, well-represented and all inclusive industry body																								
Develop National Seaweed Vision and Strategy																								
Environmental Impact Assessment for the balance of Velddrif Saldanha ADZ																								
Seaweed industry with strong cohesive foundation																								
Focused Research, Development and Implementation																								
Continuation of SA Kelp Farming Project																								
Kelp trials in Big Bay and Outer Bay North																								
Off-shore Kelp cultivation trials																								
Establishment, development and expansion of commercial Kelp cultivation																								
UNDP <i>Gracilaria</i> Feasibility Study																								
UNDP <i>Gracilaria</i> Pilot																								
Establishment, development, expansion of commercial <i>Gracilaria</i> cultivation																								
UNDP testing of other <i>Ulva</i> species																								
UNDP <i>Porphyra</i> cultivation experiments																								
UNDP other species feasibility studies & pilot projects																								
UNDP ongoing community awareness workshops																								
Artisanal product development, market testing by local entrepreneurs																								
Research circularity and other aquaculture linkages																								
Primary and secondary processing research																								
Product development																								
Increasing numbers of species farmed, applications and products developed																								
Enabling Environment																								
RDI coordination and online portal																								
Generate knowledge base																								
Regulatory helpdesk																								
Regulatory review																								
Develop standards and protocols																								
Establish local accredited test facility																								
Design and implement incentives																								
Support for feasibility studies and business plans																								
Growing numbers of successful enterprises in the seaweed value chain																								
Market Development																								
Establish a unified brand/identity																								
Develop provenance story																								
Ongoing seaweed publicity																								
Establish and operate export processing help desk																								
Ongoing market research																								
Vertical integration and circularity in Seaweed sector																								
Enterprise Development																								
Establish Enterprise Development Centre/incubator																								
Establish new enterprises based on RDI above																								
Technical support and mentoring																								
Business support and mentoring																								
Market support and mentoring																								
Piloting/demonstration infrastructure																								
New entrants to seaweed sector achieving inclusivity																								

Figure 22: Roll out plan for development of the seaweed sector

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APPENDIX A: SPECIES DESCRIPTIONS

Ecklonia maxima (brown alga)

Sea bamboo, Seebamboes



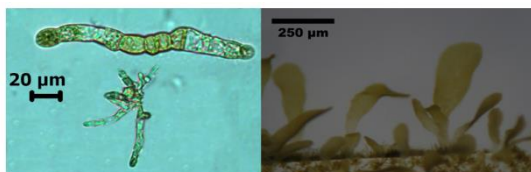
Ecklonia maxima at low tide [Photo: <http://southafrseaweeds.uct.ac.za/>]

Distribution and habitat

- Rocky shores, formerly from just north of Lüderitz (Namibia) to just west of Cape Agulhas. Can survive high wave conditions.
- A new population appeared at De Hoop, east of Cape Agulhas, around 2006.
- Grows from just below low water of spring tide to around 10-20m (max. 40m)
- Stipes are much shorter in shallow water.

Reproduction

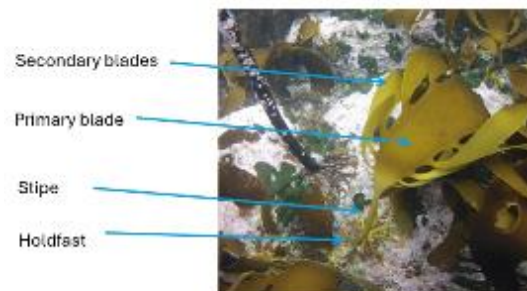
- The large kelps (sporophytes) live for up to 5-6 years.
- Each sporophyte kelp produces billions of tiny spores every year from darkened areas on both surfaces of the secondary blades (the sorus).
- Spores that manage to attach grow into microscopic gametophytes.
- In perfect conditions, male and female gametophytes (separate individuals) produce eggs and sperm in about 2 weeks.
- Fertilised eggs grow into sporophytes, attached to rock



Microscopic kelp gametophytes (left, with female above and male below), and small kelp plants (sporophytes) growing on a rope (Photos: Mark Rothman)

Description

- Brown kelp (maximum 17m long, but usually a few metres).
- Has single main (primary) blade with many secondary blades on each side.
- Grows from a growth point (meristem) where the primary blade meets the stipe, with secondary growth points just above where the secondary blades grow from the primary blade. This means that the tissue at the base of the blade is young, whereas the tissue near the tips of the blade is the oldest.
- Has long, hollow, gas-filled stipe (stem), which can be most of the length. This is usually wider at the top, forming a gas-filled float.
- Attached by holdfast, made up of branched, finger-like structures (haptera).
- Blades mostly close to the surface at low tide due to gas-filled stipe/float.
- Smaller (1-2m) relative with short, solid stipe on south coast (*Ecklonia radiata*).



Wild resource and cultivation

- Cut from boats for feed on abalone farms (4 000-7 000 wet t per year).
- Cut mostly by divers for agricultural biostimulant product (5 000 wet t per year).
- Washup (drift) collected and dried for overseas shipping for alginate extraction (2 000 dry t per year).
- Experimental cultivation underway in Saldanha Bay (BSASA/UKInternational Development project since 2022).

Interesting facts

- Was the first seaweed species from South Africa to be described scientifically (Osbeck 1757, as *Fucus maximus*).
- Although it probably only grows in Southern Africa, floating specimens have been recorded as far away as Tristan da Cunha (2787 km from Cape Town).
- Floating masses are mentioned in journals of Portuguese explorers sailing down west coast of Africa in 15th and 16th centuries, sometimes called 'trombas' (meaning 'trumpet').
- Genus is named after C.F. Ecklon, a plant collector from Schleswig-Holstein (then in Denmark) who collected in South Africa from 1829-1838.
- *Ecklonia* species contain some interesting chemicals useful in the nutraceutical, cosmetics, and possibly pharmaceutical industries.

Laminaria pallida (brown alga)

Split fan kelp



Laminaria pallida, with single split blade (Photo: Sam Bolton)

Distribution and habitat

- Rocky shores, formerly from the extreme north of Namibia (Rocky Point) to near Gansbaai.
- Has also been recorded at Tristan da Cunha, in the south Atlantic Ocean, and at St Paul Island, in the southern Indian Ocean.
- In the southwestern Cape, mostly grows deeper (>5m) than inshore forests of *Ecklonia maxima*, although also occurring in shallow water in wave-sheltered habitats and harbours.
- Further north (from around Yzerfontein) stipes start to become hollow and longer, and increasingly dominates over *Ecklonia maxima* inshore. The dominant inshore kelp in southern Namibia, and the only kelp in northern Namibia.
- Grows to a maximum depth of 40m (in clear water)
- Stipes are shorter in shallow water

Reproduction

- The large kelps (sporophytes) are perennial, although no data on how long they live.
- See *Ecklonia maxima* for other reproductive information. In *Laminaria pallida* the reproductive area of the sporophyte blade (the sorus) tends to be on the tips of the split blades.

Interesting facts

- Can survive with less wave action than *Ecklonia maxima*, and tends to grow in harbours and in sheltered areas of Saldanha Bay and Langebaan lagoon
- With extreme shelter the blade can grow without splitting, forming an entire, round blade. This has occurred in the past in the kelp tank at the Two Oceans Aquarium in Cape Town. In North Atlantic *Laminaria* species this is known as a 'cucullate form'.
- *Laminaria* refers to the flat blade ('lamina'), and the name '*pallida*' refers to the pale, yellow-brown colour, compared to similar species in the North Atlantic (e.g. *Laminaria digitata*).

Description

- Yellow-brown, large kelp (maximum 5m long, mostly 2-3m).
- Has single main (primary) blade with genetically determined splits.
- Grows from a growth point (meristem) where the blade meets the stipe, which means that the tissue at the base of the blade is young, whereas the tissue near the tips of the blade splits is the oldest. Growth has been described as 'a moving belt of tissue'.
- In the south of its distribution stipes are solid; in the Northern Cape and Namibia stipes are longer and hollow for most of their length. Hollow not gas-filled.
- Attached by holdfast, made up of branched, finger-like structures (haptera)
- Doesn't float well, even with hollow stipe.



Wild resource and cultivation

- Small amounts harvested in South Africa and Namibia for abalone feed. The upper layer of the blades was peeled off in Namibia several years ago to make a cosmetic product to be placed around eyes to enable hydration (as the alginate contained in it holds moisture). This was exported to Germany.
- Other *Laminaria* species, especially *Laminaria hyperborea*, are harvested from natural populations in the North Atlantic for alginate extraction (e.g. in Norway and Brittany, France).
- Experimental cultivation underway in Saldanha Bay (BSASA/UKInternational Development project since 2022).

Gelidium pristoides (red alga)

Saw-edged jelly weed



Tuft of *Gelidium pristoides* at low tide (Photo Robert J Anderson)

Distribution and habitat

- Only occurs in South Africa, from the Cape Peninsula (from Sea Point to the Eastern Cape/KwaZulu Natal border. Most abundant in the Eastern Cape.
- Dominates a zone in the lower intertidal on rocky shores.
- In the Eastern Cape mostly attached to the shells of limpets, which the holdfasts are embedded in. Most abundant on quite wave-exposed shores.

Reproduction

- Has a complicated red seaweed life history, with three different types of plants, but these look the same and grow together in the same clump in nature. Spores are produced in small, rounded branches on the side of the individuals.

Interesting facts

- Two attempts have been made to cultivate *Gelidium pristoides* in South Africa in the past, both unsuccessful.
- There are around a dozen other species of *Gelidium* in South Africa. Two of them have been collected in small amounts in the Eastern Cape in the past, along with *G. pristoides* (*Gelidium abbotiorum* and *Gelidium pteridifolium*).
- *Gelidium vittatum* (formerly known as *Suhria vittata*) grows on the stipes of *Ecklonia maxima* on the west coast. In the colonial era it was used by the colonists to make jelly for food and was known as 'red ribbons'. An attempt to cultivate it was unsuccessful, as the small plants were eaten from the ropes by an unknown grazer.

Description

- Hundreds of small, reddish-brown plants, each a few mm wide with wavy, toothed edges, grow together from fused holdfasts in tough, tight clumps attached to rocks on the lower seashore at low spring tide.
- Usually a few cm tall but can grow to 20cm tall.
- One of the most abundant seaweed species on the intertidal seashore on the South African south coast



Harvesting *Gelidium pristoides* by hand in the Eastern Cape (Photo: Robert J Anderson)

Wild resource and cultivation

- Has been harvested in a single commercial Concession Area (between Gqeberha and East London) for many years. Between 70-100 t dry weight per year are plucked by teams of workers and sold overseas for agar extraction.
- For a few years in the late 1990s, some *Gelidium* was collected by local communities in the former Transkei region of the Eastern Cape and bought from them by seaweed companies. This proved uneconomic, largely because of the travel logistics in reaching isolated communities.
- Agar from *Gelidium* species is of good quality and there is a limit to supply as no-one has succeeded in cultivating any *Gelidium* species commercially, despite many attempts.
- Detailed studies were carried out in the past by Fisheries Department scientists on the effects of *Gelidium* harvesting on the seashore. The harvesters only remove a relatively small amount of the material, leaving most of the holdfasts, which regrow. The material removed includes some small animals (including juvenile mussels) but it is only a very small percentage of the small animals in the *Gelidium* zone.

Ulva species (green algae)

Sea lettuce, Seeslaai



Ulva uncinata on the Cape Peninsula (Photo: Michael Quiry)

Distribution and habitat

- Different species have different habitats and environmental tolerances (such as water temperature, salt content, light conditions etc.), but little is known about this in Southern Africa as species details are still being studied.
- Some species can grow quite high on rocky shores, but there are other species below the low water mark and in estuaries and lagoons.

Reproduction

- Most species reproduce on the seashore by microscopic spores and gametes. These are produced from cells often in the outer half of the *Ulva*, around every week or two. The material from which these are released is then empty and white, and rapidly falls off.
- The released spores reattach to the rock and grow into new plants. So *Ulva* plants on the shore do not last more than a couple of weeks but are continually replaced.
- *Ulva* is one of the first seaweed colonisers of newly exposed solid material on the shore because of rapid growth rates. For example, areas of rock where mussel beds are ripped off by waves are rapidly colonised by *Ulva*, and later often recolonised by the mussels.
- *Ulva* sometimes grows free-living (not attached) in large amounts, particularly in polluted bays where it is not washed away. These are generally seasonal, and there are sometimes considerable proliferations in parts of Saldanha Bay, Knysna lagoon and to a small extent in Simon's Town harbour. These free-living populations often grow vegetatively (without spore production) involving continual breaking up of the blades, for a considerable time.

Interesting facts

- One enormous growth of free-living *Ulva* in Xingdao, China, occurred just before the China summer Olympic Games in 2008. As the yachting events were to be held in Xingdao, in a new custom-built yacht harbour, over a million t of *Ulva* were manually removed from the bay and buried.
- Large rotting piles of *Ulva* on beaches in polluted bays in Brittany, France, produce hydrogen sulphide gas. This once rendered both a rider and his horse unconscious as they rode over the piles. The horse died and the rider survived.
- If limpets (which eat seaweeds) are removed from rocks high up on rocky shores, often the rock becomes rapidly colonised by *Ulva*, which would grow there if the grazers were not there. Large growths of *Ulva* have also been reported soon after large-scale oil tanker pollution, which tends to kill animals on the shore but not seaweeds, as well as freshwater from major flood events.
- *Ulva* is becoming a common item on the menu in high-priced (Michelin-starred) restaurants in Europe). It is grown in aquaculture for human food in Portugal.

Description

- Different species of *Ulva* grow all over the world, from the poles to the tropics, in shallow seas and estuaries, even occasionally in freshwater. They often prefer habitats with high levels of nitrogen, which occurs with human pollution as well as such natural habitats as bird roosts on the seashore.
- There are many species of *Ulva* in South Africa, with probably around a dozen on the west coast.
- Different bladelike *Ulva* species consist of bright green, very thin, flat membranes, sometimes separating into various lobes, elongated ribbon-shaped or roundish. They sometimes have small, pointed projections like teeth on their edges. Sometimes they have many blades closely packed together in a rosette form.
- Blades can be from a centimetre or two, to half a metre in length.
- Attached to rock or anything solid by a tiny holdfast, although plants which grow free-floating in sheltered estuaries or bays (or aquaculture systems) grow without a holdfast.



Ulva releasing spores in a seashore rockpool, resulting in white, empty parts of the blades (Photo: John J. Bellini)

Wild resource and cultivation

- *Ulva* has occasionally been collected on a very small scale for human food products on the west coast (e.g. 'seaweed salt'). Permits have been issued for community harvesting recently.
- One species, *Ulva lacunculata*, is cultivated in large amounts on 5 land-based abalone farms, one in the Northern Cape, 3 in the Western Cape and one in the Eastern Cape. It is grown in around 30m long 'paddle raceways', which have parallel sides and rounded D-shaped ends. A single paddle per raceway moves the water and *Ulva* in a circulating fashion around a central island.
- The *Ulva* grown in local abalone farms (total of around 2400t per year) does not become fertile and lose material, despite being cultivated for more than 20 years.
- The *Ulva* is mostly grown in effluent water from the abalone tanks and is used for extra abalone feed. Also, there are two farms which use the *Ulva* to remove toxic ammonia (released by the abalone) from the water to enable recirculation of around half of the seawater. This reuse of water considerably reduces the farm costs of pumping seawater from



Paddle raceway on land-based abalone farm, recently stocked with *Ulva lacunculata*.

Porphyra capensis (red alga)

Purple laver, Nori, Klipkombers



Porphyra capensis on upper shore rocks at low tide
(Photo: Maggie Reddy)

Distribution and habitat

- Abundant on rocky seashores, all along the west coast into Namibia.
- The seaweed highest on the seashore, spending most of low tide exposed to the air.
- Attached by a very small disc-like holdfast

Reproduction

- Females when fertilised produce spores which settle on mollusc shells (mussels, sea snails etc.) and grow into a microscopic, threadlike form, which burrows into the shells, known as 'conchocelis'
- The conchocelis produces different spores which settle on the rock and grow back into the *Porphyra* plants.
- The large *Porphyra capensis* plants on the seashore do not live more than a couple of weeks but are continually re-seeded by spores from the conchoceli

Description

- Often large masses of very thin membranous sheets (only one cell thick under the microscope), blackish-purplish or yellow-brownish, often drying and stuck to the top of the rocky shore at low tide.
- Difference sexes of plants on the shore, with those with reddish edges being females and those with yellow edges being males.
- Very great variety of shapes and sizes, from almost round to ribbon-shaped or elongated, and from a few cm to half a metre in length.
- Attached by a very small disc-like holdfast



Male *Porphyra capensis*, with yellow edge (female has pink edge)
(Photo: John J Bolton)



Scallop shells, some with red conchocelis sporophyte of Japanese *Porphyra* growing in them

Wild resource and cultivation

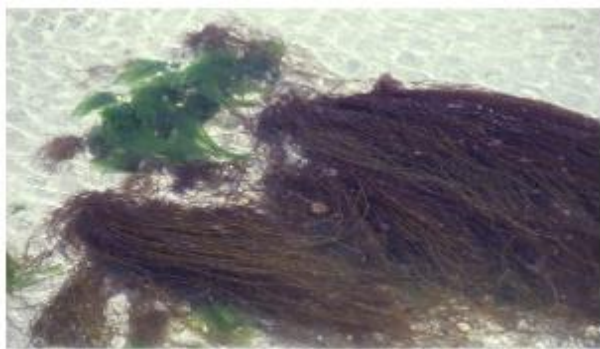
- Occasional collections on the west coast in the past of small amounts for export to Japan for human food. Closely related to species used as nori in Japan.
- Some recent community rights have been allocated by DFFE on the west coast for *Porphyra* harvesting.
- Nori (known as zicai in China and gim in Korea) is one of the staple foods in sushi bars (the black sheets around the rice). Small packets of nori are available at every traditional Japanese meal.
- Relatives of *Porphyra* make up only a few percent of global seaweed production, but it is a relatively high value product as it is grown in large amounts in temperate Asia (especially China, Japan, Korea) for human food.
- No cultivation attempts so far in South Africa, excepting laboratory experiments.

Interesting facts

- For many years it was thought that there was only one species of *Porphyra* in South Africa, but now we have several species of closely related species in different genera.
- *Porphyra* was split into several genera in 2011 and the cultivated material in Asia is no longer *Porphyra*, but in the genus *Pyropia*.
- *Porphyra capensis* is still *Porphyra*, but we have two local species of *Pyropia*. *Pyropia saldanhae* grows lower down the shore on the west coast, and *Pyropia aeodis* grows attached to a different red seaweed, *Pachymenia orbitosa* (formerly known as *Aeodes orbitosa*) at the bottom of the intertidal seashore. South African *Pyropia* species have the red and yellow female and male areas on the sheets mixed together on a single plant, rather than on separate plants as in *Porphyra capensis*.
- *Porphyra capensis* itself is very varied, both in form and genetically, and it probably consists of as many as 10 separate species that are very hard to tell apart.

Gracilaria gracilis (red alga)

Agar weed, Grac, wart weed



Gracilaria gracilis (with some green *Ulva*) in Saldanha Bay
(Photo: <http://southafrseaweeds.uct.ac.za/>)

Distribution and habitat

- Has been recorded from Lüderitz, Namibia to the Keiskamma estuary (Hamburg) in the Eastern Cape. Cultivated a little further north, in an abalone farm at Haga Haga.
- There are few large, sheltered bays in South Africa, so distribution is limited, but can be found in several bays and estuaries on close inspection. Major populations only in Lüderitz and Saldanha/Langebaan. Both of these populations are very much less abundant than a few decades ago, caused by various human activities.
- Has been shown to prefer specific sand/sediment particle sizes in Namibia.

Reproduction

- Can reproduce well by regrowth from the whole plant, and in sheltered bays probably reproduces mostly in this manner (known as vegetative growth), rather than by producing the next generation by spore production.
- Has a complex red seaweed life cycle, with separate male, female and sporophyte individuals. When fertile the females can be distinguished by small spherical swellings along their branches. These are rare in South African populations. The other reproductive cells are produced internally and are not visible without a microscope.

Interesting facts

- There is a very similar species to this, which was originally recorded from South Africa in Simon's Town in 1997. Despite being very difficult to tell apart from *Gracilaria gracilis*, the other species is in a different genus, and is called *Gracilariopsis longissima*. The only clear, visible distinction is when the females are fertile, and the round swellings which occur on the branches are a slightly different shape. Both species grew at similar rates on rope systems in St Helena Bay, and both had similar agar concentrations. Material in St Helena Bay in the past was also *Gracilariopsis* and there is some evidence that it has also spread into Saldanha Bay.
- Both *Gracilaria gracilis* and *Gracilariopsis longissima* can survive periods buried under sand, and regenerate when the sand is washed away.
- On one South African abalone farm where *Gracilaria gracilis* is grown in tanks, the material tends to get overgrown with other algae growing on it. Two employees manually pick off the contaminant algae from seeding material, which is then used to re-stock the systems.

Description

- Made up of large clumps of reddish-brown, very branched, cylindrical shoot systems with many branches, up to 2mm in diameter, all with pointed tips.
- Grows often unattached, partly loosely buried in sand in sheltered bays and open estuaries, especially in the Saldanha/Langebaan system on the west coast of South Africa and in Lüderitz Bay in southern Namibia. Occasionally found attached by a small holdfast.
- Beachcast material, as it ages and dies, loses colour and becomes first greenish, then white.
- Growth is from the tip of each branch.
- Washes up, sometimes in large amounts in the past, seasonally in bays where it occurs linked with storm and swell conditions.



Collecting large washup of *Gracilaria gracilis* in Saldanha Bay in the

Wild resource and cultivation

- Was collected in the past in Saldanha Bay and Lüderitz Bay, dried and shipped overseas for agar extraction. Two thousand dry t was collected in 1967 (equivalent to 10 000t wet), but this gradually dropped until collection ceased in 2008 due to insufficient washup.
- Two small processing facilities extracting rough agar were built a few decades ago, first in Butterworth, now in the Eastern Cape, and then in Lüderitz. Material available proved insufficient for this to be a long-term, profitable venture.
- Commercial cultivation on rope systems was carried out in Lüderitz in the early 2000s. This ran for a few years, producing around 300t per year, but eventually proved not to be profitable.
- Large-scale, successful, commercially-oriented growth experiments were carried out in Saldanha Bay (for more than 3 years) and in St Helena Bay (for more than a year) in the 1990s, but commercial attempts which followed were not successful.
- Around 600t per year of *Gracilaria* is grown on land-based abalone farms in South Africa. It is grown in pumped seawater and is considered a specialised feed for juvenile abalone. It is not grown in paddle-raceways (see *Ulva*) but generally grown in large round tanks, with water movement provided by aeration.
- Species of *Gracilaria* are among the most important cultivated species for agar production, globally. The 'stringy' species which have fine branches, like *Gracilaria gracilis*, tend to grow best in aquaculture systems, and are sometimes collectively known as 'gracilarioids' (which means 'like *Gracilaria*').

Macrocystis pyrifera (brown alga)

Giant kelp, bladder kelp



Macrocystis pyrifera at Kommetjie. (Photo: Michael Guiry)

Distribution and habitat

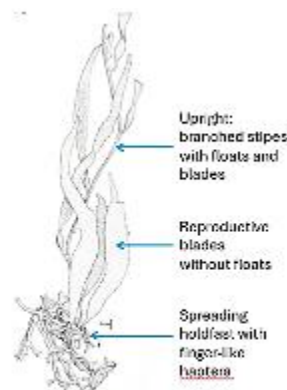
- Rare in South Africa. Only a few small populations on rocky shores, generally inshore of *Ecklonia maxima* forests, from Paternoster to Gifkommetjie (near Cape Point on the Cape Peninsula).
- Largest on the leeward side of Robben Island and also grows on the leeward side of Dassen Island.
- South African *Macrocystis* clearly prefers wave-sheltered habitats on the southern west coast.
- There is only one species of *Macrocystis*, which has a wide global distribution, along the west coast of the Americas from Alaska to Mexico (Baha California); from Peru to the tip of South America and around to Argentina; on sub-Antarctic Islands around the globe, including Marion Island; in southern Australia, Tasmania and New Zealand. It does not, though, grow in the North Atlantic or the Northwestern Pacific Oceans.
- Only recorded in shallow water (to a few metres deep) in South Africa.

Reproduction

- The spreading holdfast continues to produce new uprights, probably for several years.
- The reproductive material (sorus) occurs on both surfaces of the blades without floats at the base of the kelp.
- For gametophytes and their development, see *Ecklonia maxima*.

Description

- Yellow brown kelp, with complicated form consisting of an attached holdfast, spreading along the rock, from which arise many cylindrical, branched systems (uprights) which produce many blades.
- Length in South Africa generally 2-4m, although can get to 7-10m off Robben Island.
- Growth is from the tip of each upright, unlike in *Ecklonia* and *Laminaria*. At the tip of each upright is a curved portion where the process of producing new blades progressively by splitting can be seen.
- Each blade in most of the kelp is tongue-shaped, tapering to a point at the tip. At the base of each of these blades is a small, hollow, gas-filled float, and the blades are corrugated on their surface with ripples.
- There are a few different, smooth blades at the base of the upright and attached to the holdfast that are the site of the reproductive material (the sorus).
- The spreading holdfast is made up of branched, finger-like structures (haptera).
- Forms a canopy at the surface as the upright systems float.



Macrocystis pyrifera, 'angustifolia ecomorph' (Drawing: Herra Stenroos)

Wild resource and cultivation

- Too little material available to be used commercially in South Africa.
- Has been tested and is at least as good as *Ecklonia maxima* as feed for our local abalone in aquaculture.
- Unlike *Ecklonia* or *Laminaria*, *Macrocystis* can be grown from cut pieces of holdfast, provided at least one living upright is attached. The cut pieces regenerate new uprights within one month.
- *Macrocystis* is harvested from natural kelp forests in large amounts, in Chile, Mexico, Peru, and formerly on the west coast of the United States, for alginates and aquaculture feed.
- South African abalone farmers have shown interest in *Macrocystis* cultivation.
- A major project (Kelp Blue) to cultivate *Macrocystis pyrifera* offshore began in Lüderitz, Namibia in 2022, and now has branches of the project in Alaska, USA and New Zealand.
- Experimental cultivation underway in Saldanha Bay (BSASA/UK International Development project since 2022).

Interesting facts

- There used to be several (5) species of *Macrocystis*, based on the form of the holdfasts and blades, but these have been shown to be a single species (by DNA sequencing).
- The form of *Macrocystis pyrifera* in South Africa, with the spreading holdfast, is known as the 'angustifolia ecomorph', as it previously had a different species name (*Macrocystis angustifolia*). That species name is no longer valid.
- Giant kelp (now the same species) grows to around 30m deep in California, although the deepest record of the species recorded was 68m, off Marion Island (South African Sub-Antarctic Island).
- *Macrocystis* means 'large round structures', referring to the floats, and *pyrifera* means 'pear-shaped', referring to the shape of the very large holdfasts of the 'pyrifera ecomorph' in California and elsewhere.

APPENDIX B: COMMUNITY WORKSHOP REPORT



UNITED NATIONS
DEVELOPMENT PROGRAMME



APPENDIX B:

COMMUNITY WORKSHOP REPORT:

Igniting the Ocean Economy in South Africa –
“Exploring seaweed cultivation and value chains for enterprise
development in the coastal communities of Saldanha Bay, St.
Helena Bay and Velddrif”

REF: UNDP-ZAF-00063

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GLOSSARY OF TERMS

BSASA	-	Bivalve Shellfish Farmers Association of South Africa
BST	-	Bio Solutiones Technicas (Pty) Ltd
DFFE	-	Department of Forestry, Fisheries and the Environment
OECSs	-	Other Effective Area-based Conservation Measures
PSSA	-	Phycological Society of Southern Africa
SBWQFT	-	Saldanha Bay Water Quality Forum Trust
SSF	-	Small-scale Fishery
SDG	-	Sustainable Development Goal
UNDP	-	United Nations Development Programme
WWF	-	World Wide Fund for Nature

INTRODUCTION

BACKGROUND

Seaweed farming is considered a potential option for alternative livelihoods in vulnerable sectors of coastal society. Seaweeds have multiple uses as direct human or animal foods, for extraction of valuable compounds that can be used in other industries, for replacement of fossil-fuel derived ingredients, and other ecosystem services. Seaweed can be grown without costly inputs such as energy or fertiliser—and, on a global scale, seaweed aquaculture has grown faster than other marine production sector over the last 20 years.

The United Nations Development Programme (UNDP) established an Accelerator Lab in South Africa in 2019, to promote the realisation of the Sustainable Development Goals (SDGs). As part of its programme 'Igniting the Ocean Economy in South Africa', the UNDP is investigating the potential of seaweed to contribute to these SDGs.

To this end, the UNDP South Africa, in collaboration with the Department of Forestry, Fisheries and the Environment (DFFE), contracted Bio Soluciones Técnicas (Pty) Ltd (BST) to implement a six-month project entitled "Exploring Seaweed Cultivation and Value Chains for Enterprise Development in the Coastal Communities of Saldanha Bay, St. Helena Bay and Velddrif" in the Western Cape.

BST is an international projects company with engineering and specific aquaculture expertise. The BST project team includes a wealth of complementary relevant knowledge, expertise and experience that will ensure successful delivery of the results desired by the UNDP.

This Report describes the results of the west coast Community Engagement Workshops held during August 2024.

AIM AND OBJECTIVES

The project aim is to inform the design of future enterprise development programmes to support entrepreneurs to develop seaweed cultivation businesses, supported by local market analysis research.

The project objectives are to:

- ⇒ Compile a generic value chain for the local seaweed industry
- ⇒ Engage with the coastal communities to explore and define a variety of different seaweed products and value chains that could bring economic benefit and job creation to community members
- ⇒ Provide practical introductory training to community members on the cultivation and other aspects of seaweed (with a specific focus on *Gracilaria* and kelp)
- ⇒ Document local insights regarding the cultivation of seaweeds, including local and indigenous knowledge in relation to future seaweed production.

The specific objectives of the Community Engagement workshops included the following:

- ⇒ To provide practical introductory training to community members on the basics of seaweeds, local current and potential commercial seaweeds, the local seaweed industry, cultivation of seaweeds (with a specific focus on *Gracilaria* and kelps), global perspectives on economic seaweeds, the regulatory environment, and the requirements for turning ideas into opportunities.

- ⇒ To document local insights regarding the uses and cultivation of seaweeds, including local and indigenous knowledge in relation to future seaweed production, local understanding of seaweed concessions and value chains, and concerns and expectations from community members regarding seaweed concessions, seaweed aquaculture and seaweed value chains.

METHODOLOGY

The work comprised the following activities:

SELECTION OF WORKSHOP LOCATIONS AND VENUES

In May 2024, members of the project team attended a workshop in Port Nolloth, between the World-Wide Fund for Nature (WWF) South Africa, Conservation South Africa and the Aukotowa Small-scale Fishing Co-operative. The purpose of the workshop was to discuss Small-scale Community Fishery Areas, and Other Effective Area-based Conservation Measures (OECMs). The project team attended as observers only. Some of the notations influenced the approach to the UNDP workshops, especially with regard to issues such as language, religion, and dealing with sensitive matters.

After physical inspection of potential venues, and based on local knowledge and understanding of issues pertaining to specific communities in the geographic area, three suitable locations for community workshop in the Velddrif-Saldanha strategic marine aquaculture development zone were selected as follows:

- ⇒ Saldanha Bay (Blue Bay Lodge); 12 August, 08:00 to 17:00
- ⇒ Velddrif (Laiplek Hotel); 14 August, 08:00 to 17:00
- ⇒ St. Helena Bay (St Helena Bay Hotel); 16 August, 08:00 to 17:00.

Community members from the Velddrif-Saldanha region were provided with the opportunity to attend any of the three workshops, even if not within their area of residence. Provision was made for travel arrangements for those attending a workshop out of their immediate vicinity in an effort to ensure inclusivity. Those who could not attend the physical workshops were given the opportunity to attend an online workshop planned for 6 September. Applicants were provided with dietary catering options for Halaal or vegetarian meals.

PUBLICITY AND INVITATIONS

The final workshop dates, objectives and application process were publicised during a multi-stage process, involving 18 organisations and individuals:

- ⇒ Identification of target participants
- ⇒ Meetings with representatives of selected organisations with links to target participants
- ⇒ Publication of open information sessions and application process for workshops
- ⇒ Open access information sessions on 27 July.

Organisations with potential links to the target communities are listed in Table 14. In June and July, meetings were held with representatives of the Genesis Hub Vredenburg (YES Programme), the Cape West Coast Biosphere Reserve, the Cochoqua Khoisan leadership, ABALOB, and the Department of Forestry Fisheries and the Environment (DFFE) Small-scale Fishery (SSF) Management office, to obtain their insights and guidance regarding the target participants and participatory process. Based on

these insights and recommendations from Cape West Coast Biosphere Reserve (CWCBR), the BST team decided to host open information sessions before the workshops.

Table 14: Organisations with potential links to the target communities

#	Organisation	Contact person
1	BSASA	Vos Pienaar (Chairperson)
2	CochoQua Khoisan Community	Chief Kevin Maart
3	!Khwattu	Michael Daiber (General Manager); Nicole Loebenberg (Project Support)
4	ABALOBI	Abraham Human (Lead Trainer) and Llewellyn Kester (Community Development Coordinator)
5	YES Programme-Genesis HUB Vredenburg	Allison van der Walt (Manager); Gillian Green (administrator)
6	DFFE Mentor for SSF Co-ops (Yzerfontein–St Helena Bay)	Riaan Hendricks (Field Dev. Officer)
7	DFFE Mentor for SSF Co-ops (West Coast Region)	Wilfred Arendse
8	Cape West Coast Biosphere Reserve	Sharon February (Chairperson)
9	Zharon Damonse	KhoiKelp; Chair: Black Women and Sustainable Business; CEO: Sea Breeze Community Development
10	Adelaide Ruiters	CEO: Adelaide Ruiters Mining and ARME Host Community Kelp Agriculture Project
11	DFFE Small-scale Seaweed Rights Holders/Small-scale Fishery Co-ops	Bernacia Mullins (Director: Small-Scale Fisheries), Nhlanhla Nkosi
12	Saldanha Bay Water Quality Forum Trust (SBWQFT)	Christo van Wyk (Manager)
13	Masifundise Development Trust	Jonathan Julies; Michelle Joshua (Co-Director and Operation Manager)
14	Saldanha Bay Municipality	Nazeema Duarte (Manager: Environment and Heritage)
15	Bergrivier Municipality	Angeli Joubert (Environmental Officer)
16	WC Dept of Agriculture	Ferdie Endemann (Specialist Extension Officer: Aquaculture)
17	PSSA	Courtney Puckree-Padua (President); Akshata Mehta (Newsletter editor)
18	IOI-SA	K Govender

An advert for the information sessions and workshops was placed in The Weslander in Afrikaans, on 16 and 25 July (see Figure 23).

Inleiding tot Seewier Geleentehede

Seewiere is 'n belangrike natuurlike bron. Dit is 'n bestanddeel in baie produkte wat ons op 'n daaglikse basis gebruik en inneem. As gevolg van die potensiele voordele verbonde aan die groei van die sektor,, bevorder die United Nations Development Programme (UNDP) (vertaling as Verenigde Nasies Ontwikkelings Program) die volhoubare gebruik, boerdery, en produksie van seewiere in Suid Afrika.

Gevolgtik werk die UNDP, in samewerking met die Departement van Bosbou, Visserye en die Omgewing (DBVO/DFFE), in vennootskap met Bio Solutions Technicas (BST) om werksinkels in die gemeenskap aan te bied, wat daarop gemik is om die potensiaal van seewiere te verken, en om meer te leer van plaaslike ondervindings.

Werkswinkels sal as volg gehou word:

- Saldanha Baai: 12 Augustus 2024, 8 vm – 5 nm
- Velddrif: 14 Augustus 2024, 8 vm – 5 nm
- St Helena Baai: 16 Augustus 2024, 8 vm – 5 nm

Vir verdere inligting, woon asseblief een van die ope inligtingssessies by op 27 Julie:

- **Saldanha Baai** 10:00 - White City Multi-Purpose Centre
- **St Helena Baai** 10:00 - Steenberg's Cove Gemeenskapsaal
- **Paternoster** 12:00 - Solomon Tolman Gemeenskapsaal
- **Velddrif** 12:00 - Noordhoek Laerskool

Alternatiewelik, versoek asseblief 'n aansoekvorm van: Sel: 063 741 7379 (Voice en WhatsApp), of Epos: RSVP@Biosoltecnic.com

Die sluitingsdatum vir aansoeke vir bywoning van die werksinkels is 2 Augustus 2024. Die uitslag van u aansoek sal by 7 Augustus 2024 gekommunikeer word




Figure 23: Advert placed in The Weslander newspaper

In addition, the advert (in English and Afrikaans) was sent to the contact persons of the organisations listed in Table 14 who were requested to forward it to the community members on their databases.

Four open information sessions were held on 27 July (see Table 15). These information sessions were not originally planned. However, during consultation with some of the stakeholders in June, the project team was advised that without such sessions, community members were not likely to understand the importance of applying for attendance. This posed a risk of too many or too few people arriving on the day, or disputes over who were allowed to attend, and on what basis.

Table 15: Details of open information sessions

Location	Venue	Time	# of attendees
Saldanha Bay	White City Multi-purpose Centre	10:00–11:00	16
St Helena Bay	Steenberg's Cove Community Hall	10:00–11:00	25
Paternoster	Solomon Tolman Community Hall	12:00–13:00	4
Velddrif	Noordhoek Primary School	12:00–13:00	25

WORKSHOP APPLICATION PROCESS

Physical attendance at the workshops was limited to 30 participants per workshop venue. An application process was deemed necessary, to ensure fair process and for planning purposes. Application forms for workshop attendance were provided to interested community members after the open information sessions. Some forms were completed and submitted at the information

sessions, and others were submitted via email (to RSVP@biosoltecnic.com) or WhatsApp 063 741 7379. The due date for applications was 2 August 2024. Application forms could also be obtained via these email and WhatsApp platforms.

Successful applicants were notified of their application outcome by 7 August and provided with a ticket containing information relating to the workshop date, venue and time. Those that could not be accommodated due to over-subscription (for the Saldanha Bay workshop only) were offered spaces in the Velddrif workshop (which was under-subscribed). Notifications were made to the mobile numbers or email addresses provided in the application forms, and participants were requested to confirm attendance.

The BST team followed up on 9 August by phoning people who did not have WhatsApp or email platforms and sending SMS notifications to their mobile numbers. On 11 August, BST contacted all participants accepted for the Saldanha Bay workshop to ensure that they received the notification and workshop information. On 13 August, BST contacted all participants accepted for the Velddrif workshop and on 15 August, BST contacted all participants accepted for the St. Helena Bay workshop.

PSSA INVOLVEMENT

As incentive to attract participation, BST negotiated with management of the Phycological Society of Southern Africa (PSSA) to:

- ⇒ Offer a two-year free (PSSA) membership to the delegates who attend the physical workshops. This membership will give them access to the best technical expertise, including aquaculture specialists
- ⇒ Hold a competition for delegates after the completion of the workshops. The prize winner will receive sponsorship to attend the PSSA congress (likely to take place in January/February 2025).

WORKSHOP CONTENT

Workshops were facilitated by Nolan Adams (CEO of African Olive Trading). The language orientation was Afrikaans, the main local language, although most of the presentations were in English. One full-day workshop (08:30–17:00) was conducted in each of three locations identified, and each workshop was split into a training component and an interactive participant engagement component. Each workshop was held at a conference venue and made provision for a maximum of 30 community members per workshop, refreshments and lunch, and reading materials.

The UNDP introduced the workshops and context of the project. Guest speakers included experts from industry, government and the R&D community; they presented training material on the list of approved topics, using appropriate media such as PowerPoint presentations, videos etc. Presenter profiles are listed in PRESENTER BIOGRAPHIES. For the interactive discussion sessions, a Participlan approach with smaller groups was used. Each participant received a Training Workbook with colour printouts of all presentations, supplemented with descriptions of the most common commercial seaweed species used South Africa, and with space for notes.

Lessons learnt from the South African Kelp Farming Project, and other African seaweed cultivation initiatives were incorporated into the content. The workshop programme is set out in Table 16.

Table 16: Workshop programme

08:00	Registrasie	Registration	
09:00	Verwelkoming	Welcome	Nolan Adams
09:20	Inleiding tot UNDP en Projek	Introduction to UNDP and Project	Simone Smit
09:40	Beginsels van seewier	Seaweed basics	John Bolton
10:10	Tee	Tea	
10:30	Inleiding to seewier verbouing	Introduction to seaweed cultivation	Bernadette Brown-Webb
11:00	Die Suid Afrikaans kelp boerdery projek	SA Kelp farming project	Lizeth Botes
11:20	Pouse	Break	
11:50	Die Suid Afrikaanse regsraamwerk	SA regulatory Environment	Mark Rothman
12:10	Hulpbronne om seewier boere en entrepreneurs te ondersteun	Resources to assist seaweed farmers and entrepreneurs	Bernadette Brown-Webb and Mark Rothman
12:30	Globale perspektiewe oor ekonomiese seewiere	Global perspectives on economic seaweeds	Alan Critchley
12:40	Pad van 'n idee na 'n besigheids geleentheid	Turning an idea into an opportunity	Alan Webb
13:00	Middagete	Lunch	
14:00	Ondervindings van 'n waterkultuur boer	Experience of an aquaculture farmer	Nolan Adams
14:20	Interaktiewe bespreking	Interactive discussion	Nolan Adams
15:30	Tee	Tea	
16:00	Opsomming van gesprek	Summary of discussions	Bernadette Brown-Webb
16:20	Kompetisie besonderhede	Competition details	Simone Smit
16:40	Sluiting	Closure	Nolan Adams

The workshop content was structured as below:

- ⇒ Welcome: Welcome, Moment of silence. Purpose of workshop, Language policy, Housekeeping, Announce competition
- ⇒ Introduction to UNDP: What is the UNDP and role, project background, SDGs, global interest in seaweed, UNDP involvement in seaweed, simplified seaweed industry value chain
- ⇒ Introduction to seaweed—the basics:
 - ◆ What are seaweeds, How/where do they grow/reproduce, What are they used for, What happens with seaweeds in SA; High-level view of seaweed opportunities on West Coast
- ⇒ Introduction to seaweed cultivation:
 - ◆ Basics of seaweed cultivation, Cultivation technologies on-land, at-sea, Harvesting, Post-harvest processing, Past experiments in SA (*Gracilaria*, kelp etc.), Examples of successful integrated cultivation in SA - *Ulva/Gracilaria* (technical), Challenges
- ⇒ SA Kelp farming project
 - ◆ Overview of project, Funders/Stakeholders, Collaboration with UNDP project, Aims, Progress, Challenges, Outcomes, Future actions, etc.
- ⇒ SA regulatory environment
 - ◆ Legislation, regulations, guidelines for management of seaweed harvesting, collection and cultivation
- ⇒ Resources for seaweed farmers and entrepreneurs:

- ◆ Resources available from DFFE, Western Cape Provincial Agric, ABALOBI, PSSA, AASA, Kelp Scientific Collaboration, GreenWave, Global Seaweed Coalition, Global Seafood Alliance, AqualInvest/World Bank etc.
- ⇒ Global perspectives on economic seaweeds
 - ◆ Global view of economic seaweeds (species, applications, opportunities, challenges)
- ⇒ Turning an idea into an opportunity
 - ◆ The process of turning an idea into an opportunity: Identify Market opportunity, Feasibility study, Viability assessment, Business plan, Funding, Legal compliance, Business establishment, Facility establishment, Pilot production, Scaling up, Meeting market requirements, Timelines
- ⇒ Experience of an aquaculture farmer
 - ◆ Experiences, challenges and successes
- ⇒ Interactive discussions to gain insights and understanding about the following:
 - ◆ Facilitated session to document local and indigenous insights, concession experiences, concerns re aquaculture and seaweed production, expectations.

In preparation for the interactive discussions, the following questions were sent to participants as part of their acceptance documentation, and they were asked to think about and prepare to discuss these during the workshop:

A. INDIGENOUS INSIGHTS

1. If you reminisce, what are your first thoughts if you hear the word "Seaweed"…?
2. What (past) uses, if any, did your parents/grandparents/you have for seaweed?
3. What experience, if any, did your parents/grandparents/you have with regards to the cultivation of seaweed?

B. SEAWEED CONCESSIONS

1. Do you know what a seaweed concession is?
2. Are you part of/aware of any individual/group which holds/are in possession of a seaweed concession?
3. What are your thoughts and/or concerns about the current seaweed concessions?

C. SEAWEED CULTIVATION/AQUACULTURE

1. What is your understanding of seaweed cultivation/aquaculture?
2. According to you, what are the positives and negatives of aquaculture?
3. Name your concerns, if any, of seaweed cultivation.
4. What are your expectations, if any, of seaweed cultivation?

D. VALUE CHAIN

1. Do you know of any benefits and/or disadvantages of seaweed?
2. What uses do you know of, or can you think of, for seaweed?
3. What are your expectations, if any, with regards to the development of the seaweed market and value chain?

WORKSHOPS

PSSA APPLICATIONS

A total of 45 workshop participants indicated interest in taking up the offer of free two-year membership in the Psychological Society of Southern Africa (PSSA). Their details were submitted to the PSSA management team for processing.

COMPETITION

The competition entails the preparation of a mini-business plan for submission by 15 September. At the end of each workshop, the competition rules and requirements were explained to participants, and they were provided with copies of the competition application form. A panel of judges (including PSSA) was constituted to judge entries and choose the best one by 14 October.

The winner of the competition was Mr Myron Carolus, for his business plan entitled "Coastal Spades".

SALDANHA BAY WORKSHOP

Applications were received from 34 people via WhatsApp and email. Attendance is summarised in Table 17. Four people were offered space at the Velddrif workshop, and two declined. Eight people applied for the virtual session. Thirty applicants were successful and were sent a ticket for the workshop on 12 August. A total of 27 attended.

Table 17: Saldanha Bay workshop attendance details

Total # sent ticket	30
Total # confirmed/expected	23
Total # attended	27
Total # at end of day	21
# of PSSA applications	20
Walk-ins, extras	2
Transport required	3

The participants were asked to indicate the organisation they were affiliated with. The number of participants from each organisation (expected and actual) are summarised in Table 18. Some people indicated affiliations to multiple organisations, which made it difficult to determine true representation for each organisation.

Table 18: Saldanha Bay # of participants expected and actual attendance from each organisation

Name of organisation	Expected # from each org.	Actual # from each org.
No affiliations	11	9
Masifundise Trust	1	1
Saldanha VPK	5	3
Yes4Youth Prog./Genesis Hub	1	1
Black Women in Business	2	2
Paternoster Multipurpose Fishing Primary Co-op	3	3
Cochoqua	4	6
Communities Without Borders	3	3
Simunye Mussels	1	1
BSASA	1	1
ABALOBI	1	1
Requa Enterprises	1	1
SANWFA	1	0

The workshop attendees and presenters for the Saldanha Bay workshop are shown in Figure 24.



Figure 24: Collage of Saldanha Bay workshop

After lunch, 21 participants remained for the interactive session. They were divided into three groups, who worked together to provide responses to the four sets of questions. Two to three people captured and presented responses to each category of questions on behalf of the group. Summaries of their responses are presented in Table 19, Table 20, Table 21 and Table 22.

Saldanha Bay participants recollected the use of seaweed for income generation (perhaps because of the past *Gracilaria* industry), and as food for humans and animals (abalone). Of particular interest was the use of seaweed as a wrap to cook seafood in (which enhanced flavour), and for treatment of ailments such as dry skin or dandruff. Participants had no cultivation experience, only collection and drying of seaweed (Table 19).

Table 19: Saldanha Bay participant interactive response summary – A. Local and indigenous insights

QUESTIONS	RESPONSES					
A.1: First thoughts about "Seaweed"	Categories	Food	Health	Income generation	Environment	Family
	Details	Jellies, food security, abalone feed, bait	Sores, burns treatment	Drying, job creation, income	Kelp forests, crayfish home, cleans sea, fertiliser, firewood	Play "hair, food & washing", Slides, disciplined, meditation
	# of responses	3		3		
A.2: Past uses for seaweed	Categories	Food	Health	Environment	Family	Household
	Details	Seafood wrap, Ulva soup, flavour enhancer	Soap for dry skin, salve, dandruff treatment	Fertilisers, compost		Shoe polish (haarnaald seewier/ <i>Gracilaria</i> ?)
	# of responses	5	3	2		1
A.3: Experience with cultivation of seaweed	Categories	No cultivation experience	Only collection/drying/packing/export	Not allowed/collected small amounts	Basic training on seaweed	Seaweed cultivation experiments
	Details		Worked for Wicht (<i>Gracilaria</i> ?)	Not allowed to collect or touch		
	# of responses	1	2	1		

Saldanha Bay participant responses indicated general understanding of concessions. However, the negative response and confusion with farming seaweed indicates that more awareness creation is needed. The Paternoster Co-operative, Saldiaz and a non-specified private company were mentioned as concession holders. The biggest concerns were about the difficulty in accessing commercial concessions. Whilst it is not the intention to take existing business away, it is very difficult for new entrants to enter the commercial seaweed sector. In addition, numerous Small-scale Fishery (SSF) Co-operatives received rights in the same concession area (Area 11) as one commercial rights holder, albeit not for the same species. The seaweed species allocated to SSF co-operatives (*Gracilaria*, *Ulva* and *Porphyra*) were regarded as low volume/low value species, whilst the commercial rights holder was allocated kelp (regarded as high-volume/high value species) (Table 20).

Table 20: Saldanha Bay participant interactive response summary – B: Seaweed concessions

QUESTIONS		RESPONSES					
B.1: Know what seaweed concession is	Categories	Yes	No	Approved areas to harvest/collect seaweed	Permission to farm with seaweed	Right to exploit and trade seaweeds	Opportunity to conduct a business
	# of responses	3	1	1	1		
B.2: Part of/ awareness of concession holder	Categories	Yes	No				
	Details	Paternoster Co-op, Saldiaz, 1 private co.					
	# of responses	4	1				
B.3: Thoughts/concerns	Categories	Small-scale and commercial rights in same area	Disparity in volume and value of allocations	Commercial concessions difficult to access	Commercial sustainability of concessions	Communities not sufficiently informed	Potential long-term solution and job creation
	Details	Area 11 - numerous SSF co-ops, one commercial rights holder	SSF co-ops - low-volume, low demand Ulva/Gracilaria; Commercial RH - high-volume, high demand kelp	Community cannot collect beach-cast, difficult for new entrants, difficult application process		Not sufficiently informed about concessions	
	# of responses	3	2	4		2	

Saldanha Bay participant responses indicated that they understood what seaweed cultivation is. The potential socio-economic benefits of seaweed aquaculture were the most important positive aspect identified, and red tape/costs the most important negative aspect. Concerns about aquaculture revolve around the environment, especially potential impact on other species. Expectations focused on socio-economic benefits such as food security (Table 21).

Table 21: Saldanha Bay participant interactive response summary – C. Seaweed cultivation/Aquaculture

QUESTIONS	RESPONSES					
C.1 Understanding of seaweed cultivation	Category	Farming or breeding seaweed	Potential to become sustainable sector			
	Details		Create jobs, provide food			
	# of responses	2	1			
C.2.1 Positives of aquaculture	Category	Environmental benefits	Socio-economic benefits	Source of food	Use existing infrastructure	Do not understand enough
	Details	Reduces effect of over-harvesting & climate change, biofuel potential	Job creation, economic growth, education, skills, food security	Animal feed source		
	# of responses	4	7	1		
C.2.1 Negatives of aquaculture	Category	Red tape and costs	Potential user conflicts	High risk business	Do not understand enough	
	Details	Legislation/Red tape, costly & slow processes	Rotting seaweed contributing to pollution	Feasibility studies required		
	# of responses	2	1	1		
C.3 Concerns	Category	Environmental	Inclusiveness	Demand could destroy resource	Access to markets and resources	In-fighting
	Details	Negative impact on other species, conditions must be conducive				
	# of responses	2				
C.4 Expectations	Category	Socio-economic benefits	Develop value chain opportunities	Long-term sustainability		
	Details	Benefit economically, food security				
	# of responses	2				

The benefits of seaweed in the value chain were described mostly in terms of human and animal food. The disadvantage described reflects the unhappiness about the species allocated for SSF concessions. Potential uses were mostly described in terms of food (jellies, human and animal feed products). Expectations included inclusion in development of the value chain, value addition opportunity development, exploration of existing infrastructure for processing and bio-fuel exploration.

Table 22: Saldanha Bay participant interactive response summary – D. Value chain

QUESTIONS	RESPONSES					
	D.1.1 Benefits of seaweeds	Category	Human and animal food	Health	Socio-economic	Environmental
Details		Nutrition, food security, feeding other animals/sea life				
# of responses		2				
D.1.2 Disadvantages of seaweeds	Category	Efficient management required	Opposition from public	Markets	Co-dependence	
	Details	Not the right species for concessions				
	# of responses	1				
D. 2 Potential uses of seaweed	Category	Environmental	Food	Health	Other	
	Details	Agricultural stimulants/fertilizer, bio-fuel	Jellies, human and animal feed products	Pharmaceuticals, health products		
	# of responses	3	5	3		
D.3 Expectations	Category	Socio-economic	Develop value addition opportunities	Develop sustainable businesses	Infrastructure	Environment
	Details	Inclusion, upliftment of communities	Value addition, not only raw product		Explore existing facilities for processing	Bio-fuel research & exploration
	# of responses	1	1		1	1

Notes and quotes from participants:

Seaweed concessions:

“same companies for decades”

VELDDRIF WORKSHOP

Applications were received from 27 people. Attendance is summarised in Table 23. Four people from Saldanha were offered space at the Velddrif workshop, and two declined. Tickets for the workshop were therefore sent to 29 applicants. A total of only 12 attended. The reason for the low attendance was in-fighting amongst the members of the Velddrif Small-scale Fishing Co-operative, which caused many of the members to stay away from the workshop. It is also understood that this may have caused others wishing to avoid potential conflict to stay away too. The project team informed the UNDP and DFFE mentor of the situation, and prepared to ask participants to leave the workshop in the event of any conflict.

Table 23: Velddrif workshop attendance details

Total # sent ticket	29
Total # confirmed/expected	12
Total # attended	12
Total # at end of day	12
# of PSSA applications	8
Walk-ins, extras	3
Transport required	0

The participants were asked to indicate the organisation they were affiliated with. The number of participants from each organisation (expected and actual) is summarised in Table 24. Most of the participants that attended (67%) indicated that they had no affiliation to any organisations.

Table 24: Velddrif # of participants expected and actual attendance from each organisation

Name of organisation	Expected # from each org.	Actual # from each org.
No affiliations	9	8
Masifundise Trust	2	1
Saldanha VPK	1	0
Cochoqua	1	0
Velddrif SSF	13	2
Co-op Primary Ltd	1	0
Griqua	1	0
Communities Without Borders	1	0
Isiphiwe Enterprises	2	1
Coastal Links	1	0

The Velddrif participants and presenters are pictured in Figure 25.



Figure 25: Collage of Velddrif workshop

After lunch, 12 participants remained for the interactive session. They were divided into two groups, who worked together to provide responses to the four sets of questions. One person captured and presented responses to each category of questions on behalf of the group. A summary of their responses is presented in Table 25.

Velldrif participants recalled the use of seaweed for income generation (because of the past kelp industry), and for its environmental benefits such as providing a home for crayfish, kelp used as fertiliser and firewood, and the kelp forest benefits. They also mentioned the past use of seaweed as a wrap to cook seafood in (which enhanced flavour), for animal food and for firewood. Participants had no cultivation experience, only collection and drying of seaweed (Table 25).

Table 25: Velldrif participant interactive response summary – A. Indigenous insights

QUESTIONS	RESPONSES					
	Categories	Food	Health	Income generation	Environment	Family
A.1: First thoughts about "Seaweed"	Details	Jellies, food security, abalone feed, bait	Sores, burns treatment	Drying, job creation, income	Kelp forests, crayfish home, cleans the sea, fertiliser, firewood	Play "hair, food & washing", Slides, disciplined, meditation
	# of responses	1		2	3	1
	Categories	Food	Health	Income generation	Environment	Family
A.2: Past uses for seaweed	Details	Seafood wrap, flavour enhancer, spices, dog food additive	Salve	Fertiliser, firewood		
	# of responses	4	1	2		
	Categories	Food	Health	Environment	Family	Household
A.3: Experience with cultivation of seaweed	Details	Cultivation was a secret	Bamboes			
	# of responses	1	1			
	Categories	No cultivation experience	Collection/ drying/ packing/ export of seaweed	Not allowed/ collected small amounts	Basic training on seaweed	Seaweed cultivation experiments

Responses indicated that Velldrif participants had a broad understanding of seaweed concessions. They mentioned Verdino and Velldrif Primary Co-operative as groups with concessions. The greatest concern was the difficulty in accessing commercial concessions, coupled to difficult application processes. While the beach-cast was perceived as not fully utilised by the commercial rights holder, no one else had permission to collect it. Coupled to this, is the problem of small-scale and commercial concession holders having concessions in the same area, although not for the same seaweed species (Table 26).

Table 26: Velddrif participant interactive response summary – B: Seaweed concessions

QUESTIONS	RESPONSES						
B.1: Know what seaweed concession is	Categories	Yes	No	Approved areas to harvest/collect seaweed	Permission to farm with seaweed	Right to exploit and trade seaweeds	Opportunity to conduct a business
	# of responses			1		2	
B.2: Part of/ awareness of concession holder	Categories	Yes	No				
	Details	Verdino, Velddrif Primary Co-op					
	# of responses	3					
B.3: Thoughts/ concerns	Categories	Small-scale and commercial rights in same area	Disparity in volume and value of allocations	Commercial concessions difficult to access	Commercial sustainability of concessions	Communities not sufficiently informed	Potential long-term solution and job creation
	Details	Area 11 - one commercial rights holder, with kelp rights		Communities cannot collect beach-cast, difficult for new entrants, difficult application process, kelp not fully utilised		Communities /SSF co-ops not sufficiently informed about concessions	
	# of responses	2		5		1	

Although some Velddrif participants indicated that they understood what seaweed cultivation is, one of the groups indicated that most of them knew little or nothing about it until the workshop. Positive aspects mostly revolved around the socio-economic benefits, and negatives typically around red tape and costs. The majority of concerns were around the need to be included in industry development, especially through government support. Expectations were mostly for socio-economic benefits such as employment and poverty relief (Table 27).

Table 27: Velddrif participant interactive response summary – C. Seaweed cultivation/Aquaculture

QUESTIONS	RESPONSES					
C.1 Understanding of seaweed cultivation	Categories	Farming or breeding seaweed	Potential to become sustainable sector	Most of the group knew little/nothing until today		
	Details					
	# of responses	2		1		
C.2.1 Positives of aquaculture	Categories	Environmental benefits	Socio-economic benefits	Source of food	Use existing infrastructure	Do not understand enough
	Details	Cleans water and reduces pollution impacts	Job creation, economic growth, education, skills, food security		Positive addition to existing fishing concessions	
	# of responses	2	4		1	
C.2.2 Negatives of aquaculture	Categories	Red tape and costs	Potential user conflicts	High risk business	Do not understand enough	
	Details	Costly and slow processes	Compete for sea space with other activities	Feasibility studies required		
	# of responses	3	1	1		
C.3 Concerns	Categories	Environmental	Inclusiveness	Demand could destroy resource	Access to markets and resources	In-fighting
	Details	Cleaning chemicals from ships polluting water	Included in industry development, complicated process, need more support from government			
	# of responses	1	3			
C.4 Expectations	Categories	Socio-economic benefits	Develop value chain opportunities	Long-term sustainability		
	Details	Benefit economically, employment, poverty relief				
	# of responses	4				

Velddrif participants described the benefits of seaweed in terms of food for humans and animals, health benefits and socio-economic benefits (see Table 28). The disadvantage is that it rots if not efficiently managed. The most important potential uses were described as food related, and expectations were for socio-economic development and development of sustainable businesses.

Table 28: Velddrif participant interactive response summary – D. Value chain

QUESTIONS	RESPONSES					
D.1.1 Benefits of seaweeds	Category	Human & animal food	Health	Socio-economic	Environment	Value-added products
	Details	Nutrition, food security	Medical benefits	Export and construction benefits		
	# of responses	2	2	2		
D.1.2 Disadvantages of seaweeds	Category	Efficient management required	Opposition from public	Markets	Co-dependence	
	Details	Rots if not processed				
	# of responses	1				
D. 2 Potential uses of seaweed	Category	Environmental	Food	Health	Other	
	Details	Agricultural/ Fertilisers	Making jellies and food products	Ingredients in cosmetics & beauty products	Construction - bricks	
	# of responses	1	3	2	1	
D.3 Expectations	Category	Socio-economic	Develop value addition opportunities	Develop sustainable businesses	Infrastructure	Environment
	Details	Education, youth involvement, awareness creation		Start income generating business, export markets		
	# of responses	2		2		

Notes and quotes from participants:

People collected, dried and milled seaweed (bamboo) in early years. They also liquidised fresh seaweed (Kelpak)—in Velddrif.

'Bamboes' is used as a collective term for all seaweeds. Strictly speaking, it refers to sea bamboo, or kelp (*Ecklonia maxima*), which is the dominant kelp known in the area. Other seaweeds occur in lesser volumes.

ST HELENA BAY WORKSHOP

Applications were received from 31 people. Attendance is summarised in Table 29. Thirty applicants were successful and were sent a ticket for the workshop. A total of 22 attended.

Table 29: St Helena Bay workshop attendance details

Total # sent ticket	30
Total # confirmed/expected	18
Total # attended	22
Total # at end of day	21
# of PSSA applications	16
Walk-ins, extras	0
Transport required	1

The participants were asked to indicate the organisation they were affiliated with. The number of participants from each organisation (expected and actual) is summarised in Table 30. Some people indicated affiliations to multiple organisations, which made it difficult to determine true representation for each organisation.

Table 30: St Helena Bay # of participants expected and actual attendance from each organisation

Name of organisation	Expected # from each org.	Actual # from each org.
No affiliations	15	11
Masifundise Trust	1	0
Steenberg's Cove	3	3
Cochoqua	5	4
Stompneusbaai	1	0
ABALOBI	2	2
Weskusmandtjie	2	2
Amalula	3	3
Food Security Research Institute	1	1
Mamre Enterprise Fishing Co-op	1	1
SA Fishing Collective	1	1
Coastal Links	1	0

Participants and presenters for the St Helena Bay workshop are pictured in Figure 26.



Figure 26: Collage of St Helena Bay workshop

After lunch, 21 participants remained for the interactive session. They were divided into three groups, who worked together to provide responses to the four sets of questions. For this workshop, group facilitators asked each participant to write down their own ideas, instead of one or two persons recording on behalf of the group. Two people presented responses to each category of questions on behalf of the group (see Figure 27). Summaries of their responses are presented in Table 31, Table 32 and Table 33.



Figure 27: St Helena Bay Interactive group feedback

St Helena Bay participants had fond thoughts of seaweed especially around food and family traditions (playing, enjoying, getting disciplined with bamboo sticks, meditating on the sea). They also used seaweed for income generation (because of the past kelp and *Gracilaria* industries), and for its environmental benefits. They also mentioned the past use of seaweed as a wrap to cook seafood in (which enhanced flavour), for human and animal food, health, environmental benefits and family (including as a treatment for bed wetting). Many participants had no cultivation experience. However, some had experience of collecting and drying of seaweed, and cultivation experiments (Table 31).

Table 31: St Helena Bay participant interactive response summary – A. Indigenous insights

QUESTIONS	RESPONSES					
A.1: First thoughts about "Seaweed"	Categories	Food	Health	Income generation	Environment	Family
	Details	Jellies, food security, abalone feed, bait	Sores, burns treatment	Drying, job creation, income	Kelp forests, crayfish home, cleans the sea, fertiliser, firewood	Play "hair, food & washing", Slides, disciplined, meditation
	# of responses	8	4	5	5	10
A.2: Past uses for seaweed	Categories	Food	Health	Environment	Family	Household
	Details	Seafood wrap, eaten fresh/dried, livestock feed additive	Soap for dry skin, salve, dandruff treatment, medicinal use	Fertilisers, compost, firewood	Played with bamboo, prevented bed wetting	
	# of responses	12	8	10	5	
A.3: Experience with cultivation of seaweed	Categories	No cultivation experience	Collection/ drying/ packing/ export of seaweed	Not allowed/ collected small amounts	Basic training on seaweed	Seaweed cultivation experiments
	Details		Exploitation of bamboo or seegrass (Gracilaria) - e.g. Maribus Industries	Picked up enough for own use	Training on seaweed types, exploitation, harvesting, eating	On abalone farm
	# of responses	5	3	1	2	1

Although most participants demonstrated some understanding of a seaweed concession, seven said that they did not know. They mentioned the Amalula and Steenberg's Cove Co-operatives, Verdino 143 and the Abalone Farmers' Workers Trust as groups in possession of a concession. Participants were most concerned about the sustainability of the concessions allocated, and the difficulty in accessing commercial concessions (Table 32).

Table 32: St Helena Bay participant interactive response summary – B. Seaweed concessions

QUESTIONS	RESPONSES						
B.1 Know what seaweed concession is	Categories	Yes	No	Approved areas to harvest/ collect seaweed	Permission to farm with seaweed	Right to exploit and trade seaweeds	Opportunity to conduct a business
	# of responses	3	7	3		7	1
B.2 Part of/awareness of concession holder	Categories	Yes	No				
	Details	Amalula & Steenberg's Cove Co-ops, Verdino 143, Abalone Farmers' Workers Trust					
	# of responses	12	9				
B.3 Thoughts/ concerns	Categories	Small-scale and commercial rights in same area	Disparity in volume and value of allocations	Commercial concessions difficult to access	Commercial sustainability of concessions	Communities not sufficiently informed	Potential long-term solution and job creation
	Details	Area 11 - numerous SSF co-ops, one commercial rights holder	SSF co-ops - low-volume, low demand <i>Ulva/ Gracilaria</i> ; Commercial RH - high-volume, high demand kelp	Difficult for new entrants in commercial sector, lack of transparency about utilisation	Insufficient experience to build sustainable businesses, market fluctuations	Do not know enough to have an opinion	Hope for positive solution
	# of responses	3	1	3	5	2	3

Although many St Helena Bay participants indicated an understanding of seaweed cultivation, there were also many who acknowledged they knew little about it until the workshop. This was reflected in answers about the positives and negatives, where most indicated that they did not understand enough about aquaculture to venture an opinion. Most of the concerns were about access to markets and resources, and most expectations about socio-economic benefits (Table 33).

Table 33: St Helena Bay participant interactive response summary – C. Seaweed cultivation/Aquaculture

QUESTIONS	RESPONSES					
C.1 Understanding of seaweed cultivation	Category	Farming /breeding seaweed	Can become sustainable sector	Most knew little/nothing until today		
	Details	Includes product development and sale, for profit	Can create businesses, jobs, food and other products e.g. medicines			
	# of responses	8	5	6		
C.2.1 Positives of aquaculture	Category	Environmental benefits	Socio-economic benefits	Source of food	Use existing infrastructure	Do not understand enough
	Details	Reduces effect of over-harvesting	Job creation, economic growth, financial independence	Potential for food security, animal feed	Can use longlines to grow seaweed	
	# of responses	2	3	3	1	6
C.2.2 Negatives of aquaculture	Category	Red tape and costs	Potential user conflicts	High risk business	Do not understand enough	
	Details	Costly and slow processes, access to funding	Rotting seaweed/ pollution, competition for sea space with other users	Luxury products depend on export markets, weather events		
	# of responses	3	3	4	6	
C.3 Concerns	Category	Environmental	Inclusiveness	Demand could destroy resource	Access to markets and resources	In-fighting
	Details	Impact on other species, cleaning chemicals from ships polluting water		Laminaria in very high demand; also E. maxima; could lead to resource destruction	Need access to good markets, land, capital etc, and set-up costs high	
	# of responses	2		3	6	1
C.4 Expectations	Category	Socio-economic benefits	Develop value chain opportunities	Long-term sustainability		
	Details	Benefit economically, employment	New products e.g. medicines, revolutionise kelp	Re-introduce seaweed in communities, co-ops should work together		
	# of responses	6	3	3		

St Helena Bay participants listed the most important benefits of seaweed as environmental, and the most important disadvantage as the requirement for efficient management. Health and food-related uses were identified as having the most potential. The most important expectation with regard to development of the market and value chain was for the development of sustainable businesses (Table 34).

Table 34: St Helena Bay participant interactive response summary –D Value chain

QUESTIONS	RESPONSES					
D.1.1 Benefits of seaweeds	Category	Human and animal food	Health	Socio-economic	Environmental	Value-added products
	Details	Nutrition, food security, food for other animals/sea life	Medicines e.g. for stomach acid	Community empowerment	Ecosystem/climate, minimal inputs, fertilisers	Products e.g. cosmetics, fertilisers etc.
	# of responses	3	3	3	4	1
D.1.2 Disadvantages of seaweeds	Category	Efficient management required	Opposition from public	Markets	Co-dependence	
	Details	Efficient processing and management needed to succeed	Lack of public knowledge & understanding	Dependence on export markets	Requires co-operation and honesty	
	# of responses	4	1	1	1	
D. 2 Potential uses of seaweed	Category	Environmental	Food	Health	Other	
	Details	Fertilizers, bio-fuel	Human food & beverages, animal feed	Pharmaceutical drugs, health products, cosmetics	Textiles (shoes, handbags)	
	# of responses	3	10	11	1	
D.3 Expectations	Category	Socio-economic	Develop value addition opportunities	Develop sustainable businesses	Infrastructure	Environmental
	Details	Inclusion, socio-economic upliftment, youth education	Fast-track value chain development	Start successful businesses, develop markets, mentoring of Co-ops	Obtain required infrastructure & equipment for success	Use to mitigate pollution & climate change effects
	# of responses	5	1	10	1	1

Notes and quotes from participants:

Gracilaria is called "seegras".

"My pa het seegras huis toe gebring. My ma was kwaad, sy vra wat maak jy met die seegras hier? Pa sê toe ons eet dit vanaand, ek het gelag. My pa maak 'n pot stywe pap en sit die seegras daarin en toe die pap geskep word was dit baie heerlik".

Translation: *My father brought seaweed (Gracilaria) home. My mother was angry and asked what are you doing with the seaweed here? Father then said we will eat it tonight, and I laughed. My father made a big pot of pap (porridge) and put the seaweed in it and when the pap was dished up it was delicious.*

Food—seaweed can be eaten directly (fresh or dried), used as a condiment (e.g. spice), processed further into food product (e.g. jelly) or processed into ingredient for various products including cosmetics, drugs etc.

Fertiliser—can steep in water, and use liquid on plants, or dry and mix with compost.

Required infrastructure for success include boat, processing facility, marketing, logistics.

CONSOLIDATED WORKSHOP RESULTS

Participant responses reflected widespread local and indigenous uses of seaweed in the past. These uses ranged from food and health to garden or agricultural use. Popular uses across all three groups included the wrapping and cooking of seafood in seaweed (which enhanced the flavour), using seaweed as soil conditioner or fertiliser, and using dried sea bamboo (kelp) as firewood. Seaweed was also popular in health remedies (for skin problems, cuts and burns, inflammation, etc.). In Velddrif and St Helena Bay, seaweed was used by children in their daily play (as make-believe hair and food, and as slides). Although very few participants had experience of cultivation, some had experience of seaweed collection, drying and export.

Many participants knew what seaweed concessions are. However, there were a large number of participants, especially in St Helena Bay, who indicated that they did not. The issue of allocation of kelp to one commercial rights holder, and other species to many SSFs, in Area 11, drew much reaction. Some participants thought that they were getting concessions for kelp and could not understand why they were getting other species. *Gracilaria*, *Ulva* and *Porphyra*, the species allocated to SSFs, were regarded as low volume/low value, and participants indicated that these were difficult to exploit on a commercially successful basis. They wanted kelp (*Ecklonia maxima* and *Laminaria pallida*), which could not happen as there were already 15-year allocations to other concession holders in those areas. In addition, many participants referred to seaweed collectively as “bamboes” (kelp), adding to the confusion.

Although many participants knew what seaweed cultivation is, there were again many (especially in St Helena Bay) who admitted that they did not. In St Helena Bay this was reflected in answers about the positive and negative aspects of seaweed aquaculture, where many indicated they did not understand enough to give an opinion. The most important positive aspects of aquaculture across the groups were the potential socio-economic benefits. Negatives were mostly red tape and costs (Saldanha and Velddrif), and the high risk of aquaculture (St Helena Bay). In St Helena Bay, most cultivation concerns were around access to resources, while Velddrif and Saldanha groups were more concerned with being included in the development of the industry, and the environmental impacts. Expectations for all groups were centered on the potential socio-economic benefits such as employment.

In terms of the value chain, each group had a different emphasis on the potential benefits of seaweed. In St Helena Bay, the environmental benefits were most important and in Saldanha Bay, food benefits were important. In Velddrif, the food, health and socio-economic benefits were equally important. For all three groups, the greatest disadvantage was the requirement for efficient management of the resource. In Saldanha Bay, potential food uses of seaweed were most important. For Velddrif and St Helena Bay, the biggest potential uses were food- and health related. In Velddrif and St Helena Bay, socio-economic development and the development of sustainable businesses were the greatest expectations with regard to the development of the seaweed market and value chain.

PRESENTER BIOGRAPHIES

Profile Ms Simone Smit

Simone Smit is the Head of Exploration at the United Nations Development Programme Accelerator Lab, as well as the Innovation Focal Point for the Nature, Climate and Energy Portfolio in South Africa. She has a master's degree in transformational systems change, and has over 12 years' experience in climate and environmental programming. She is passionate about finding solutions that bridge the divide between conservation and socio-economic development.

Profile Mr Nolan Adams

Nolan M. Adams is the CEO and Board Chairperson of African Olive Trading, the largest 100% black mussel farming business as well as one of the three largest mussel farms in South Africa, for almost 10 years.

He also serves as Director and Non-Executive Board Chairperson of New Blue Ocean Mussels, the owners of the Blue Ocean Mussels- and the Gallo Group Seafood Processors—as well as the owners of the Blue Ocean Mussel farm—who is also a shareholder in Imbaza Mussels.

Nolan is an entrepreneur by birth and a mussel farmer by default; he believes that through sustainable farming practices, all industries will ensure that generations to come will continue to “reap the fruit from Mother Nature”.

Profile Emeritus Prof. John J. Bolton

Prof. John J Bolton is Emeritus Professor of Biological Sciences and Senior Research Scholar at the University of Cape Town, South Africa. He is a marine plant biologist and research interests cover the biodiversity, biogeography and phylogeography, systematics, the ecology, resource management and aquaculture of seaweeds, and the integrated aquaculture of seaweeds and marine animals. He has worked widely in Southern Africa and the Western Indian Ocean, has over 170 peer-reviewed journal publications and has supervised 22 graduated PhD students.

Profile Dr Mark D Rothman

Dr Mark D Rothman is a Specialist Scientist at The Department of Forestry, Fisheries and the Environment, South Africa and a Research Associate at the University of Cape Town, South Africa. His research interests include seaweed aquaculture, seaweed biology, biogeography and ecology. Since he took up the position as head of the Benthics and New Fisheries Research Unit, he has also ventured into research on various marine fauna (white mussels, octopus, abalone and red-eye).

Profile Dr Bernadette Brown-Webb

Dr Bernadette Brown-Webb is an Associate Partner at Bio Soluciones Technicas, an international company providing integrated business and engineering solutions in the biological industries. She has a PhD in Sustainable Agriculture from the University of the Free State (South Africa). She is passionate about using science and technology solutions to develop small businesses in the bio industries, with more than 20 years' experience in this domain. Her research interests include seaweed aquaculture, sustainable agriculture and the circular economy.

Profile Dr Lizeth Botes

Dr Lizeth Botes has been working in the aquaculture industry for nearly 30 years. Since 2010 she has been running her own company, Sound Interaxions, which provides advisory and consultancy services ranging from project management, drafting and implementing of responsible aquaculture standard operating procedures, on-farm red tide managing and monitoring plans etc. She also provides accredited aquaculture training to farmworkers in the aquaculture industry, supervises university students from both UWC and UCT, and played an instrumental role in the development of the new Aquaculture farmworker and Aquaculture farmer QCTO qualifications.

Profile Dr Alan T. Critchley

Dr Alan T. Critchley started his academic and seaweed career in Portsmouth UK. Upon gaining his PhD he began a 20-year career first at UKZN, then at Wits and then at the Univ. Namibia. He moved to the commercial world in France researching sources of seaweed colloids (carrageenans and alginates) and later Canada, to work on seaweed cultivation on land and commercialisation of seaweed extract biostimulants. He is now a Research Fellow and Consultant at the Verschuren Centre for Sustainability in Energy and Environment, Canada.

Profile Mr Alan G.E. Webb

Alan Webb is the Managing Director of Bio Soluciones Técnicas. He has 30-plus years of socio-economic development experience (yes, he is really that old!), mostly gained while working for the CSIR. He has extensive experience in investigating business opportunities and establishing manufacturing and agro-processing businesses. With keen interest in manufacturing and sustainability, he completed a wide range of projects, including studies and strategy development, across various sectors, for local and international government departments and development agencies. Alan is a practical generalist who likes to develop useful solutions.

Profile Ms Andrea Bernatzeder

As Director of Aquaculture Innovation and Technology at the DFFE, Ms. Bernatzeder oversees sustainable aquaculture research in South Africa, which includes various international and local collaborations. Her work includes strategic involvement in the multi-disciplinary project looking at testing the farming potential of kelp. She has a Masters in Ichthyology and Fisheries Science from Rhodes University and over 10 years wide-ranging experience in the aquaculture sector, including policy development, environmental programs, market development, certification, and impact assessment.