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Better Management Practices (BMPs) for Seaweed Farming in Tanzania



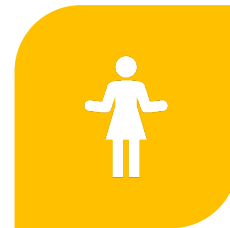
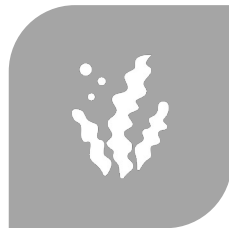
Roshni Lodhia/The Nature Conservancy



Roshni Lodhia/The Nature Conservancy



What are the Conditions for Sustainable Seaweed Farming?



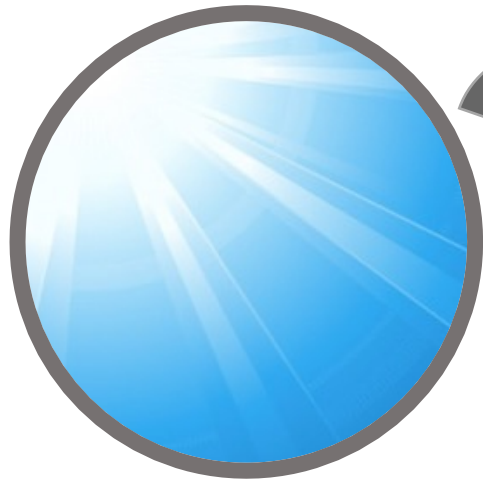
A HEALTHY ENVIRONMENT
PROVIDES CONDITIONS FOR SEAWEED TO GROW WELL

BETTER FARMING PRACTICES MAINTAIN A HEALTHY ENVIRONMENT AND BENEFIT FARMERS

DEDICATED FARMERS MAINTAIN THE FARM, HELP SEAWEED GROW, AND IMPROVE YIELD AND QUALITY

HEALTHY SEAWEED

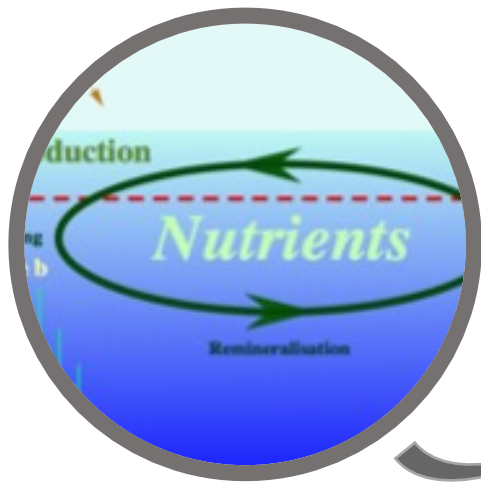
Needs for Healthy Seaweed



Light for photosynthesis



Healthy environment



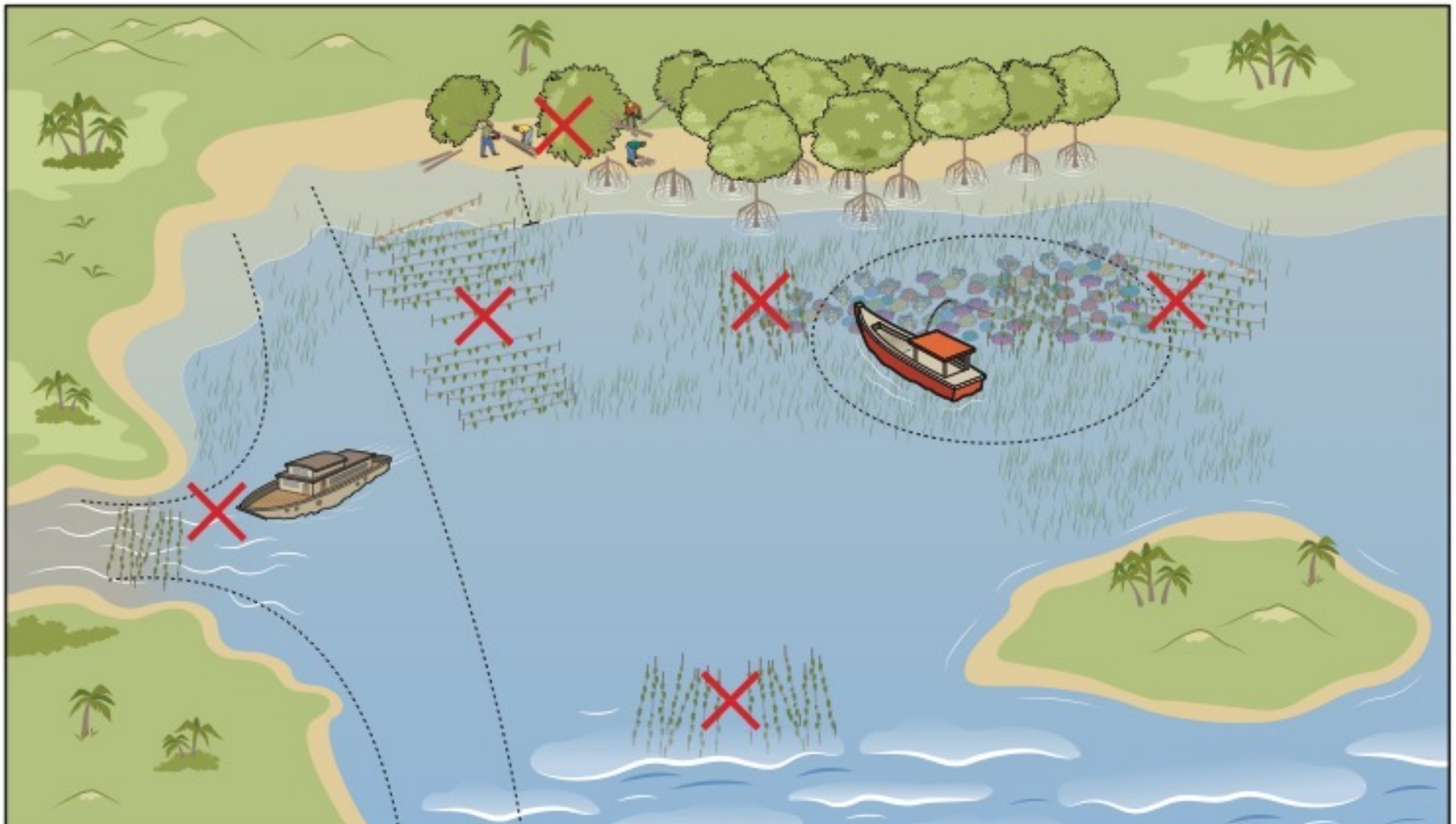
Nutrients brought by the current



Attention from farmer



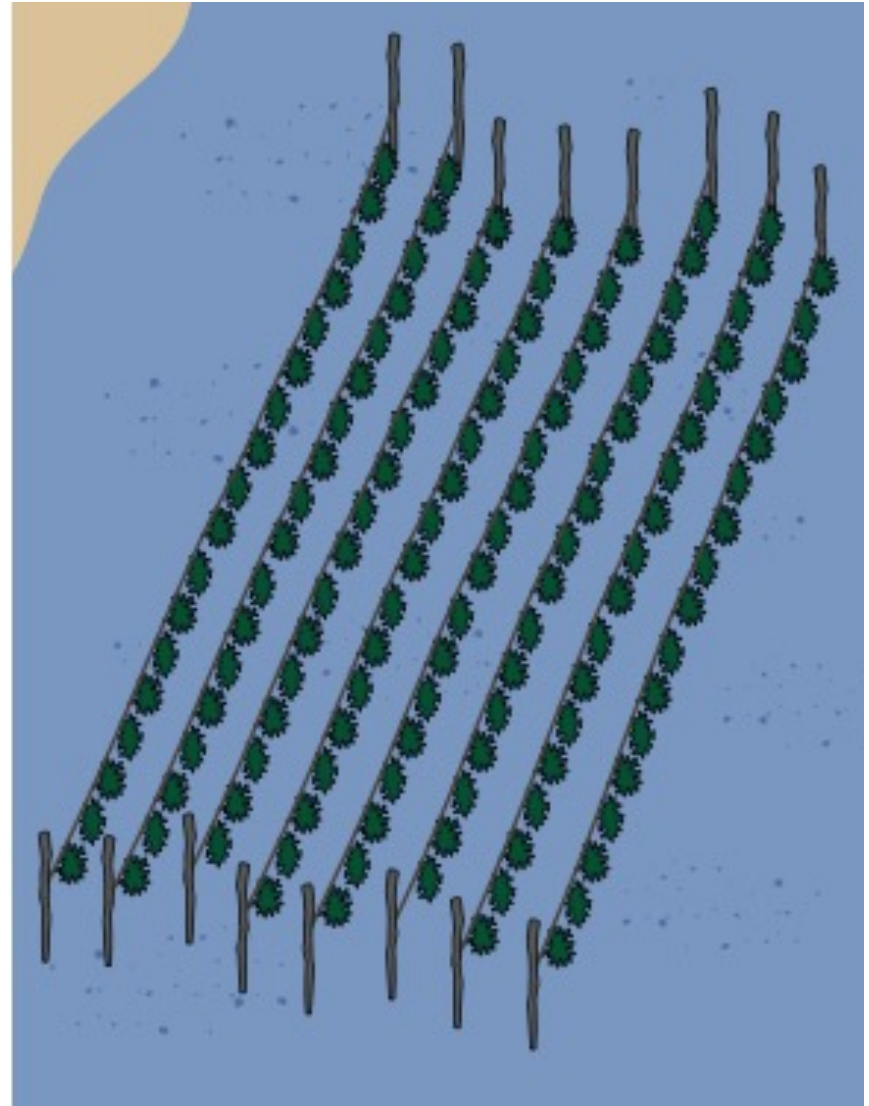
What are practices to avoid and why?



Practices to Avoid

Traditional seaweed farm in Pemba

- 400 lines of 11m each in 4 plots of 500m²
- Single made loop with 50 loops per cultivation lines
- Seedlings of small size
- Lack of maintenance



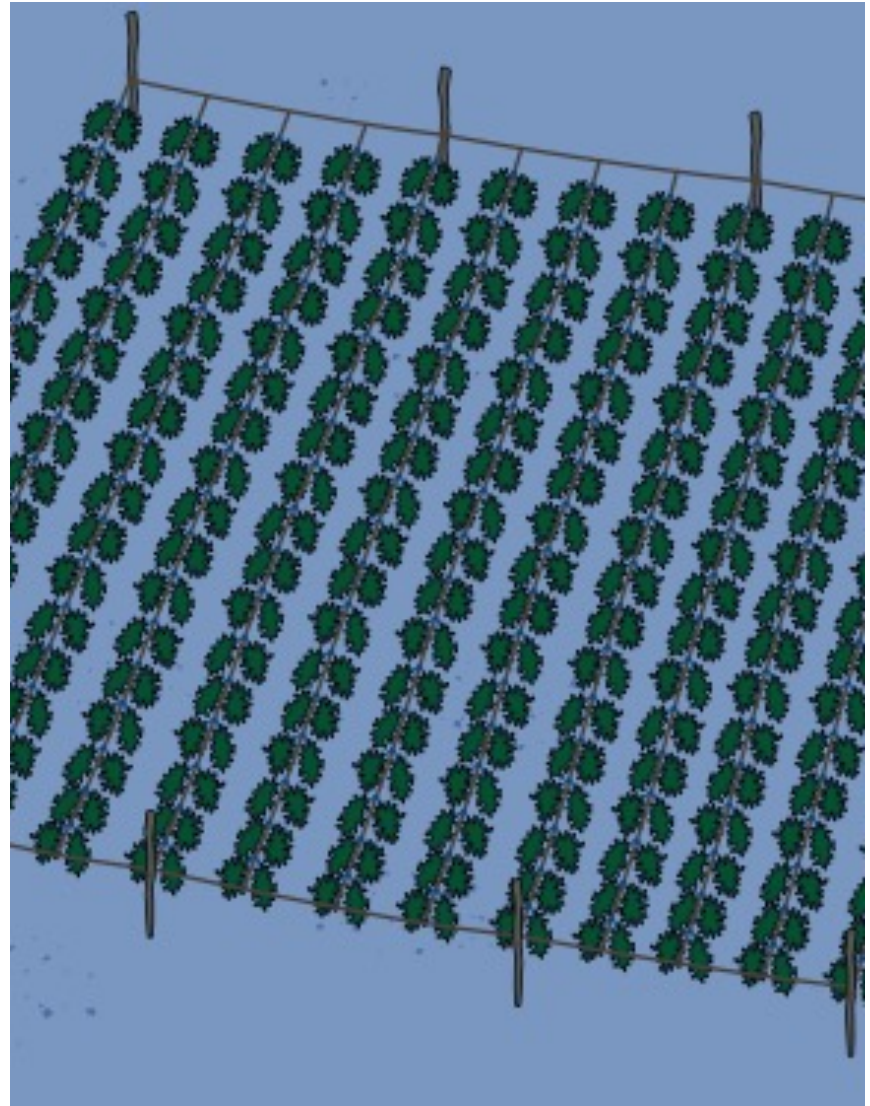
Improved seaweed farm design

GOOD YIELDS

=

- farming practices +
- environmental conditions +
- farmer dedication

If any of these are lacking or has limitations, then there will be poor seaweed yields and economic returns



Poor economic returns & high social and environmental costs

YIELD is the amount of seaweed produced per low tide cycle

- Example of poor yields: 100-150kg of dried seaweed per low tide (200-300kg per month)

ECONOMIC RETURNS are the amount of money a farmer receives for the seaweed *MINUS* the amount of resources that is used to produce the seaweed.

- The more efficient you are on the farm (less stakes, ropes, time), then the greater economic returns.

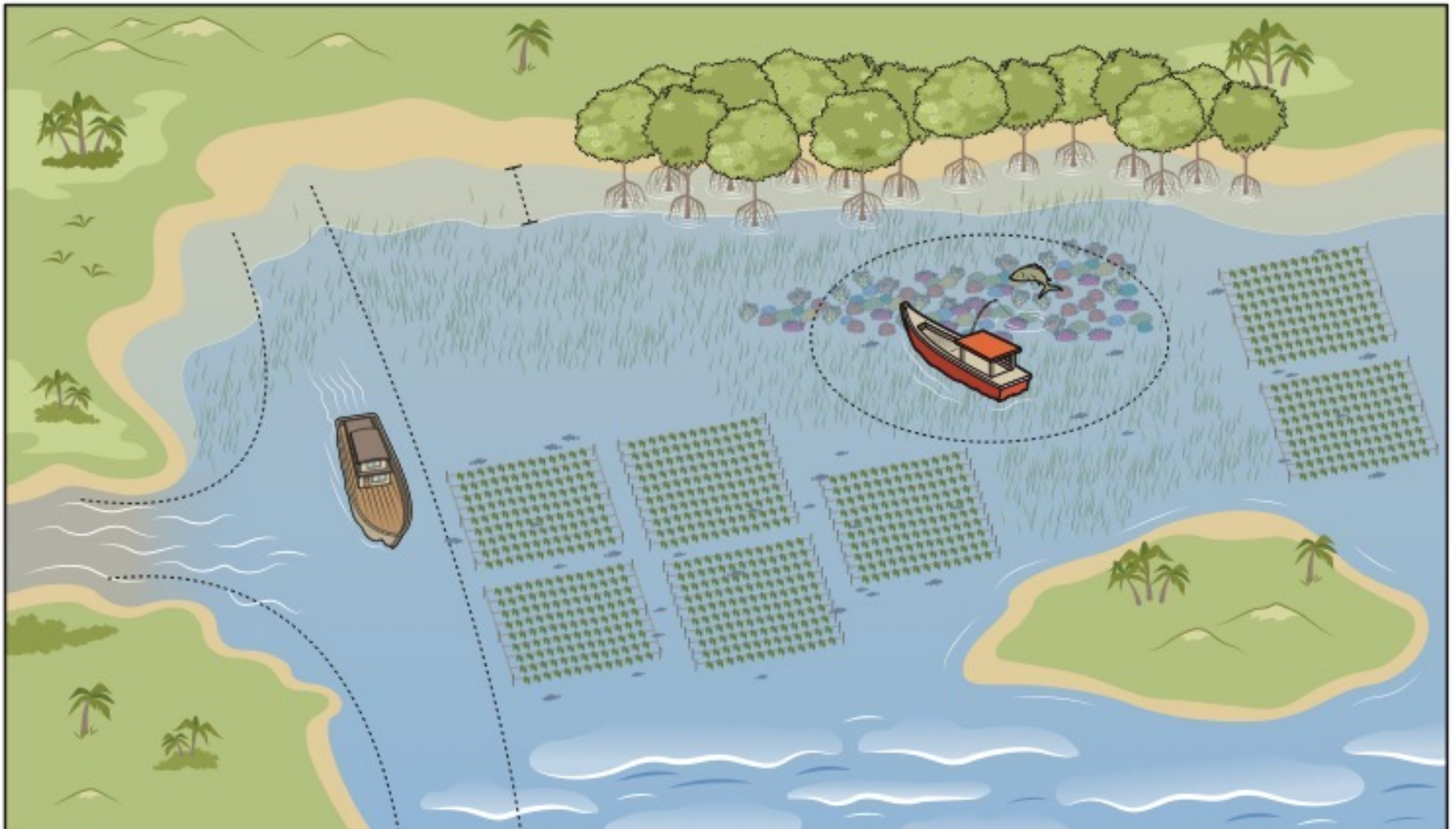
The farmer wants both good yields AND economic returns. Using the BMPS can double (2x) the yields for farmers and use less time and resources

If poor farming practices are used, then this will have a negative impact on the yields AND the environment.





What are better
management practices?



BMPS = Better Management Practices

Economic Growth & Good Yields

- A **positive economic return** is when the good yields are obtained AND the farmer uses fewer stakes, ropes, and their time
- Example of **good yields**: 200-300kg of dried seaweed per low tide (400-600kg per month)
- *If better farming practices are used, then seaweed farming can have a POSITIVE impact on the environment, seaweed quality, and farmer life*



Sébastien Jan / Cargill



Roshni Lodhia/The Nature Conservancy

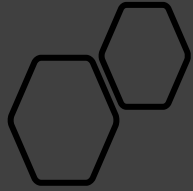
Tomi Prasetyo Wibowo / The Nature Conservancy

BMP focus areas

- Environmental protection & seaweed farm siting
- Farming tools, safety, & farm construction
- Seed sourcing, transportation, & tying
- Farm operations, maintenance and disease prevention
- Seaweed harvesting, post-harvest care, & markets



Environmental Protection & Seaweed Farm Siting

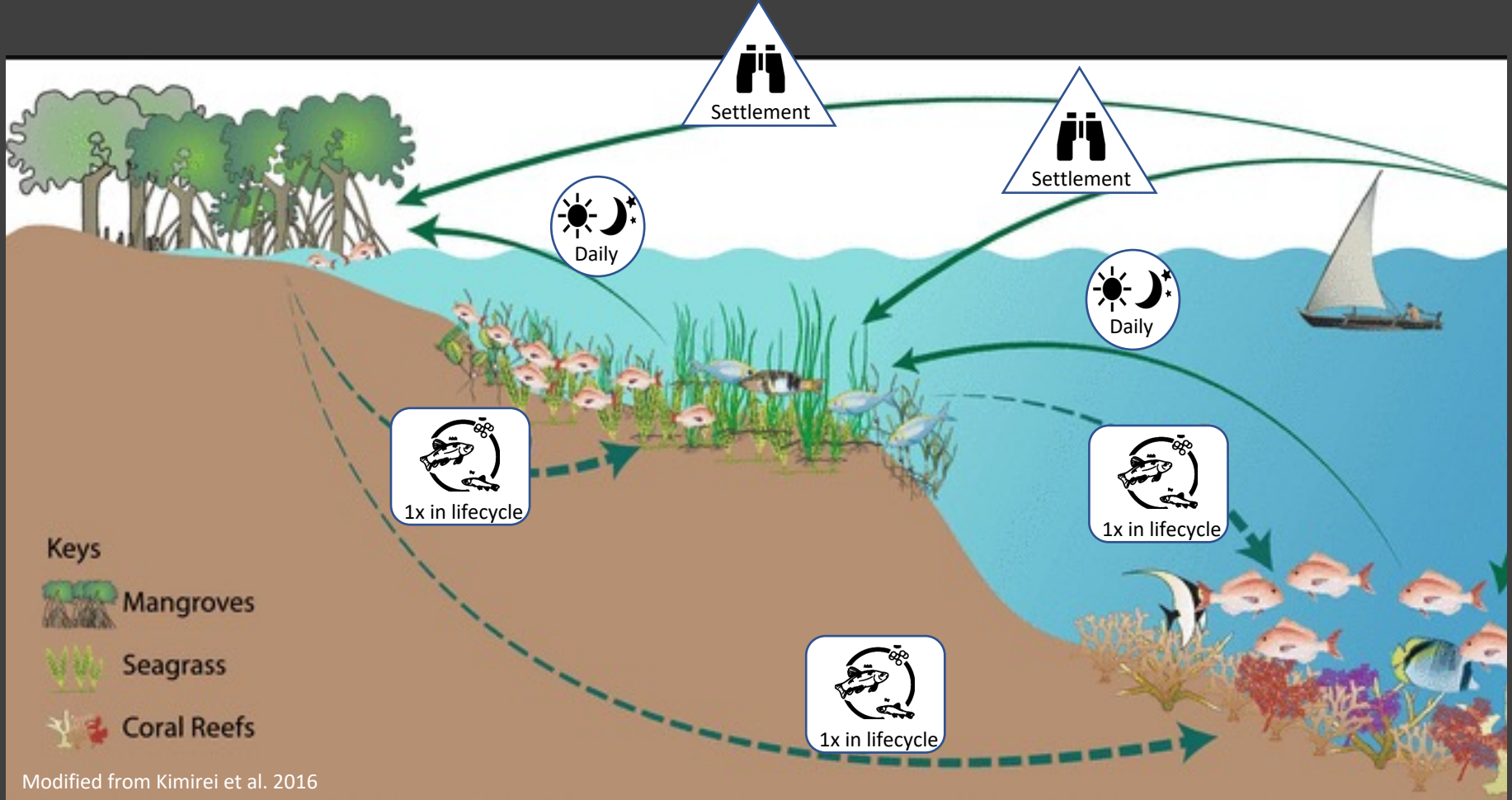


The tropical coastal environment

Tanzania's tropical coastal environment is very special. Here, you can find mangroves, seagrass beds, and coral reefs all near one another with high synergies between them.

These healthy environments are essential to help seaweed grow. **Good environmental conditions are needed for seaweed farming.**

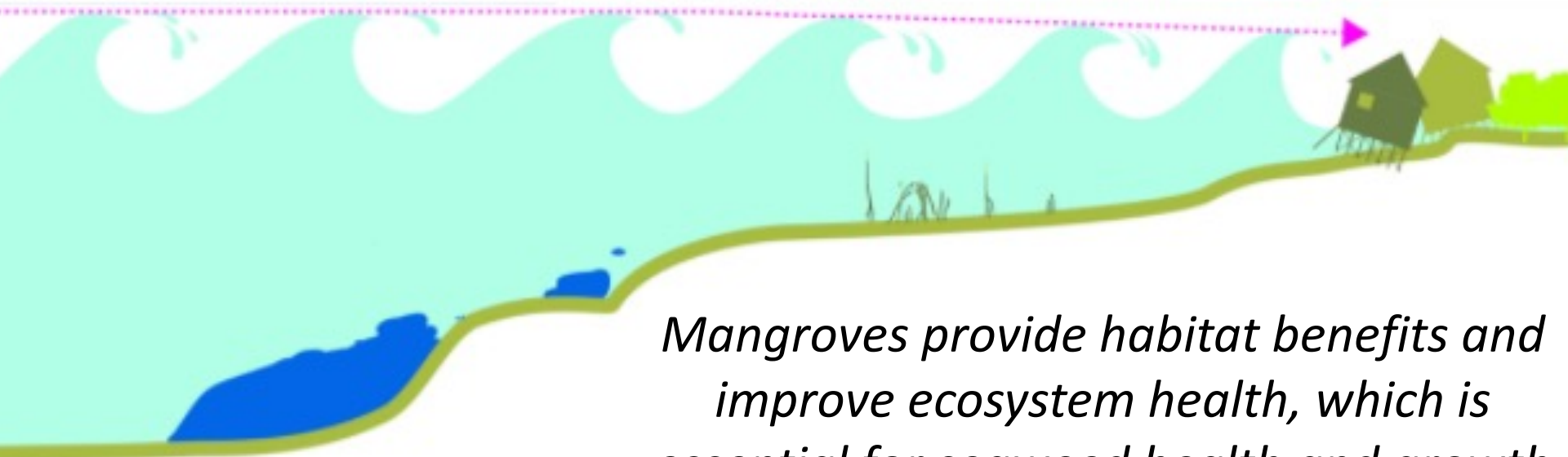
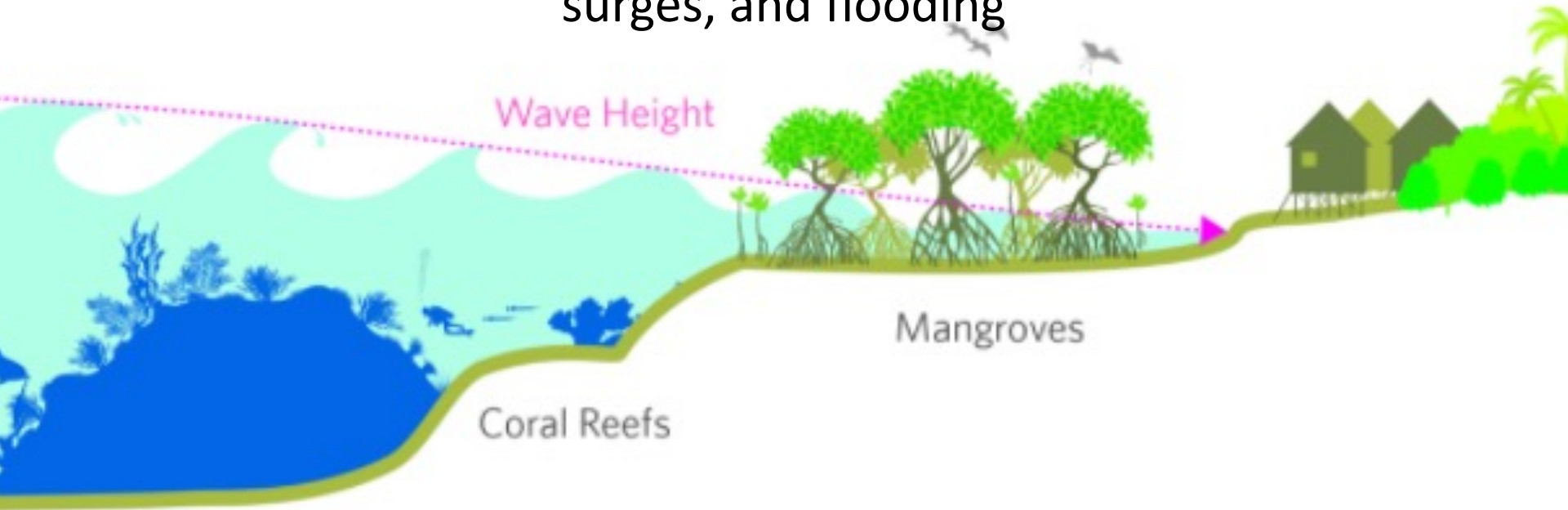




A healthy marine environment

- Mangroves and seagrass beds support habitat for fish, invertebrates, birds, and amphibians
- Some species move between mangroves, seagrasses, and coral reefs as they grow – others move between them every day
- Mangroves provide protection from coastal erosion and support fishing and tourism

Mangroves prevent erosion and reduce the force of waves, storm surges, and flooding



Mangroves provide habitat benefits and improve ecosystem health, which is essential for seaweed health and growth



Coastal wetlands are
THE ONLY HABITAT
that can continuously sequester
and store carbon in soil
FOR MILLENNIA

In some areas
ONE HECTARE OF SEAGRASS
CAN STORE 2X
THE CARBON
captured by an average
terrestrial forest



Seagrasses

- Seagrasses provide essential habitat for fish and invertebrates and store carbon
- Seagrasses improve water quality, which helps seaweed grow

Life in East African seagrass beds

There is a diverse array of plants and animals in the seagrass beds in East Africa (and around the world), but this region is very special and important:

In the region, there are:

- Macroalgae: > 50 species
- Algal epiphytes: > 18 species
- Benthic invertebrates: > 75 species
- Fish: > 100 species


- 1/5 of the world's seagrasses are in East Africa
- **3X more seagrass diversity than the Mediterranean**
- **VERY DIVERSE ECOSYSTEM!!**

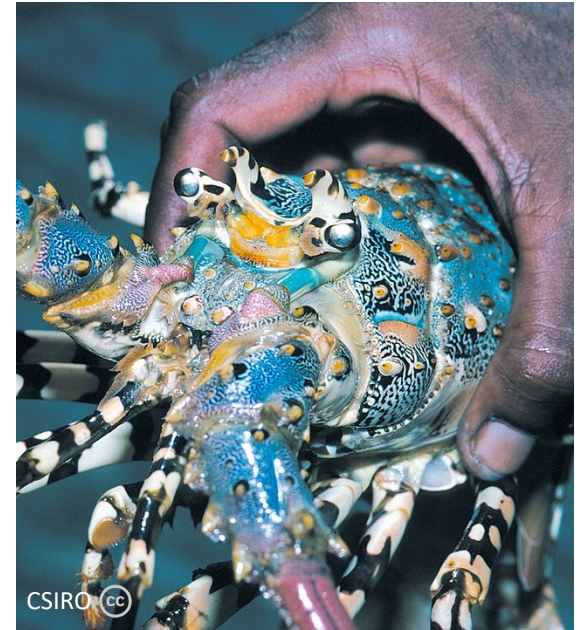





Philippe Bourion 




Philippe Bourion 



CSIRO 



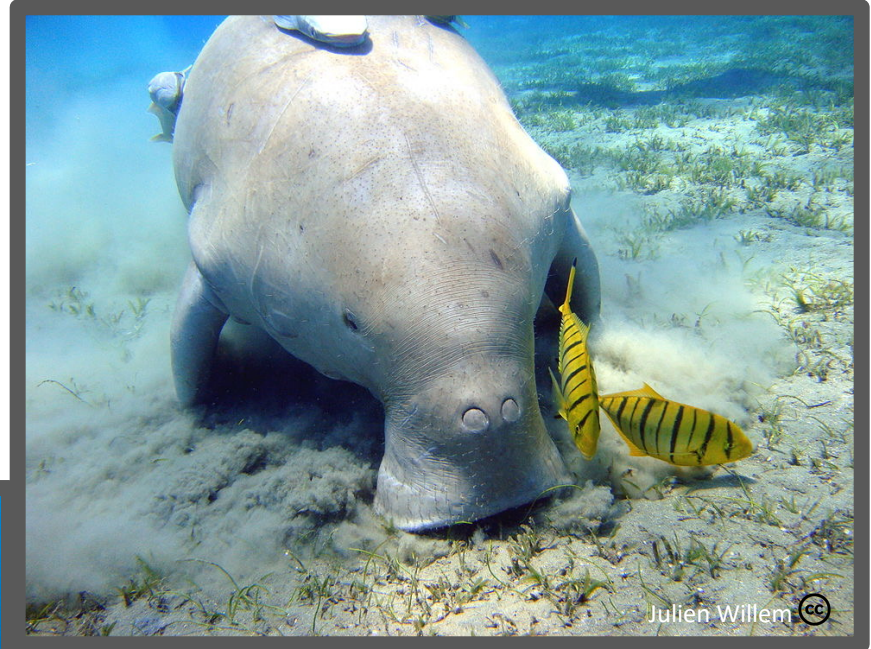
Rickard Zerpe 

Life in East African seagrass beds

Fish, crustaceans and marine mammals use seagrass beds for nursery habitat, breeding and feeding.

Food for endangered species

Some animals eat the seagrass directly, while others eat the epiphytes living on or in the seagrass or the seagrass detritus.



At least two endangered species feed on seagrass:

- Green sea turtle (*Chelonia mydas*)
- Dugong/sea cow (*Dugong dugon*)



CORAL REEFS: Protectors and Providers



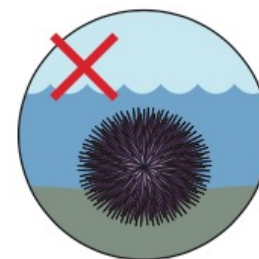
\$3.4 billion value every year, benefiting fisheries, tourism, and coastal communities

Coral Reefs

- Like mangroves and seagrasses, coral reefs provide essential habitat for marine animals.
- Healthy corals are a foundation species for the ecosystem and will benefit water quality, which benefits seaweed

A healthy environment encourages seaweed growth

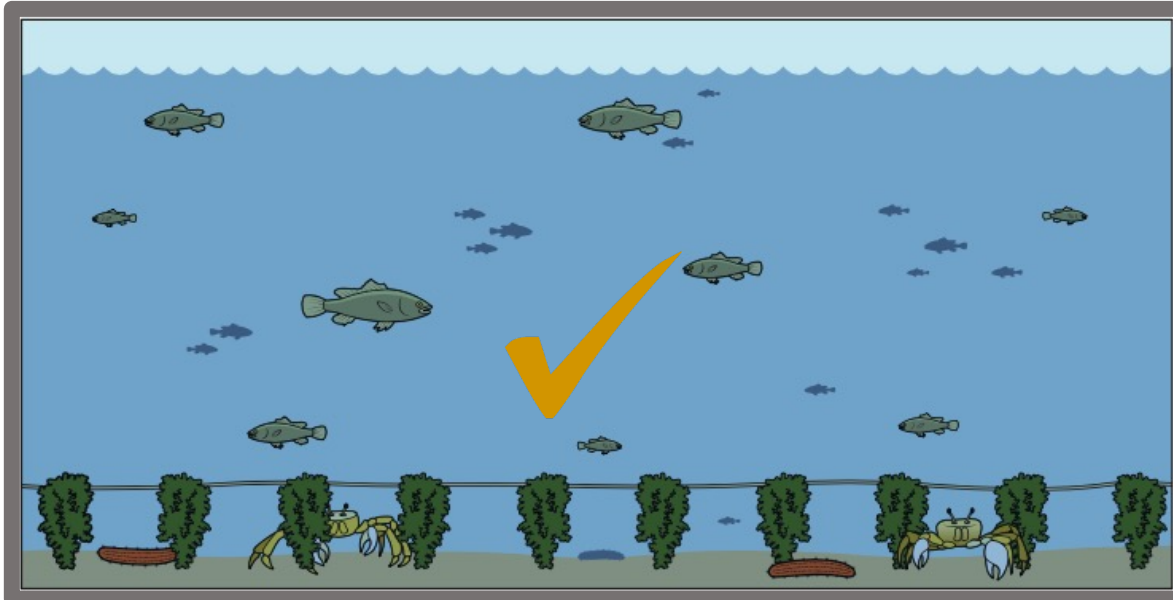
- If fish and other animals are near your farm, this is positive because it indicates that there is good water quality
- Presence of animals (except sea urchins) near the farm provide nutrients for the seaweed farms
- Keeping your seaweed farming area clean helps to ensure the well-being of the nearby plants and animals



Remove sea urchins

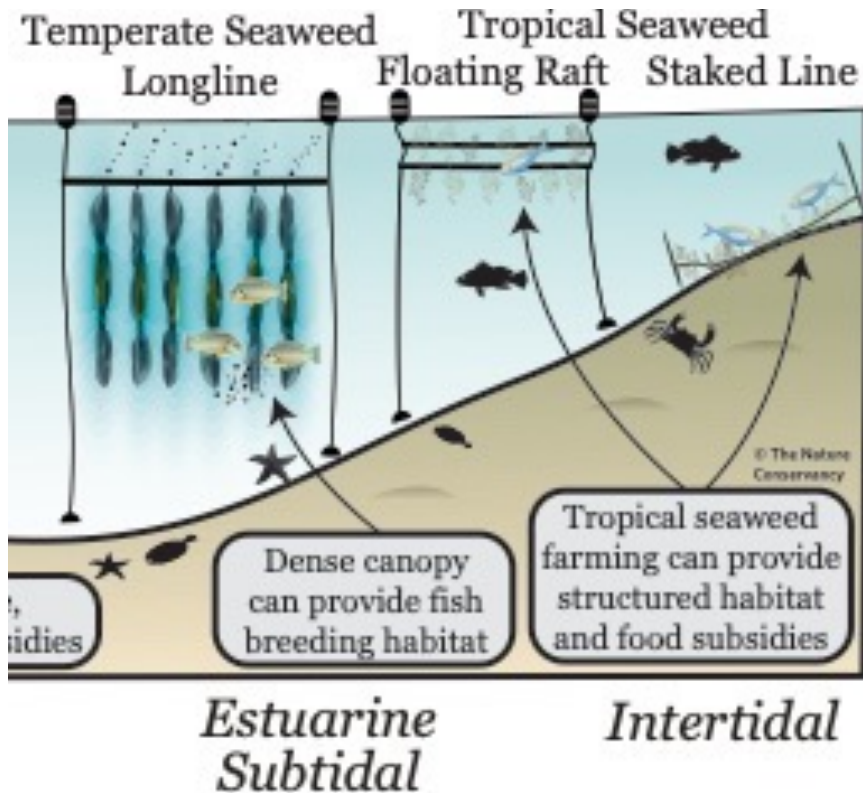


Roshni Lodhia/The Nature Conservancy



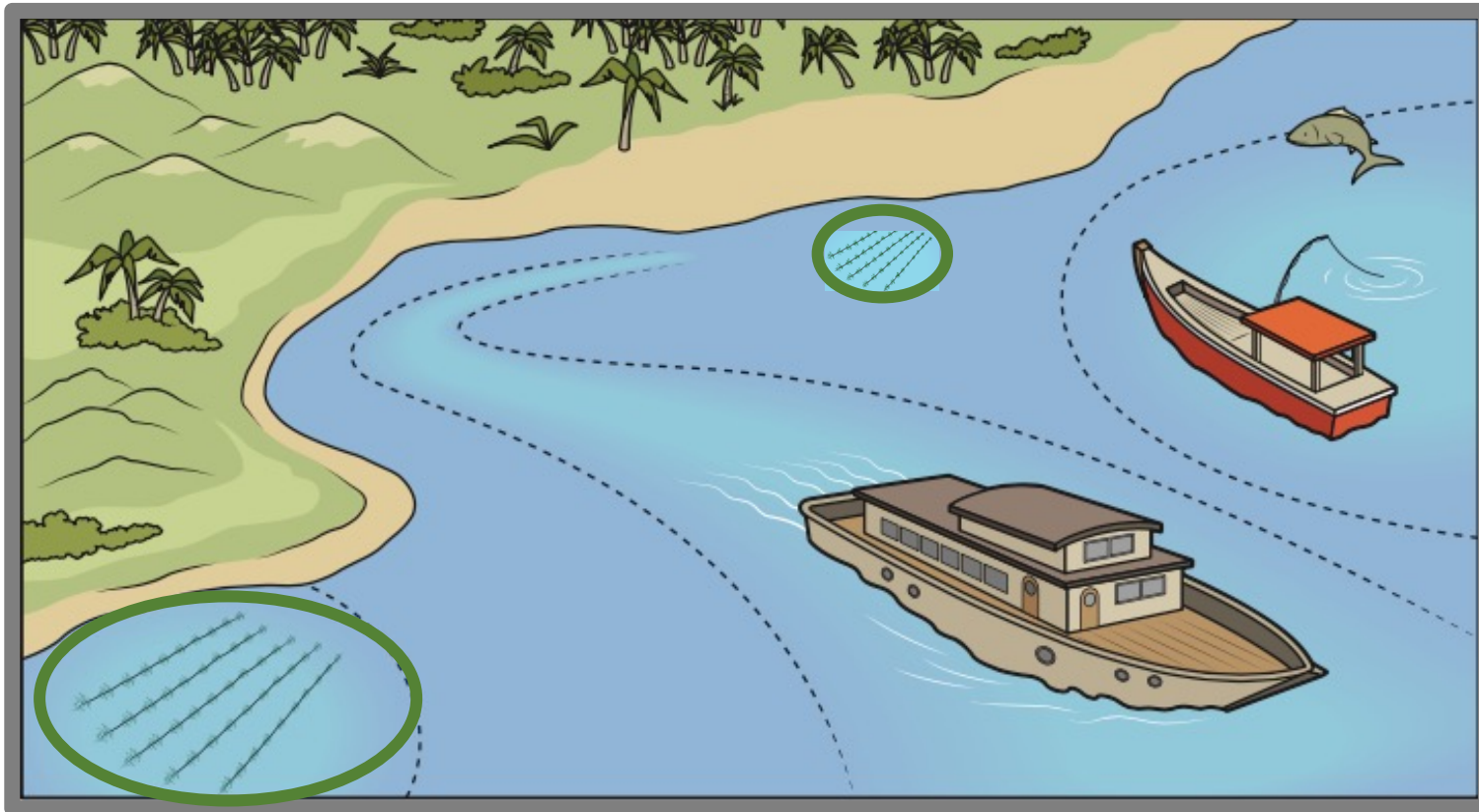
Seaweed can provide environmental benefits too, when farmed well

- Remove excess nutrients from the water
- Provide nursery habitat for fish and invertebrates
- Reduce carbon dioxide and oxygenate water benefiting the seagrass



Sébastien Jan / Cargill

Site farms away from other marine uses





- Use multiple farm sites in different locations to mitigate risk and weather changes
- Site farms outside of fishing areas, navigation channels, and places with regular human activity

Optimal siting for seaweed farms

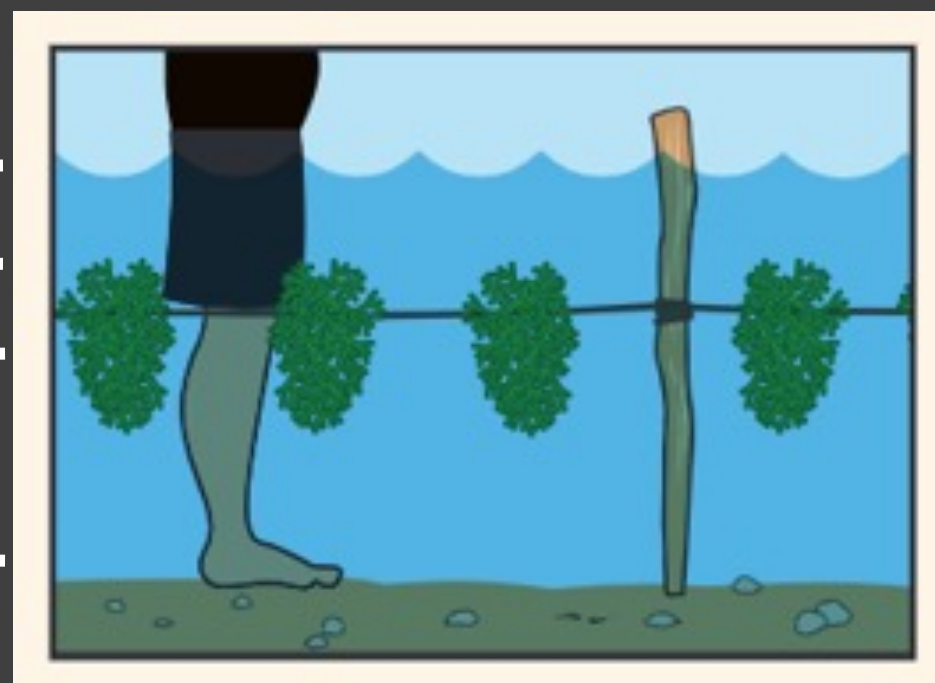
- Use sandy bottoms where it's easier to anchor stakes
- Seek out good water current to ensure good level of nutrients flowing into your farm
- At low tide, seaweed should still be submerged under water to avoid sun exposure. The sun causes stress, impacting growth or leading to ice ice
- Avoid areas exposed to strong wave action to limit loss of seaweed and equipment

 $\geq 10 \text{ cm}$ 

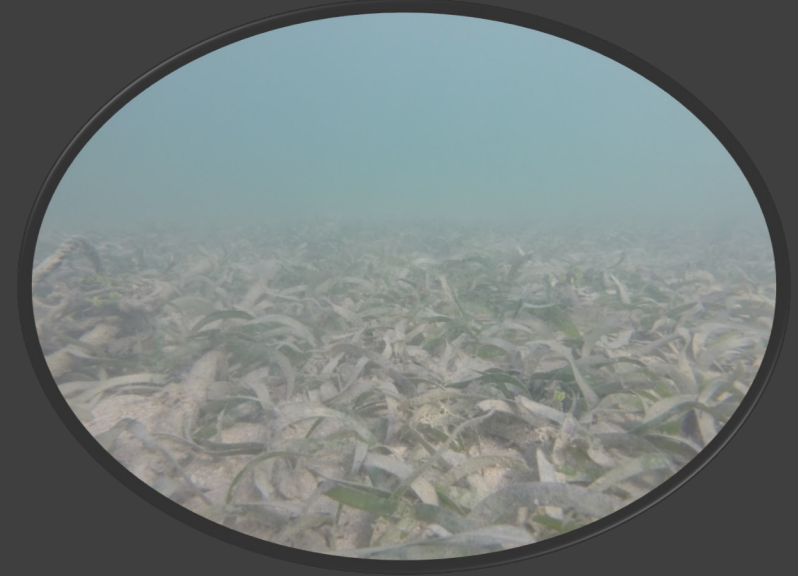
 $\geq 10 \text{ cm} - 1 \text{ m}$ 



Gretchen Grebe/Dayna Zimmermann

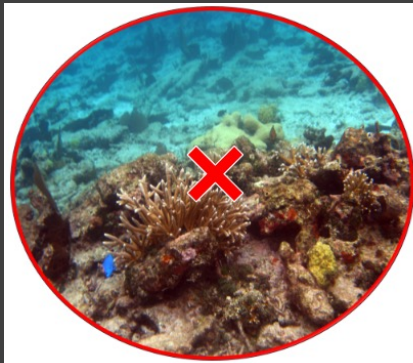


Some areas are not good for seaweed farms



Avoid areas with high amounts of:

- rocks
- silt (use floats if necessary)
- < 1 km from river mouths (low salinity during rainy season)
- mangrove swamps (low salinity, high dead organic matter and H_2S)
- corals (do not dig them up)
- abundant seagrasses (do not pull them out)
- turtle nesting
- small pools with little water exchange (they have limited nutrients and water becomes too warm)



Important site conditions to ensure seaweed is productive, not under stress, and does not develop ice-ice

Depth:

submerged even at lowest tide (alt: 1 – 2 hrs exposed)

Water temperature:

23 - 30°C @ low tide

Salinity:

23 – 38

Water velocity:

≥ 20 cm/s @ max tidal flow (↑ is better for growth)

Substrate:

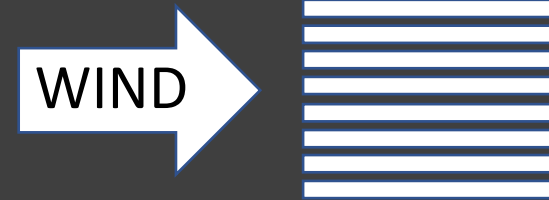
sandy (rocky areas can work with additional effort)

Sébastien Jan / Cargill

The farmer should understand these parameters, know her environment, and be flexible and act quickly if seaweed becomes stressed

Important site conditions (continued)

- **Wind:** orient lines parallel with dominant seasonal wind direction



- **Barriers:** nearby reefs or islets can provide protection from waves

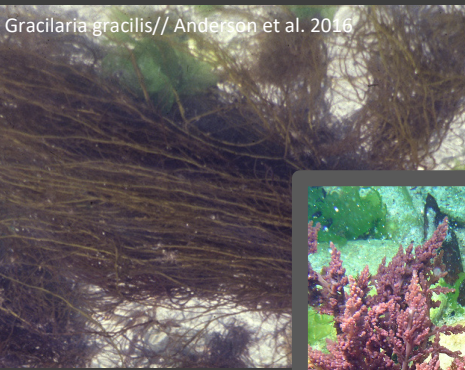


Modified from Maxicons and Vectorstall from Noun Project

- **Associated species:** look for nearby eelgrass and red algae which indicate good growing conditions



Acanthophora spicifera// Anderson et al. 2016



Gracilaria gracilis// Anderson et al. 2016



Laurencia glomerata// Anderson et al. 2016



Hypnea musciformis// Anderson et al. 2016



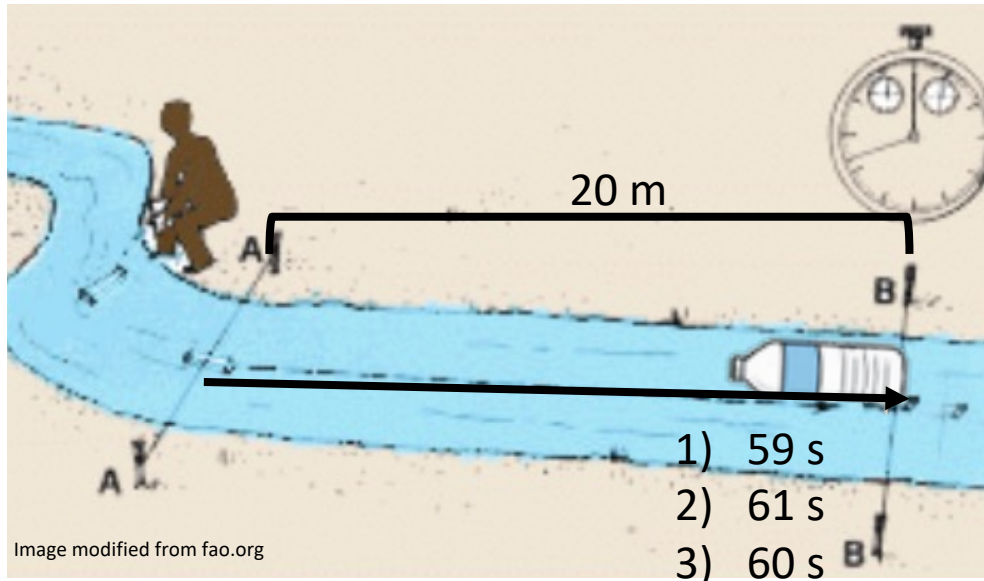
algaeBASE
© M. van Keulen



algaeBASE
Ángel Fernández

Measuring surface water velocity

- Water flow (> 20 cm/s) helps to provide adequate nutrients for the seaweed
- Starving seaweeds become more susceptible to ice-ice and pathogens



$$\begin{aligned}51 + 61 + 60 &= 180 \\180 \div 3 &= 60 \text{ s} \\20 \text{ m} \div 60 \text{ s} &= 0.33 \text{ m/s} \\0.33 \text{ m/s} \times 0.85 &= 0.27 \text{ m/s} \\0.27 \text{ m/s} \times 100 &= 27 \text{ cm/s}\end{aligned}$$

*If water flow
is too low, find
a different site*

To find average surface water velocity:

- Measure out a known distance (ex: 20 m)
- Have a friend release a bottle on the water at Line A while you stand at line B. Use a watch to measure how many seconds it takes the float to travel between the lines.
- Repeat 3 times (ex: 59, 61, 60) and calculate the average (ex: 60)
- Divide the distance (20 m) by the average time (60), and then multiply by the correction factor 0.85
- Multiply by 100 to obtain cm/s



C-Weed

The ecosystem approach to seaweed farming

Farmers must take care to avoid damaging local habitats, littering the environment with trash and old ropes, polluting farms areas with human and other waste, or undertaking destructive collateral activities such as dynamite fishing and harvesting mangroves.

Taking care of the environment will protect water quality and encourage healthy growth of the seaweed. Damaging or changing the environment will negatively impact seaweed growth and value.

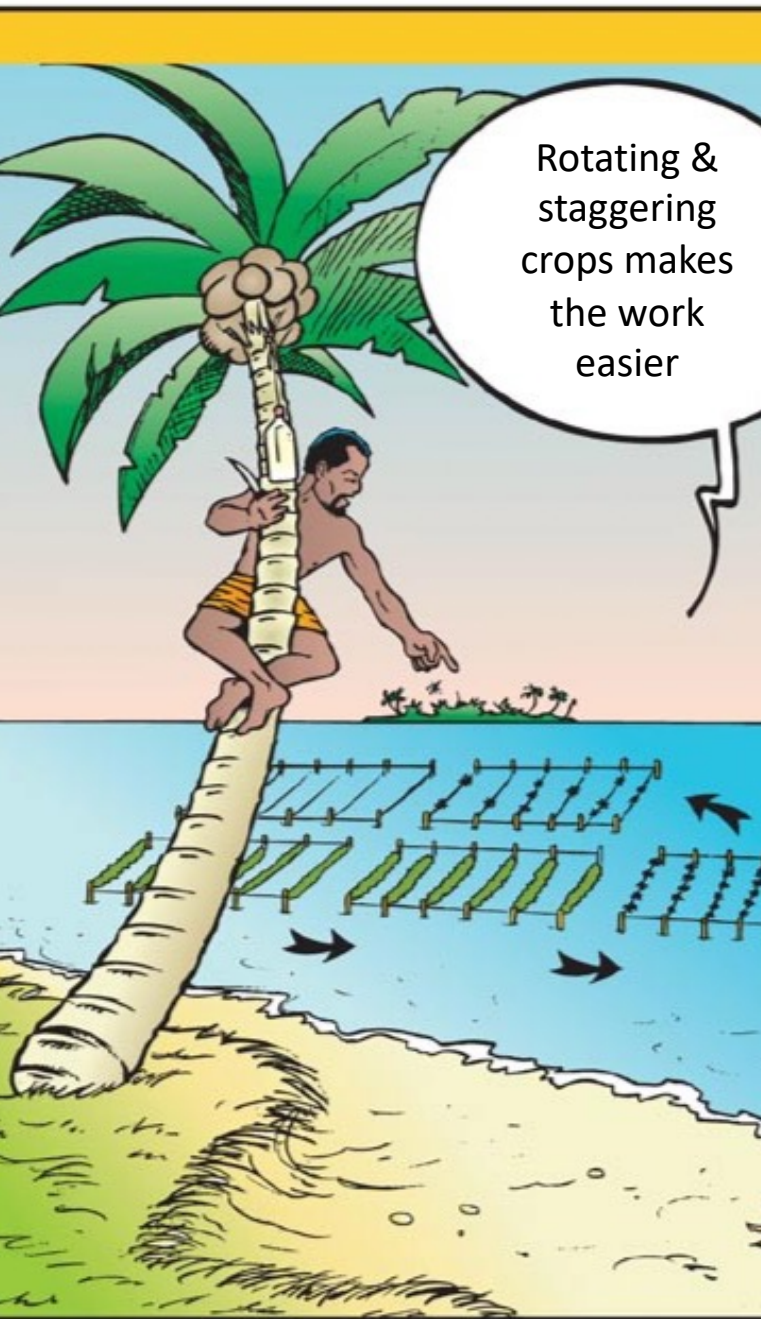


Farming Tools, Safety, & Farm Construction



The seaweed farming mindset

- Preparing a seaweed farm is tedious – it should take time
- When constructing a farm, ask: How can my work now make my future work easier?
- Regular weekly maintenance is required



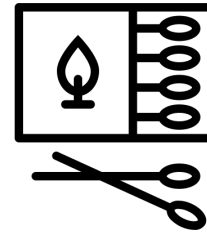
Multiple farms and crop rotation

- Having more than one farm reduces risk from weather events, but it also allows for crop rotation and staggering growth cycles
- If seaweed is planted at different times for each farm, then seaweed can be maintained and harvested at different times, which can make the work easier for the farmer

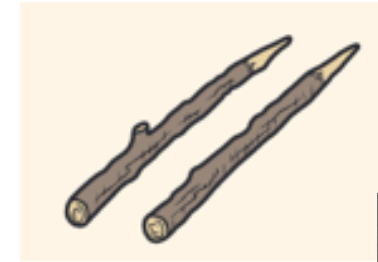
Tools and materials for farm construction



- Ropes
- Matches or lighter
- Hammer
- Mining bar (to make holes in sand and not break stakes)
- Stakes
- Flotation (optional)



Created by Weltenraser
from Noun Project

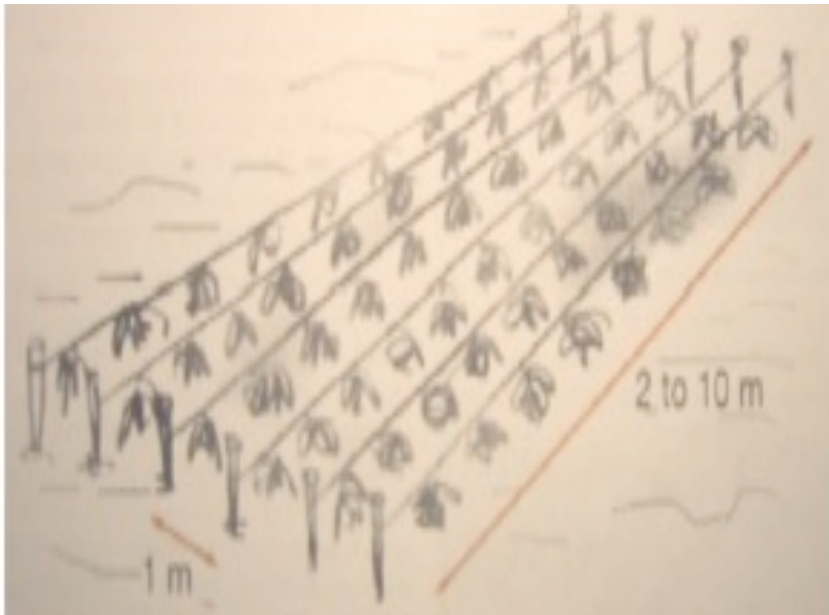


Created by Simon Mettler
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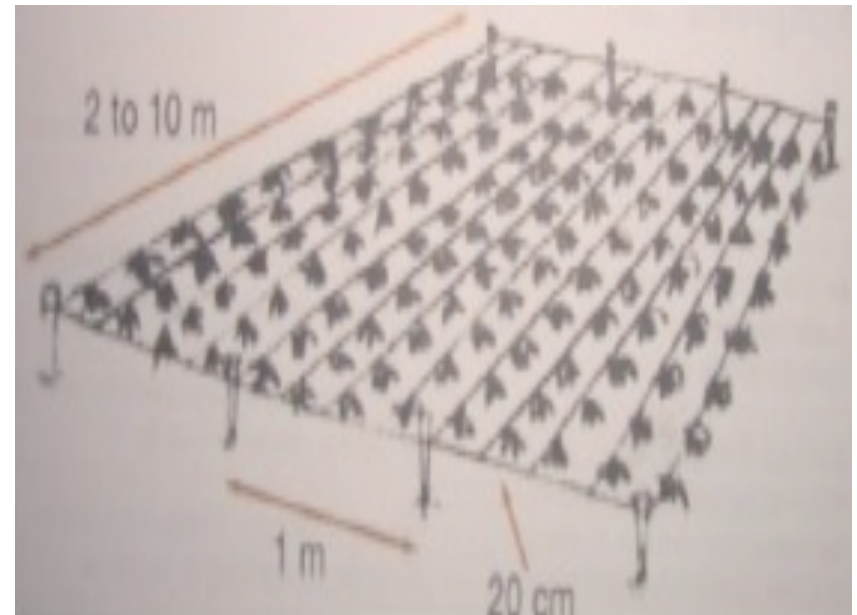


Auctelia

Traditional vs. improved construction



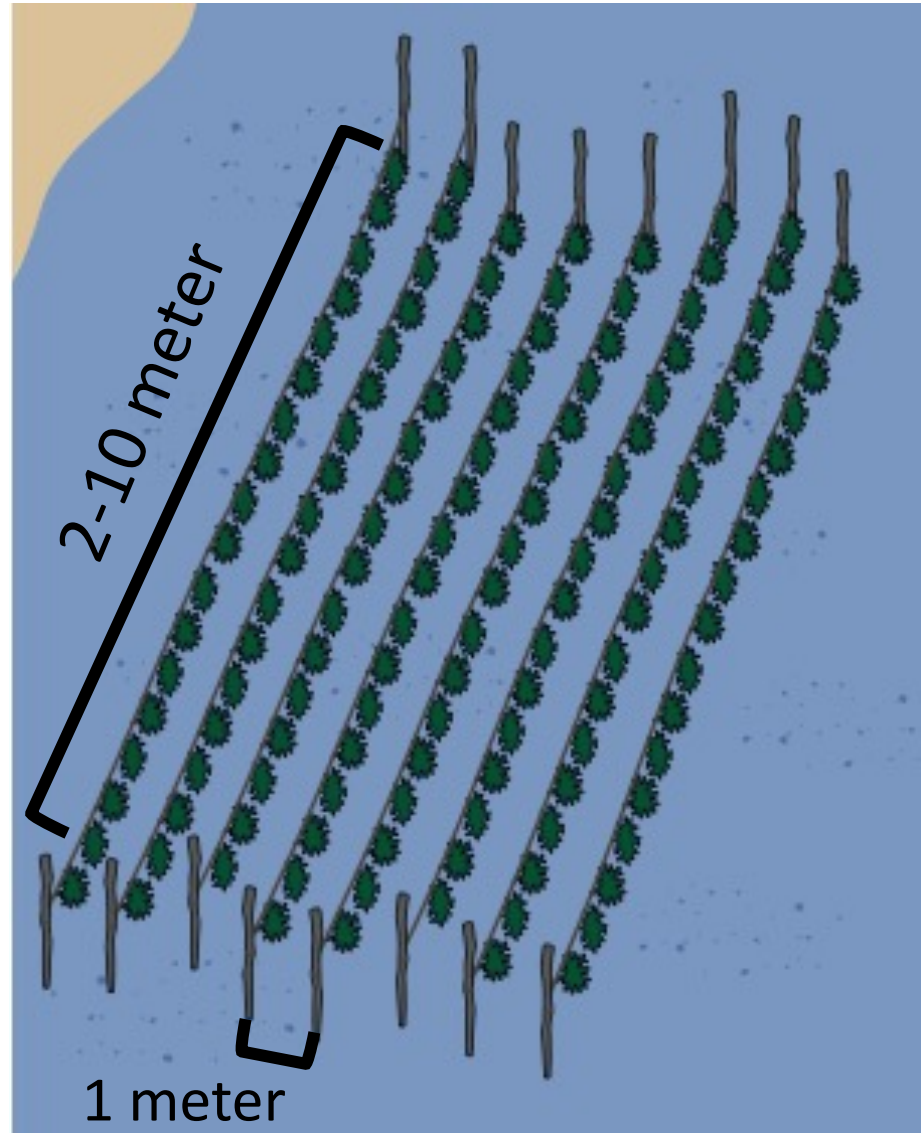
- Traditional farms use stakes for every line
- The line lengths (and stake locations) may be irregular



- Improved off-bottom construction can use 4 stakes for every 5 ropes (plus corner stakes)
- All lines are standardized lengths
- Both characteristics facilitate repair

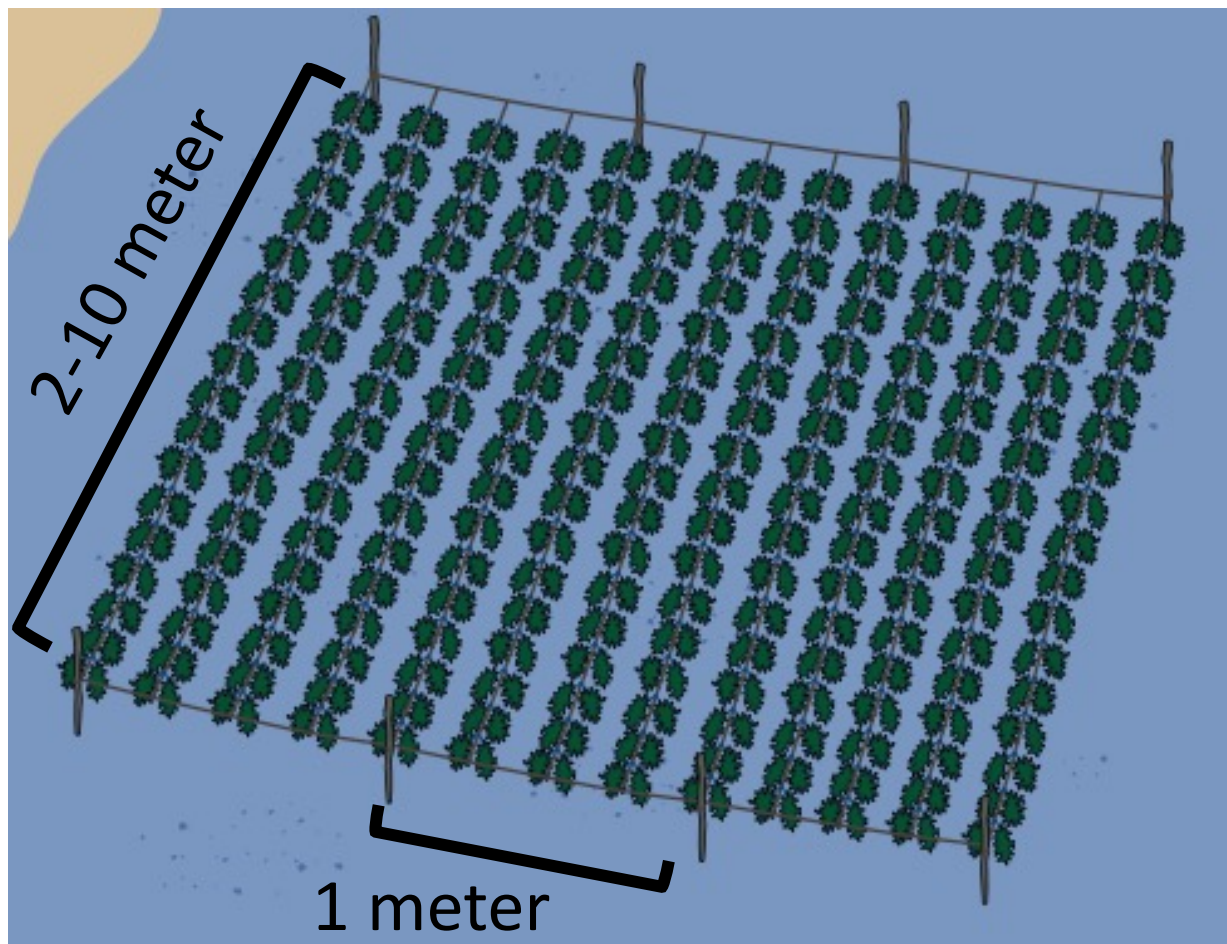
Traditional Construction

- More stakes
- More rope to farm the same amount of seaweed as improved construction
- Less seed and seaweed
- Lines are further spaced
- ~100 stakes for a 50-line farm



Improved Construction

- need fewer stakes
- more work in setting up farm, but less work in but then less work in tying ropes to structure
- Less maintenance (fewer stakes to check and anchor)
- Double Made Loops double the harvest
- Only ~22 stakes for a 50-line farm



- 20cm - 50cm between each cultivation line
- 4 plots of 50 lines each (200 lines)

Optimal stake characteristics

Wood type:

Bushweed, Java plum, Guava tree, False Bride's Bush or others (see handout)

Length: 2 ft (60 cm)

Diameter: 1.3-1.5 inches (3.3-3.8 cm)

Depth in sand: about 1 foot in ground or sand so it is stable and won't be washed away

Shape: as straight as possible

Line position on stakes: 10 – 15 cm off seafloor



Mondy Muhando / The Nature Conservancy



Mondy Muhando / The Nature Conservancy



Mondy Muhando / The Nature Conservancy



Mondy Muhando / The Nature Conservancy

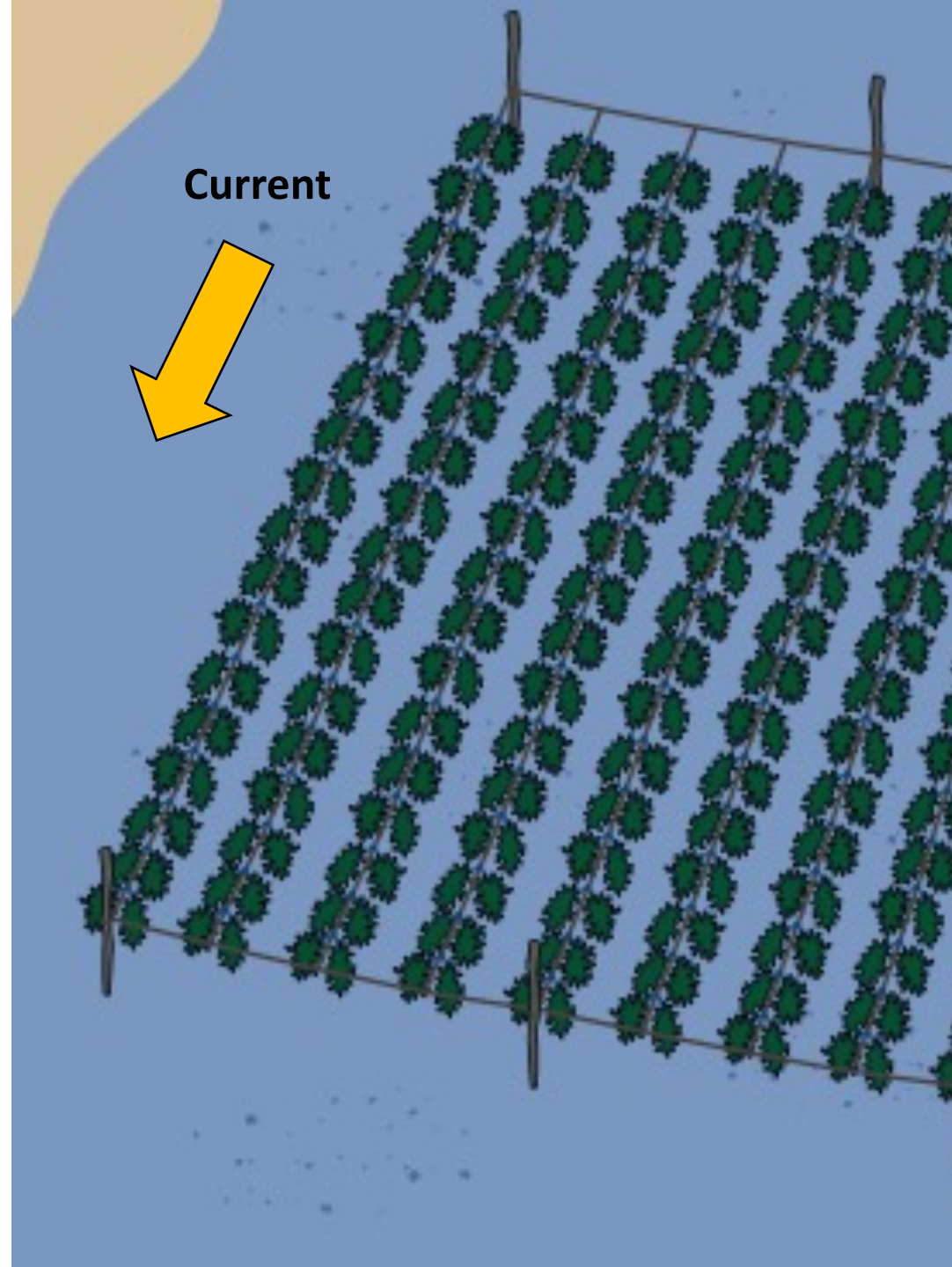
Farm shape and orientation

Farms should be square or rectangular

- All lines will be the same length (facilitating repair)

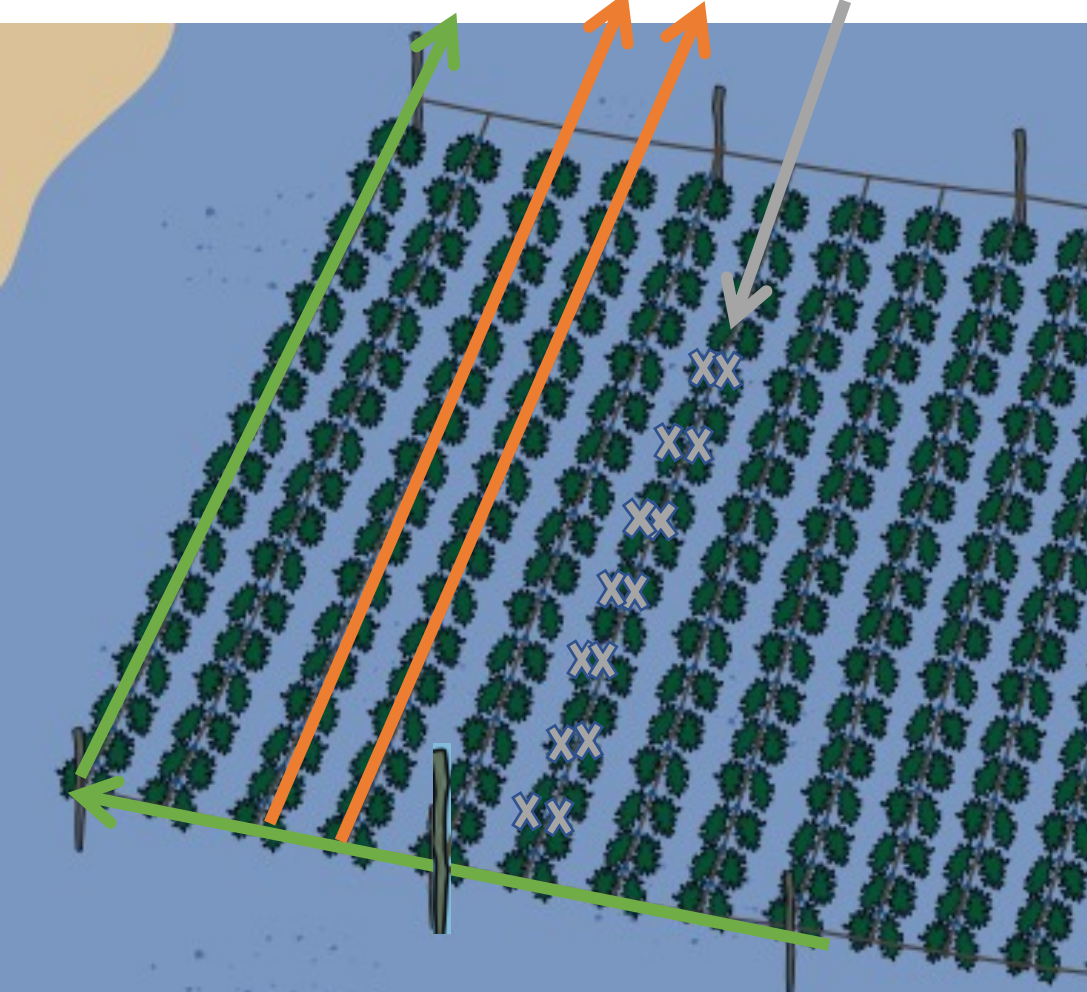
Making lines parallel to current helps by reducing:

- chances of entanglement
- forces on the lines
- drifting seaweeds from getting caught on the lines
- drives flow of nutrients for all seaweed in the farm

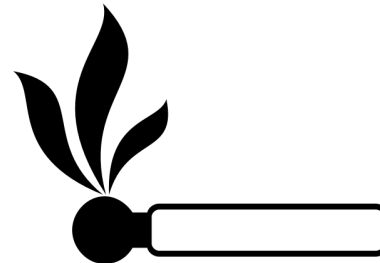


Rope size, standardization, and tying are very important

10-12 mm PP 4 mm PP 1-2 mm PP



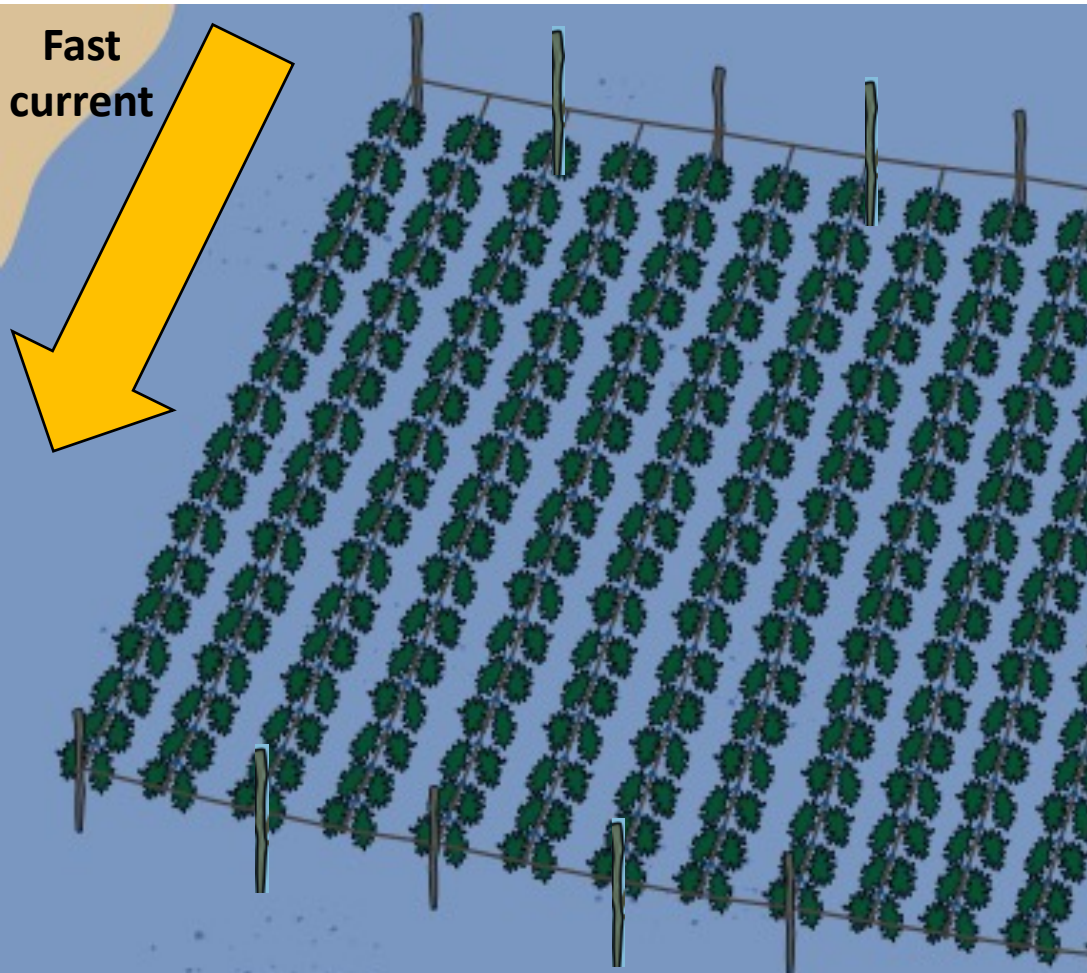
- Ropes should be clean and cut to correct lengths before tying begins



Created by yudiyanto
from Noun Project

- Burn the ends of all ropes to prevent fraying

BUT, if 8-10mm rope is not available or current too fast, then can be flexible



- More stakes may be used or needed, if current is too fast or appropriate rope is not available

Traditional Farming - Pros and Cons



PROS

- May feel more flexible
- Lines are lighter at harvesting time as there's not as much seaweed
- Less time needed to put seed on line as not farming as much
- Less seaweed lost if cultivation rope gets lost

CONS

- Significantly more time to collect and prepare stakes
- A very large plot is needed if wanting to expand
- Much more effort in maintaining farm, at least 2x the rope maintenance, and more time to verify and anchor the stakes
- Need many more ropes to increase production

Improved Farming - Pros and Cons

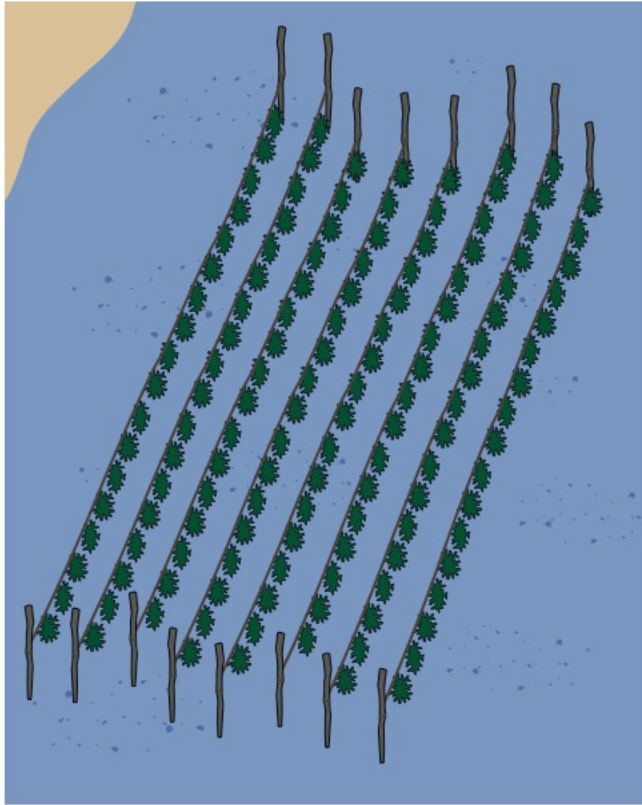


PROS

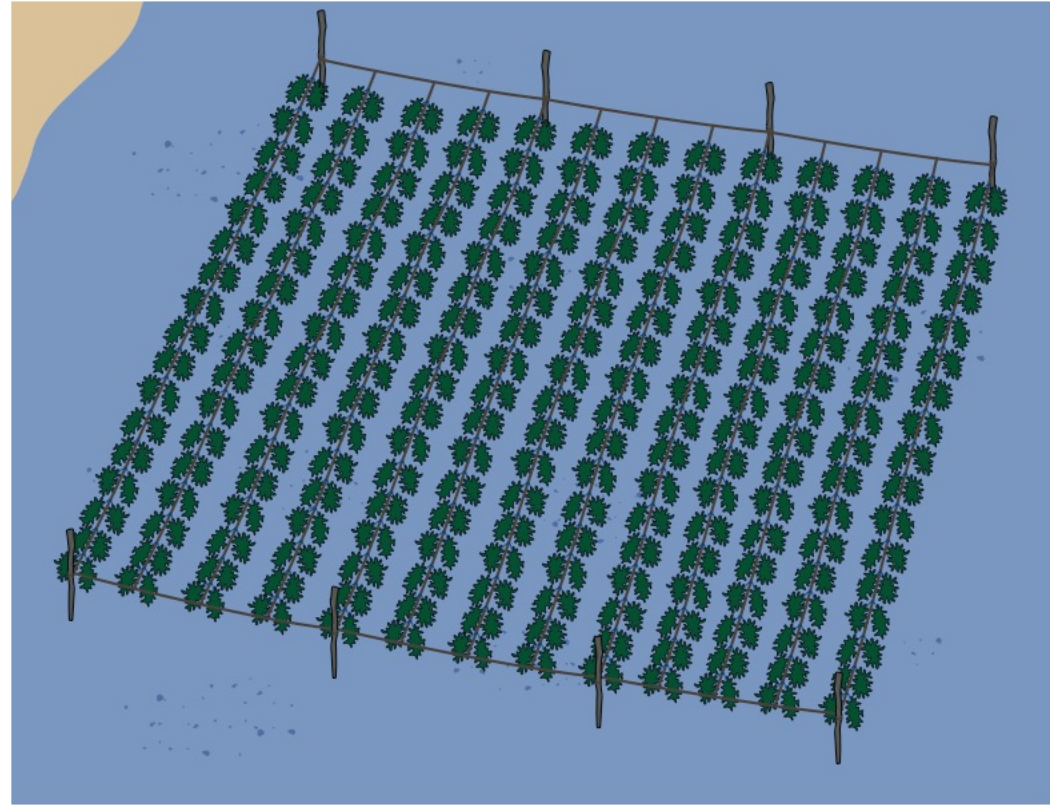
- Less time spent collecting stakes and less cost
- Need less space for farming to produce similar quantity – reduced access conflicts and can double production without expanding
- Less maintenance and time spent farming, lower risk of rope entanglements
- Need fewer ropes to produce larger quantities, reduced costs
- Easier to control pests & diseases
- Better protection against grazers

CONS

- Stronger stakes required
- Need 8-10mm and standardized ropes to build farms
- Heavier lines at harvesting due to more seaweed
- If line is lost, then more seaweed could be lost
- More time to put seedlings on line



Traditional



Improved design

Rope preparation and maintenance

Initial construction:

- 1) Prepare the 4mm ropes
- 2) Prepare 1 - 2mm ropes for Double Made Loop (DML)
- 3) Attach the DML to the main rope → 2 DMLs every 20cm (100 loops on 10.8 m length rope)

After harvest, and before reseeding:

- 1) Clean ropes before tying new seaweed on (use a freshwater dip/rinse if possible)
- 2) Check to see if all loops are there
- 3) Repair any damage



Knots for farm construction

The Double Made Loop system was created by **Pak Made Simbik**, a seaweed farmer in Bali, Indonesia who farmed for over 30 years



Roshni Lodhia/The Nature Conservancy



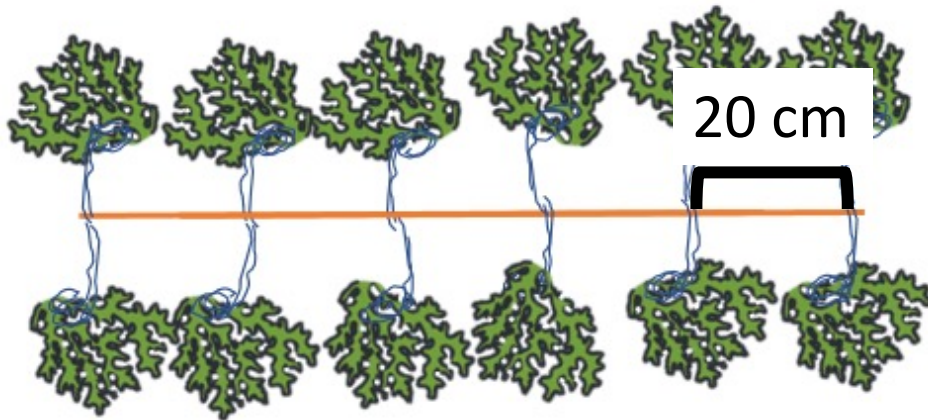
Thefishsite.com

Double Made Loop (DML)



Benefits

- Twice the production on single 10 m line than traditional farm
- Fewer materials needed (ropes & stakes)
- Smaller farms can be used to produce same amount of harvest
- Less maintenance
- Less grazing pressure



Directions

- Use 1 – 2 mm pp rope
- 1 seeding for 1 loop
- Avoid clumps of seedlings
- Leave 20 cm spacing between loops



Distance between lines

- Aim for 20cm - 50cm between each cultivation line
- Lines that are closer together may help to protect the seaweed from sun and limit grazing pressure
- Experiment on your farm – put some lines 20 cm apart and others 40 – 50 cm apart and see which ones grow best



- Get your ropes from C-Weed – they have high quality ropes

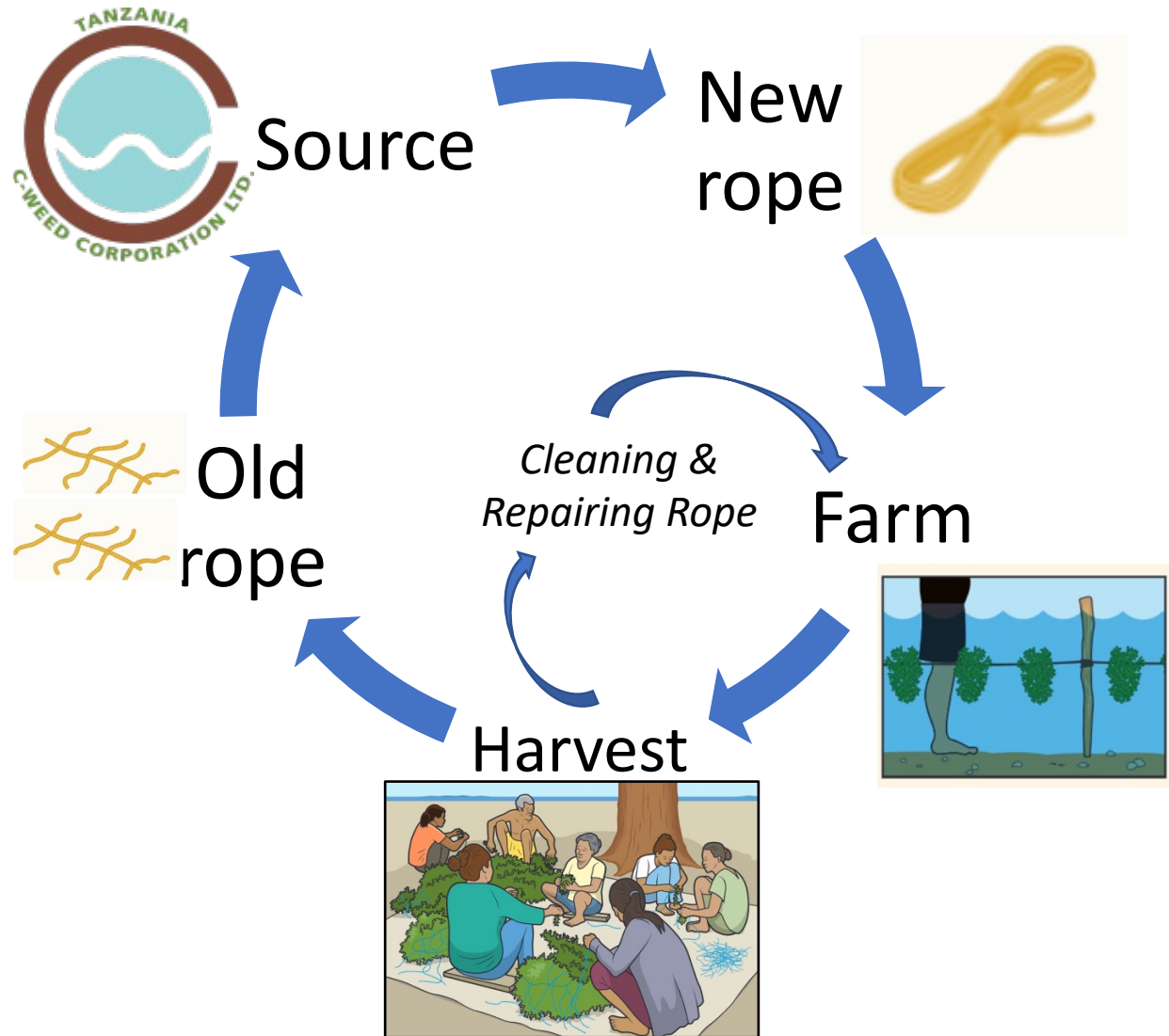
- Give your old or broken ropes to C-Weed – they will provide you with new seaweed ropes for free

- Ropes should last at least 2 years

- Do not dispose of ropes or rope fragments in the ocean

- When building new farms, make sure to collect the small, cut pieces of rope and return them to C-Weed.

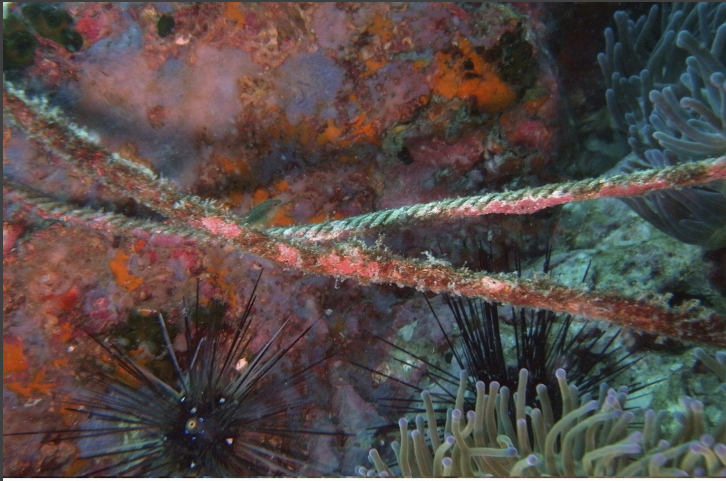
Rope maintenance is integral to successful farming



Abandoned ropes can harm marine life

Polypropylene ropes are made from plastic.

Plastic does not easily degrade, which is good for seaweed farming, but when it is un-anchored it can become wrapped around marine organisms.



Ballesteros et al. 2018

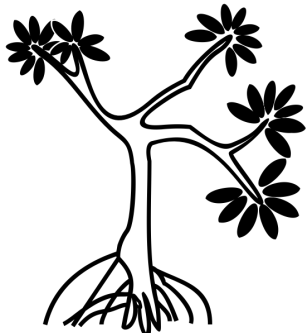


Kate Charles, Ocean Spirits

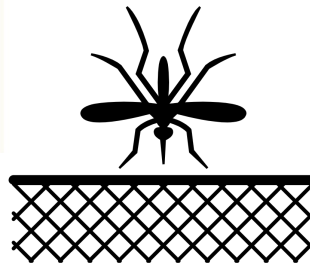
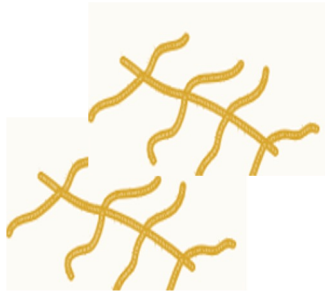
Tools/Materials to Avoid



- Mangrove stakes or wood from any other sensitive species
- Poor quality or irregularly shaped stakes
- Poor quality ropes like sisal or twisted ropes (short lifetime, more frequent repairs required, heavier, attracts organisms)
- Irregular rope and haphazard tying
- Use of mosquito netting as rope (they often have insecticides that are bad for the environment)
- Large amounts of plastic → return plastic waste to C-Weed
- Fertilizers

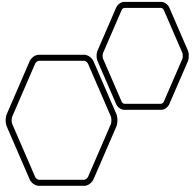


Created by Misru
from Noun Project



OCHA visual





Storage and maintenance of materials and tools

Boats

When they're not being used, store boats out of the water and in the shade / warehouse

Ropes

- Clean them after each cultivation cycle to remove fouling seaweed
- If the ropes are removed from the water, store them in a cool, dry, dark place
- Ropes can also be repaired to the correct length if cut and still can be used

Stakes

Have additional stakes ready in case some get lost in the farms

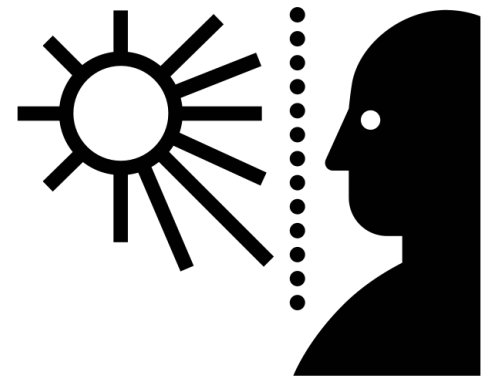


Potential hazards of seaweed farming

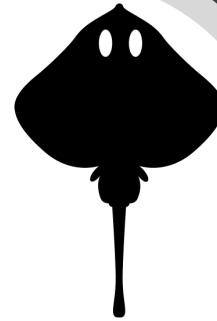
- Sun exposure
- Sea urchins, sting rays, and scorpion fish, biting insects, rocks
- High/incoming tides



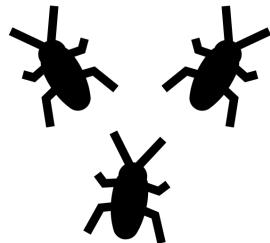
Created by Vrijlansier
from Noun Project



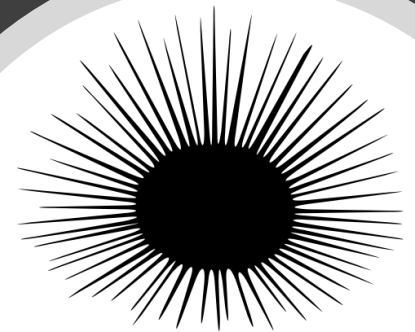
Created by Luis Prado
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Safety and addressing injuries



Gretchen Grebe/Dayna Zimmermann

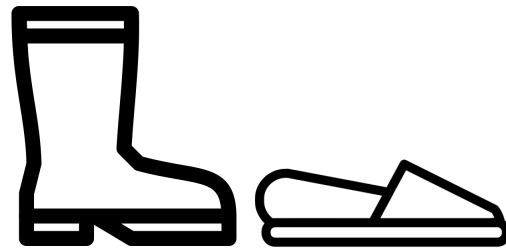


C-Weed



C-Weed

- Use a hat and scarf to reduce sun exposure and protect against insect bites
- Life jackets should be used if farming deep water

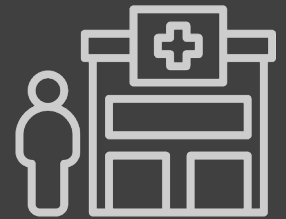


Created by Sidq Fathurochman from Noun Project

Iconfield

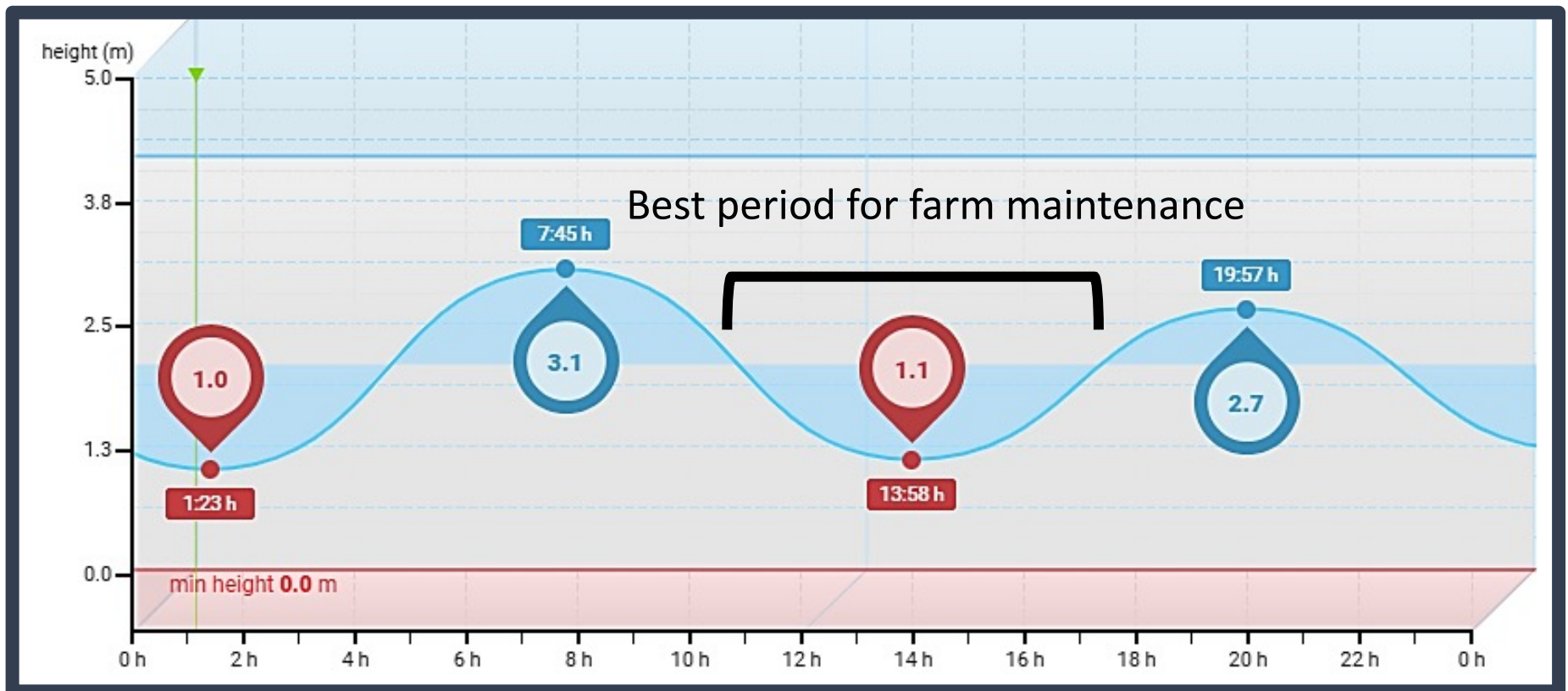
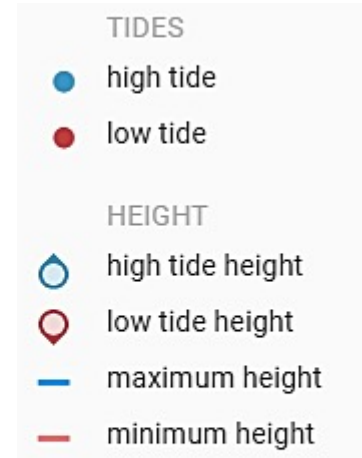
Shoes or boots will help to prevent injuries from stingrays, scorpion fish, urchins, and rocks

If you are stung, let any nearby farmers know and then go back to shore. If possible, seek care at a medical dispensary or hospital. Cweed can assist you.



Created by Berkah Icon from Noun Project

Safe timing for farm maintenance





Seed Sourcing, Transporting, & Tying

The appearance of good seed

- mucus on skin (indicates good health; it protects the seaweed against silt and fouling)
- should be of dark colour
- without signs of ice-ice, epiphytes, or grazing
- many secondary branches and selected from younger branches

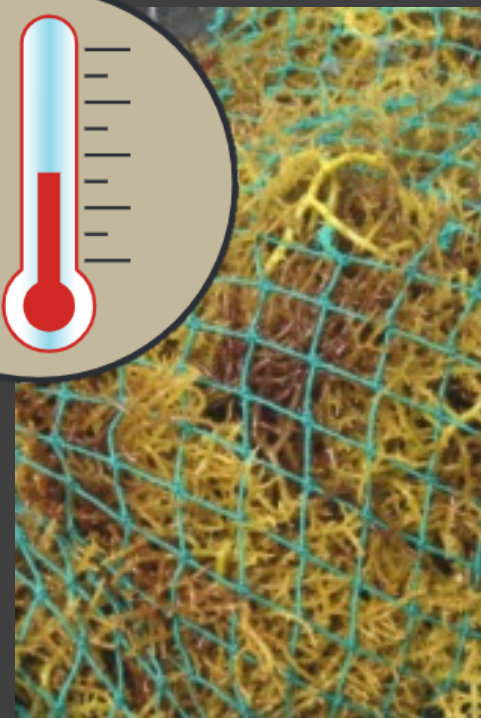
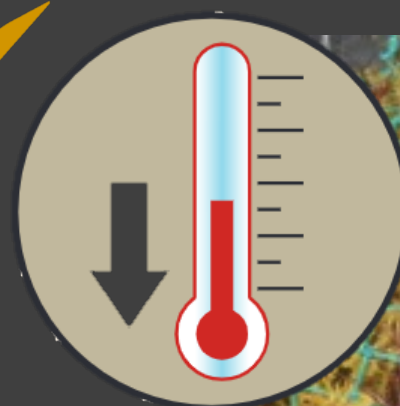


Sébastien Jan / Cargill



Sébastien Jan / Cargill

Transporting seed



- **Best option:** transport seed in mesh bag in the water
- **Second best option (≤ 3 hrs):** use a mesh bag and cover the bags with a light-colored tarp to reduce heating. Pour seawater over the seed regularly



- Transport seed in the morning or evening when the air temperature is cooler
- Rice bags will work for transporting seed if net bags are not available
- Transporting big volumes of seeds (≤ 24 hrs): avoid sunlight, rain, and air. Upon arrival, put the seed immediately in the water or pour seawater on it

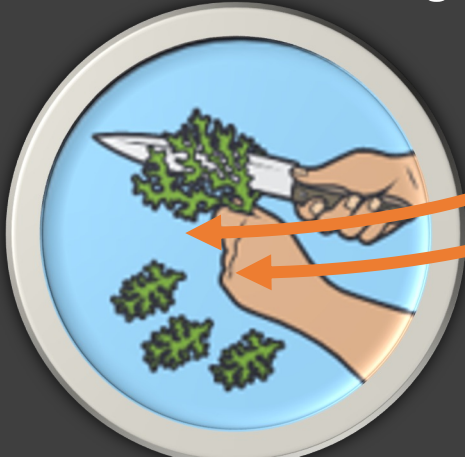
Best Methods for Tying Seed



- ~ 100 seed pieces
- Tying should occur in the water to avoid stress on seaweeds (hire help if necessary)
- Use one seedling for one loop
- Pour seawater on seedlings to prevent drying
- Store unfinished lines at sea respecting same rules as for farm siting (water temp, salinity...)



100 – 150 g each



*If using ~50-70g,
production will
reduce by ~50%*

Epiphytes



An **epiphyte** is an organism that grows on the surface of another organism



Epiphytes can be more abundant when seaweed is under stress conditions or diseased (ex: ice-ice) because the seaweeds' natural defenses are compromised



Seaweeds with abundant epiphytes usually have a lower value



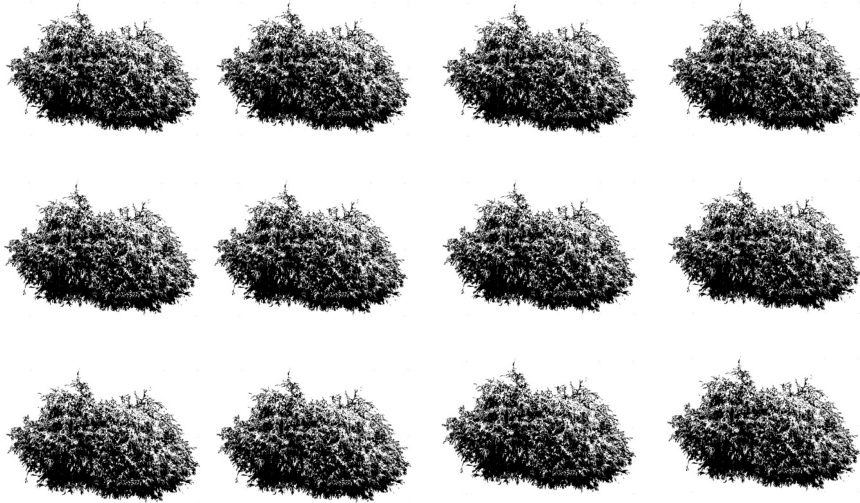
Ceramium sp.



Cavity after removal



Epiphytes (cont.)



- Epiphytes can block access to sunlight and nutrients and attract grazers
- If not removed immediately, **epiphytes will grow and spread very quickly.**
- The sooner they can be removed, the better
- Check seasonal calendar



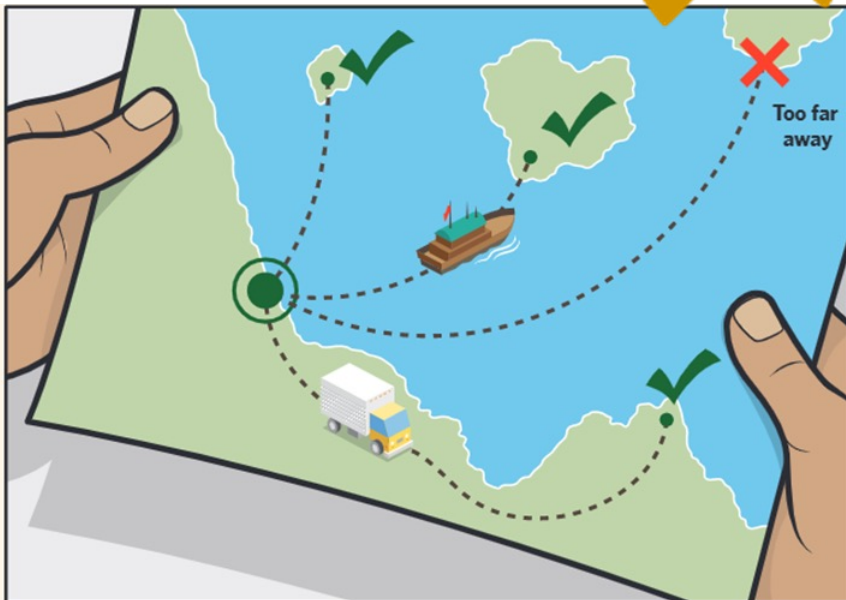
Ceramium sp.



Cavity after removal



Avoid These Seed Selection and Tying Practices



Avoid using seed from far away --
Local seed will be better adapted to
local conditions

- Do not use seed with epiphytes, discoloration, old branches, or ice-ice
- Avoid putting 3 – 4 small seeds (~50 g) in the same loop (too dense)
- Prevent sun exposure, drying out from wind, or freshwater/rain
- Do not use small seedlings (< 100 g)
- The exception is for sites with very strong currents. In this case, use smaller seedlings (50 - 70 g) to prevent the risk of breaking mature seaweeds



Farm Maintenance & Disease Prevention



Tender Loving Care ("TLC")

Successful seaweed farming requires dedication and daily activity from the farmer

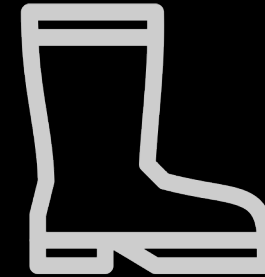


The most productive farms are small enough that they can be maintained every day during low tide

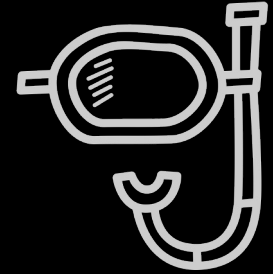
Low yields, fouling, and disease can result from lack of TLC



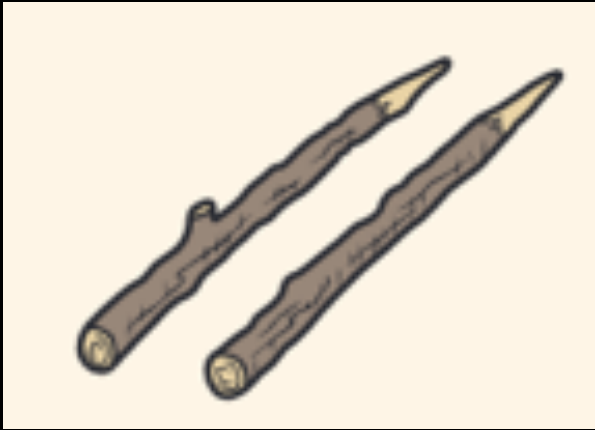
Sébastien Jan / Cargill



Created by Sidiq Fathurochman from Noun Project

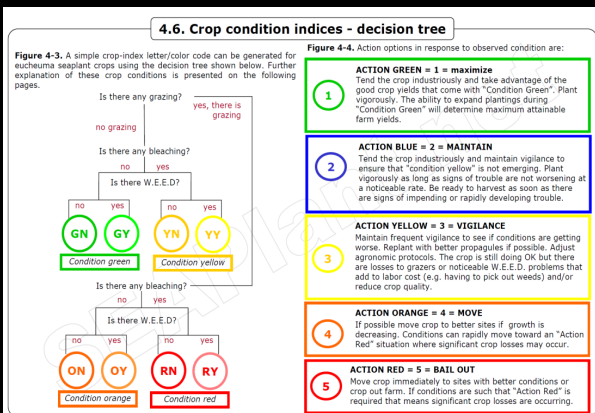


Created by P Thanga Vignesh from Noun Project



Tools for farm maintenance

- Extra stakes
- Harvesting boats (supplied by C-Weed)
- Crop condition index decision tree
- Boots or shoes
- Diving goggles (helpful but not necessary)



4.6. Crop condition indices - decision tree

Figure 4-3. A simple crop-index letter/color code can be generated for eucalyptus crops using the decision tree shown below. Further explanation of these crop conditions is presented on the following pages.

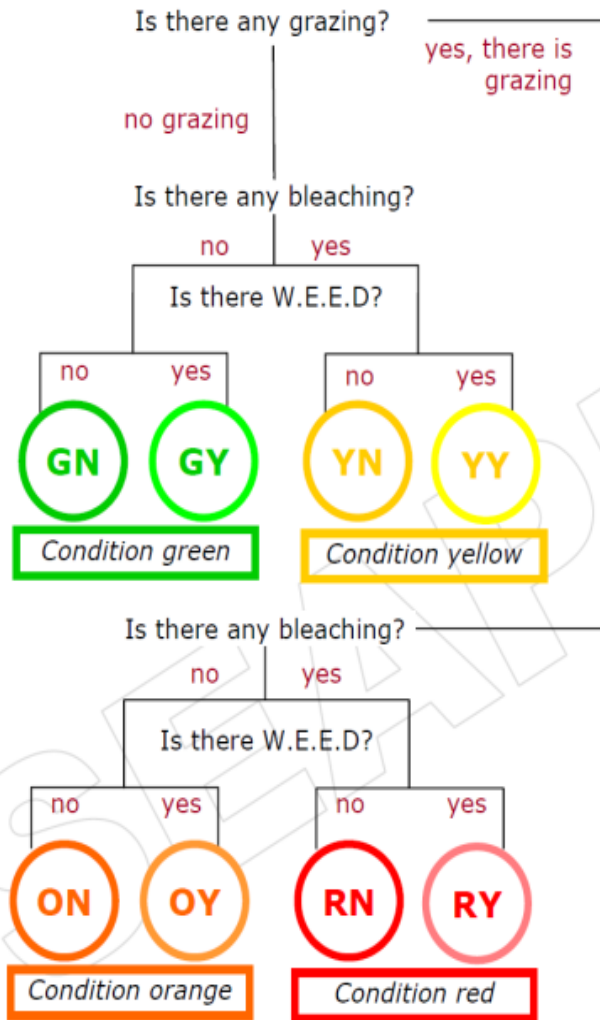


Figure 4-4. Action options in response to observed condition are:

1

ACTION GREEN = 1 = MAXIMIZE

Tend the crop industriously and take advantage of the good crop yields that come with "Condition Green". Plant vigorously. The ability to expand plantings during "Condition Green" will determine maximum attainable farm yields.

2

ACTION BLUE = 2 = MAINTAIN

Tend the crop industriously and maintain vigilance to ensure that "condition yellow" is not emerging. Plant vigorously as long as signs of trouble are not worsening at a noticeable rate. Be ready to harvest as soon as there are signs of impending or rapidly developing trouble.

3

ACTION YELLOW = 3 = VIGILANCE

Maintain frequent vigilance to see if conditions are getting worse. Replant with better propagules if possible. Adjust agronomic protocols. The crop is still doing OK but there are losses to grazers or noticeable W.E.E.D. problems that add to labor cost (e.g. having to pick out weeds) and/or reduce crop quality.

4

ACTION ORANGE = 4 = MOVE

If possible move crop to better sites if growth is decreasing. Conditions can rapidly move toward an "Action Red" situation where significant crop losses may occur.

5

ACTION RED = 5 = BAIL OUT

Move crop immediately to sites with better conditions or crop out farm. If conditions are such that "Action Red" is required that means significant crop losses are occurring.

Decision Tree

Healthy seaweed

1

ACTION GREEN = 1 = maximize

Tend the crop industriously and take advantage of the good crop yields that come with "Condition Green". Plant vigorously. The ability to expand plantings during "Condition Green" will determine maximum attainable farm yields.

2

ACTION BLUE = 2 = MAINTAIN

Tend the crop industriously and maintain vigilance to ensure that "condition yellow" is not emerging. Plant vigorously as long as signs of trouble are not worsening at a noticeable rate. Be ready to harvest as soon as there are signs of impending or rapidly developing trouble.

W.E.E.D?

3

ACTION YELLOW = 3 = VIGILANCE

Maintain frequent vigilance to see if conditions are getting worse. Replant with better propagules if possible. Adjust agronomic protocols. The crop is still doing OK but there are losses to grazers or noticeable W.E.E.D. problems that add to labor cost (e.g. having to pick out weeds) and/or reduce crop quality.

Grazing & W.E.E.D

4

ACTION ORANGE = 4 = MOVE

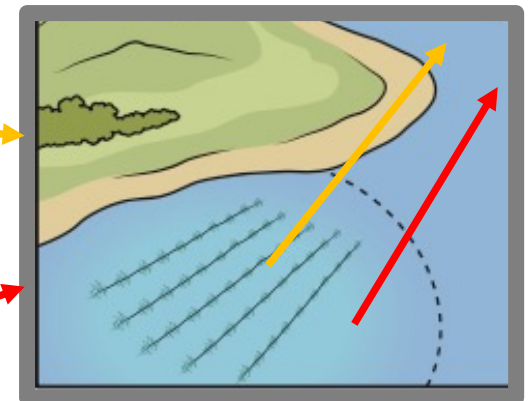
If possible move crop to better sites if growth is decreasing. Conditions can rapidly move toward an "Action Red" situation where significant crop losses may occur.

Grazing, bleaching & W.E.E.D

5

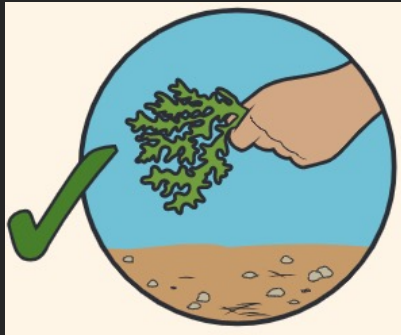
ACTION RED = 5 = BAIL OUT

Move crop immediately to sites with better conditions or crop out farm. If conditions are such that "Action Red" is required that means significant crop losses are occurring.



Farm Maintenance

- have your tools ready
- check if all ropes are well-attached to prevent tangled ropes
- re-attach or tighten detached and loose lines
- shake ropes to remove sediments
- replace loose or weak propagules
- remove drifted seaweed from ropes/ground -- -- bring them back to shore for disposal (don't throw them on your neighbor's farm)
- remove sea urchins from farm area – move them to a location without farming activity
- gather stray ropes, floats, etc.



Conditions needing action

- Abundant epiphytes: harvest quickly and do not use seaweed as seedlings
- Seaweed is exposed > 1 – 2 hours at a time: adjust rope position on stakes or move farm to new location



Farm Maintenance and Disease Prevention

For healthy and productive seaweed, maintenance must occur at least three times per week. More maintenance will be needed before and after storms to make sure the lines are secure, and during bigger tides (half-moon tides). Check to make sure the seaweed is tight on the ropes and, for the long lines, that the seaweed is always below the water. Shake the seaweed and manually remove epiphytes and other seaweeds from the lines.

Epiphytes:

Examples of epiphytes that can affect seaweed. Maintaining seaweed lines and removing these is important for the highest quality seaweed. Remove and dispose of on land.



Farms in Need of TLC



Epiphyte Prevention



Select cultivation sites with few naturally occurring epiphytes



Select areas with suitable current



Regularly remove epiphytes



Properly discard affected seaweed

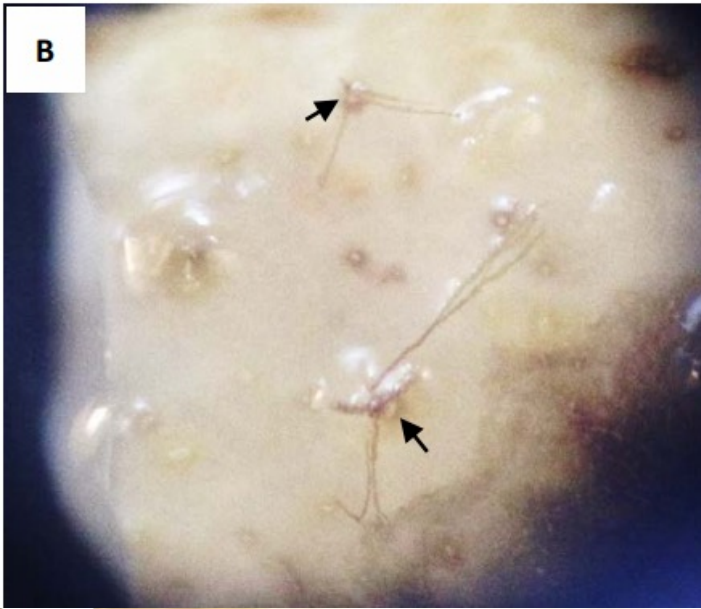


Wilbur Dubon



Roshni Lodhia/The Nature Conservancy

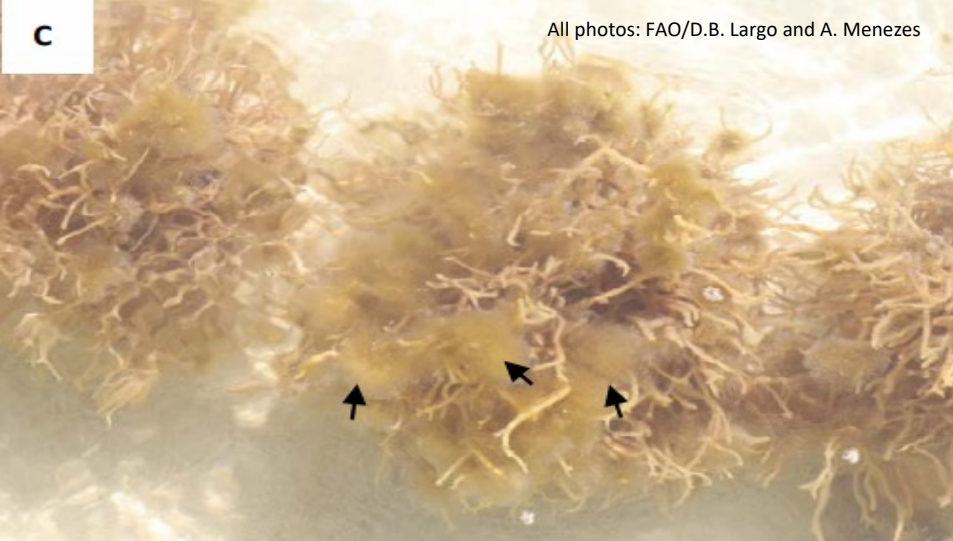
Epiphytic and endophytic filamentous algae



Filamentous algae can grow on or burrow into the spinosum seaweed

Prevention:

- site farms in areas away from nutrient and freshwater runoff
- choose deeper sites with less water temperature fluctuation
- manually remove epiphytes every day



All photos: FAO/D.B. Largo and A. Menezes



Ice-Ice



Stress (low salinity, extreme temperature, sun exposure) and malnutrition are the most common conditions leading to ice-ice

Prevention:

- site farms where seaweed is always submerged under water to avoid sun exposure
- Site farms away from freshwater sources

Actions needed if ice-ice appears:

- harvest immediately
- stop farming at that site until disease is gone
- source new seed from areas away from pollution or nutrient runoff



Grazers and biofouling organisms



FAO/D.B. Largo and A. Menezes



Gretchen Grebe/Dayna Zimmermann

Algae, sponges, sea anemones, and shelled molluscs can foul cultivated seaweed

Prevention:

- ensure seaweed is not touching the ground
- Shake lines and remove organisms by hand every day
- Site farms in areas with good water flow and away from eelgrass and coral reefs



Seaweed Harvesting, Post-Harvest Care, & Markets



Sébastien Jan / Cargill



Sébastien Jan / Cargill

Timing the harvest

To obtain the highest quality and quantity of seaweed, plan to harvest:

- after 45 days of cultivation
- during dry weather
- during low tide
- in the morning (to allow adequate time for removal and drying set-up)

Use harvesting boats



- Harvesting vessels help with the efficient and safe transport of large amounts of seaweed
- C-Weed can provide harvesting boats
- Dugout canoes are also a good option

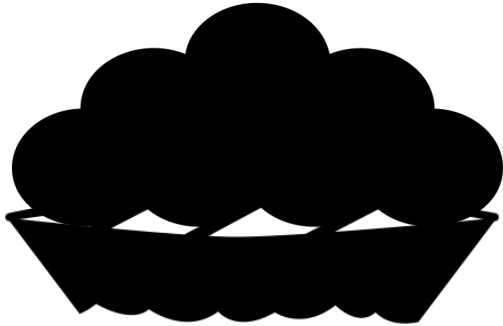


Sébastien Jan / Cargill



Sébastien Jan / Cargill

Avoid damaging or dangerous boat use



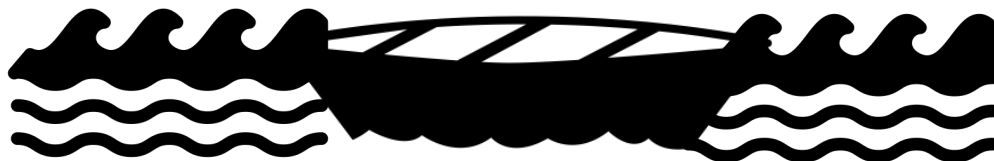
- Limit weight of seaweed (or size) to 500 kg maximum

Modified from images created by Saifurrijal and Pinto K Shine from Noun Project



Modified from images created by ProSymbols, Pinto K Shine, and Hasanudin from Noun Project

- Do not use the boat as a trailer



Modified from images by Pinto k Shine and Vectorstall from Noun Project

- Do not use harvesting boats to go to deep water - this is unsafe



Poor maintenance of
boats = damage

Drying set-up

- Shake seaweed to remove water and fouling
- Strip it off the rope by hand
- Dry the seaweed on racks (if available) → if not, tarps, rocks are better
- Spread it out in a think layer (5 - 10cm)
- Remove any visible impurities (other seaweed species, etc.)



Gretchen Grebe/Dayna Zimmermann



Gretchen Grebe/Dayna Zimmermann



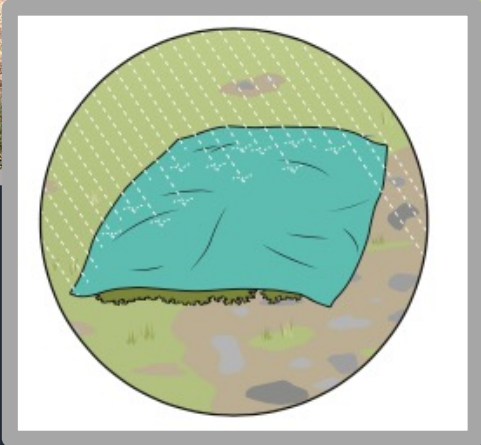
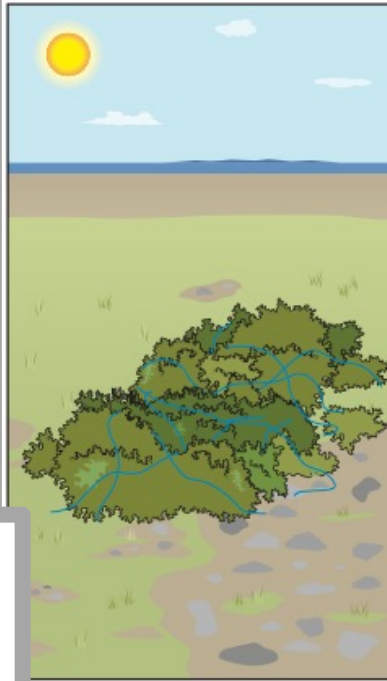
Roshni Lodhia/The Nature Conservancy



C-Weed



Sébastien Jan / Cargill



Best methods for drying and storage

- Rotate and turn the seaweed every day
- Dry for ≥ 3 days (\uparrow time if cloudy/humid)
- Use a light-colored tarp to protect the seaweed from rain, mist, and dew (fresh water removes carrageenan)
- Once dry (crunchy in your hand), store the seaweed in a cool and ventilated place
- If possible, sell it quickly



Drying conditions to avoid



- sand/dirt
- other seaweed species
- trash
- thick layers that limit drying (> 10cm)
- do not add seawater to dried seaweed to increase the weight – this degrades the quality and lowers the sale price
- do not harvest during rainy weather

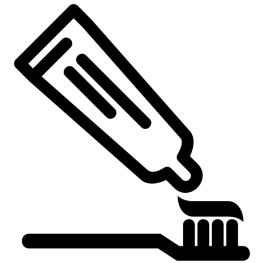


Seaweed Products & Applications

Eucheuma species like spinosum are used to make carrageenan

Carrageenan helps to thicken or bind many commonly used products like:

- Toothpaste
- Ice cream
- Animal feeds



Created by styleku
from Noun Project



Created by darvis
from Noun Project



Value-added products

Eucheuma can also be used to make:

- **Body products:** soaps, cream, massage oil
- **Snacks:** cookies, cakes, juice, pudding, salad



Seaweed powder



All photos from ZASCI

