Process Analysis Team Project (2+2)

Operations Management

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Executive Summary

Background

The Sugar Kelp Cooperative is a New England based, ocean farming association consisting of five ocean farmers who grow seaweed and shellfish off the coasts of Connecticut, Rhode Island, and Massachusetts. The sugar kelp industry is a relatively new industry, so the cooperative was formed as a marketing strategy to build up the demand for kelp-related food products. Upon analysis, it was determined that there are three major problems facing the Sugar Kelp Co-op:

1. Lack of a consistent commercial seed-string spore supply
2. A new market with limited infrastructure
3. A short stabilization period for kelp

Analysis

The main challenges we uncovered include bottlenecks and lack of infrastructure. By analyzing cycle time, we discovered that harvesting kelp is a quick and well utilized process, however, capacity is more constrained with multiple harvests per season. It had been discovered during analysis that the Sugar Kelp Co-op harvests multiple times a season even though they are aware that standard practice is to harvest once per season. This increases labor by 71 hours per season and increases boat fuel costs by $438.90. Currently the co-op farmers are harvesting per order, which means the kelp is smaller and the farmers have to use time and gas money to collect the kelp for high end chefs and restaurants. The stabilization of kelp is a short 6 hour window and there are not enough processing facilities in the New England area to turn the kelp into its end product in a time-sensitive manner.

Recommendations

Our recommendations for the Sugar Kelp Cooperative would be to support the Crop Project, a new sugar kelp wholesaler that guarantees the purchase of entire yields. Farmers can also focus on more shelf stable products they can do without facilities such as pickled stipes. Next, we applaud the cooperative for its passion to support land farmers with the donation of kelp fertilizers, however, we encourage the farmers to consider adding value by selling the fertilizer at a low cost. Not only will this add a revenue stream, but it will provide there is legitimate value of the product which will encourage land farmers to use the fertilizer as its intended environmental benefit. Finally, by advocating at the local municipality level, farmers can help improve legislation and subsidy initiatives in order to increase the number of processing facilities within the industry.

Background

The Sugar Kelp Cooperative is a group of five ocean farmers in the New England area who are joined in a collaborative effort to develop, market, and sell sugar kelp products. The co-founder of the Sugar Kelp Co-op owns and operates Stonington Kelp Co. out of southern Connecticut with her husband. She co-founded the co-op as a way to help sell large volumes of sugar kelp to value-added companies since she is barely breaking even as an individual kelp farmer. The largest barrier to growth and expansion in the seaweed industry is the lack of infrastructure in place to process the kelp, which has a short stabilization period of only six hours once it is harvested from the ocean. The co-founder hopes the cooperative will help build a movement to increase the consumption of sugar kelp through education and outreach.

For the evaluation of this cooperative, the researchers interviewed two ocean farmers (Farmers B and C) in addition to the co-founder (Farmer A) in order to analyze the outplanting and harvesting processes. Ocean Farmer B runs Rhody Wild Sea Gardens while Farmer C operates New England Sea Farms. All cooperative members work full time jobs while ocean farming is an additional and supplemental income. They have started within the last five years and all receive their kelp spores from GreenWave nurseries, a nonprofit who trains many ocean farmers in the New England area. GreenWave has the only hatchery in the area and there was an issue with its supply this year. The delay in receiving spores caused the co-op to push back their outplanting season from November to January/February which greatly impacted their yields. With less time in the water, the kelp could not grow to full length and because it is sold by weight, the smaller kelp sold for a lower price. The kelp could not stay in the ocean longer due to state regulations that do not allow ocean farming in the summer, touristy months.

Sugar kelp is a brown alga species that can grow blades of up to 20 feet. The blades grow from a stipe, or stem, that is linked to a holdfast which is attached to rocks in nature and ropes when ocean farming (Exhibit 8). As shown in Exhibit 7, the process flow of sugar kelp farming begins by unspooling the string of kelp spores onto longlines attached to buoys that are anchored to the ocean floor in an area of 200 ft x 600 ft (Exhibit 12). The kelp is monitored for 3-4 months before it is harvested onto the boat with a crank and the blades are separated from the holdfasts. The blades are then processed and sold to restaurants and high-end chefs to be used as kelp noodles and other innovative seaweed products.

One of the initiatives the farmers requested help on is what they are calling the Sea to Soil project. The goal of this project is to collect and dry the leftover blades of kelp that did not get processed into food so that it can instead be donated to land farmers as an eco-friendly soil fertilizer. Currently, the excess seaweed is dumped back into the ocean, but the cooperative wants to utilize these scraps and offer them to land farmers as a way to reduce nitrogen in the soil and offer an alternative to chemical-laden fertilizers.

Analysis

Through the elaboration of a process flow map, we were able to identify constraints and variances within the sea to soil workflow. The main challenges we discovered were a raw materials bottleneck, limited market infrastructure, and a short processing window. Currently, the Sugar Kelp Cooperative farmers are harvesting to order, this means that the kelp is cut at a smaller size (baby blades) and can regenerate. However, harvesting multiple times a season is creating time and cost inefficiencies for farmers. Cycle time was calculated to compare the time it takes for a kelp farmer to produce 1 pound of sugar kelp (Exhibit 9). We first calculated the cycle time for the industry standard of one harvest at the end of the season. The total production time including non-value add time such as roundtrip transportation to/from the farm and clean-up is approximately 2,825 minutes. Sugar kelp yields are approximately 5 pounds per linear foot, which amount to a yield of 5,000 pounds for the particular farm we examined. Therefore the cycle time is 0.565 or 34 seconds per 1 pound of sugar kelp (Exhibit 9). Based on this calculation we concluded that harvesting kelp was a relatively efficient and well-utilized process. However, when accounting for current Sugar Kelp Cooperative farmer practices we compared the cycle time for three harvests. The total production time increased to 3,420 minutes and the harvest decreased to 3,500 pounds to adjust for harvests of smaller volumes of kelp. The new cycle time for 3 harvests is 0.98 or 59 seconds of production time for a farmer to produce 1 pound of sugar kelp (Exhibit 9). Hence sugar kelp production is most efficient when harvested once at the end of the season.

Sugar kelp is a supplemental income, meaning all of the individuals in the cooperative have full time jobs in addition to being seaweed farmers. Furthermore, the difference between harvesting once versus multiple times a season has time and cost implications. Harvesting once will take approximately 40 minutes of roundtrip travel time and 750 minutes (12 ½ hours) cutting sugar kelp off longlines and sorting them into containers (Exhibit 10). However, in measuring the time of three harvests, it would be approximately 120 minutes in roundtrip travel and 2,850 minutes of harvesting (Exhibit 10). This is a difference of 2,180 minutes or 36 hours. Furthermore, the Sugar Kelp Cooperative must consider cost savings associated with boat fuel. Although the boat engine will not be needed the entire time while out at the farm site we estimated it would be about half of the time; 6 hours for a single harvest, and 25 hours for 3 harvests (Exhibit 10). A fishing boat expends about 5.5 gallons of gasoline per hour (Sullivan, 2020). Therefore using $4.20 per gallon of gas, fuel differences amount to $438.90. Furthermore, recent inflation and increasing gas prices is an additional consideration for sugar kelp farmers that will impact their profit margins.

Furthermore we examined the utilization rates of two phases of the workflow processes: transportation and harvesting. Although utilization rate is usually defined by an employee's work capacity, it's important to note that sugar kelp farmers don’t work a standard 40 hour work week. We took the measure of the average time spent (activity time) over the maximum amount of time that is spent (total available time). Farmer C noted that travel time on the boat to their farm was approximately 10-15 minutes and up to 20 minutes depending on the weather. Transportation to the farm would need to occur with less than 10 miles per hour wind conditions. Between November and April, there are approximately 10 trips to the farm (20 roundtrip). The activity time is 350 minutes which takes an average (10-15 minutes) of 12.5 minutes whereas, the total time available is 400 minutes (20 minutes). This results in a utilization rate of 87.50% (Exhibit 11). Furthermore, for harvesting the activity time is 825 minutes (average of 2.5-3 hours per longline) for all workers, and the total available time is 3 hours per line which gives us a utilization rate of 91.67% (Exhibit 11). Overall with optimum weather and one harvest per season their capacity is utilized efficiently. The data illustrates that there is a source of variance in regards to weather conditions and farm site location.

Recommendations

Recommendations for the Sugar Kelp Cooperative include harvesting once per season, selling their fertilizer, and encouraging local governments to subsidize a processing facility. Firstly based on our analysis harvesting multiple times a season is inefficient and adds non-value added time in addition to higher boat fuel expenditures. Although sugar kelp farming is receiving more media attention and gaining popularity there is still a limited market infrastructure.

We recommend that through a new partnership with a seaweed wholesaler The Sugar Kelp Cooperative will be able to harvest more efficiently. Currently, the farmers are harvesting to order and the kelp is being sold primarily to high-end chefs and restaurants in the New England area. However, a new partnership with The Crop Project (2021), a sugar kelp wholesaler will guarantee to purchase their entire yields in addition to a 10% upfront payment (to support outplanting). The process of harvesting and stabilizing sugar kelp is a short window of 6 hours. Currently, The Sugar Kelp Cooperative farmers place their harvest in a refrigerator where it must be consumed within 5-6 days. An additional suggestion would be to focus on shelf stable products that can be done without a processing facility such as pickled stipes and dried seaweed products. The cost savings of switching from three harvests a season to one would be $79.80 in boat fuel and 36 hours of labor.

We applaud the cooperative for its passion to support land farmers with the donation of kelp fertilizers, however, we suggest the farmers consider adding value by selling the fertilizer at a low cost. This will add a revenue stream and provide them a legitimate value for their product which will encourage land farmers to use the fertilizer as its intended environmental benefit.

Currently, liquid seaweed that is sold commercially as a fertilizer is sold for $17-24 a quart. The Sugar Kelp Cooperative's fertilizer is organic and local and allocating its monetary value will ensure farmers are compensated for additional labor costs associated with harvesting and processing.

Finally, by advocating at the local municipality level farmers can help improve legislation and subsidy initiatives in order to increase the number of processing facilities within the industry. This would help to encourage local governments to subsidize processing facilities. For example, if The Sugar Kelp Cooperative had a small-scale processing facility locally they would be able to consolidate seaweed used for fertilizer, dry, package, and distribute the product. Instead of the transportation and labor costs associated with delivering fertilizer to land farms, the farms could arrive at the processing facility to pick up their order. Leasing a small warehouse in Connecticut would cost between $6.50-16.00 per square foot, however, this would cost well over $100,000 annually (LoopNet, 2021). A processing facility would only be needed for a limited amount of time. Potential support from the municipal government could provide a temporary processing facility in support of sustainable waste management. The time for implementing these recommendations is within one year during the next harvest season in April 2023.

The following outlines the controls that would prevent deviation from desired outcomes after recommendations are implemented. The Sugar Kelp Cooperative should track labor time, fuel costs, and yields associated with the sea to soil work flow process in the following year. This will ensure that farmers are working efficiently and achieving a higher profit margin. Partnership with The Crop Project and potential municipalities will support farmers in the harvest and processing of their crop. Hopefully, the increasing demand for kelp will create a stronger infrastructure with greater wholesalers and hatchery options. The Sugar Kelp Cooperative is operating informally and doesn't require dues. Introducing a small annual fee will ensure greater farmer commitment and engagement. As the industry strengthens, a change management plan should be drafted collectively to outline goals regarding product development, marketing, and sales.

Integrative Conclusions

Regenerative Agriculture

Gopal Farm's method encompasses non-conventional systems of agriculture, including regenerative, organic, permaculture, and Biodynamic. They are expanding their agro-forested acres to further increase the "carbon sink" capacities of their farmland. This practice is core to the values and mission of both Gopal Farm and the Sugar Kelp Co-op. Gopal Farm's process of extracting the fronds is more time consuming because of the limited use of machinery and their dedication to limiting their footprint and meeting the mission to be more sustainable. Similarly, the Sugar Kelp Co-op can market itself as a regenerative agriculture system because kelp is a carbon-negative crop that helps to mitigate climate change as it grows.

Increasing revenue with intercropping

Both projects are attempting to make the most efficient use of the area available to them (land or water). They are hoping to best utilize this available area to maximize their revenue generation. Gopal Farm is completing the deep tilling process in order to be able to intercrop its coconut palms with bananas, papayas and jackfruit. This process while time consuming will result in more profits in the long run and continues to match actions with mission as Gopal Farms strives to be more sustainable. The Sugar Kelp Co-op would improve its bottom line and increase sustainability by focusing on polyculture and intercropping. In addition to kelp, ocean farming has made it possible to grow shellfish and bottom-dwelling creatures like lobster all in the same patch of ocean. This method allows for the shellfish to grow from the kelp and the lobsters to grow from the discharge of the shellfish.

Sustainability of Crops (Circular Farming)

As part of the deep tilling process, nothing goes to waste. Gopal Farm is recycling dead palm fronds into mulch to help turn the sandy top layer of soil into more fertile soil for future growing use. Gopal Farms is committed to this process, and it is at the core of their mission.

By starting its sea to soil project, the Sugar Kelp Co-op is already considering how it can fully integrate into the circular economy. By using the leftover portions of their kelp harvests, the farmers can increase the use of their crops not only for food consumption but as a sustainable biofuel.

Increasing Capacity

Both projects have constraints due to the need for skilled labor. In the deep tilling process, there is only one of each type of heavy machinery and one qualified operator for each. This causes several different bottlenecks as discussed in the analysis. One set of recommendations for Gopal Farm includes increasing the staff's overall capacity by renting additional heavy machinery and hiring the associated trained operators. Skilled labor is expensive, especially those with certification to operate machinery. Machinery is also a substantial financial burden for a growing organization. In the case of the Sugar Kelp Co-op, the only way to build a successful industry is by increasing the middlemen who can process the seaweed for value-added product companies. It is essential that the co-op advocate for governmental subsidy programs that can support the infrastructure needed.

Appendix

Exhibit 7

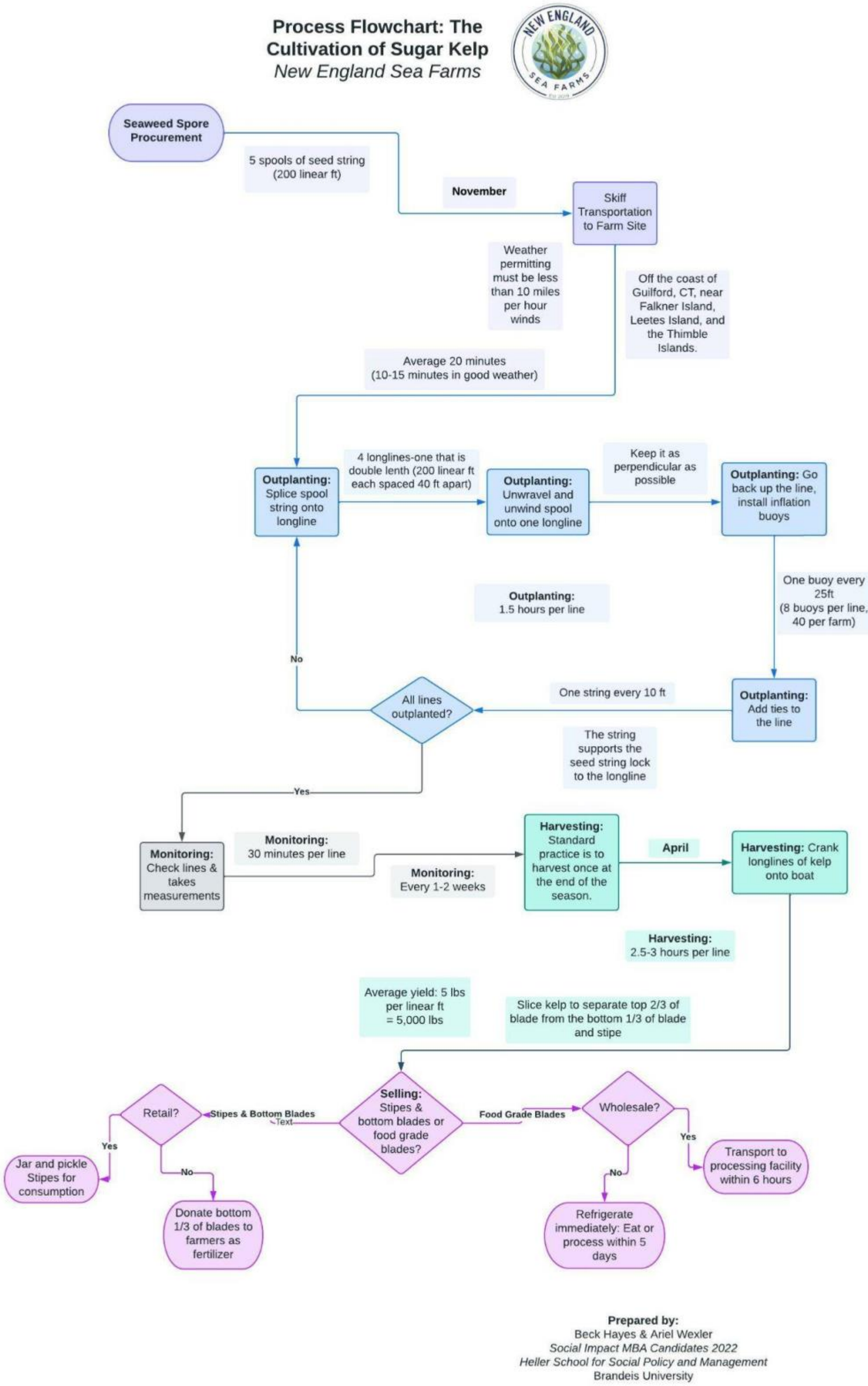


Exhibit 8

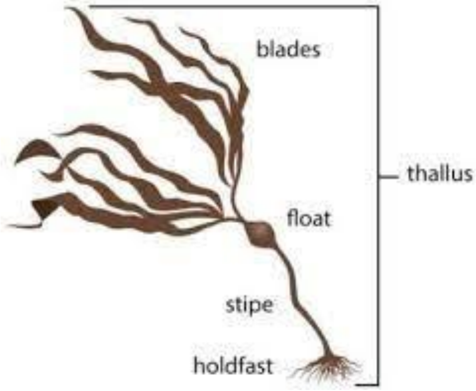


Exhibit 9

Cycle Time Calculation	**Total Production Time**	3420	Minutes
1 Harvest	**Yield**	3,500	Lbs
	Cycle Time	0.98	
Cycle Time Calculation	**Total Production Time**	2825	Minutes
3 Harvests	**Yield**	5,000	Lbs
	Cycle Time	0.57	

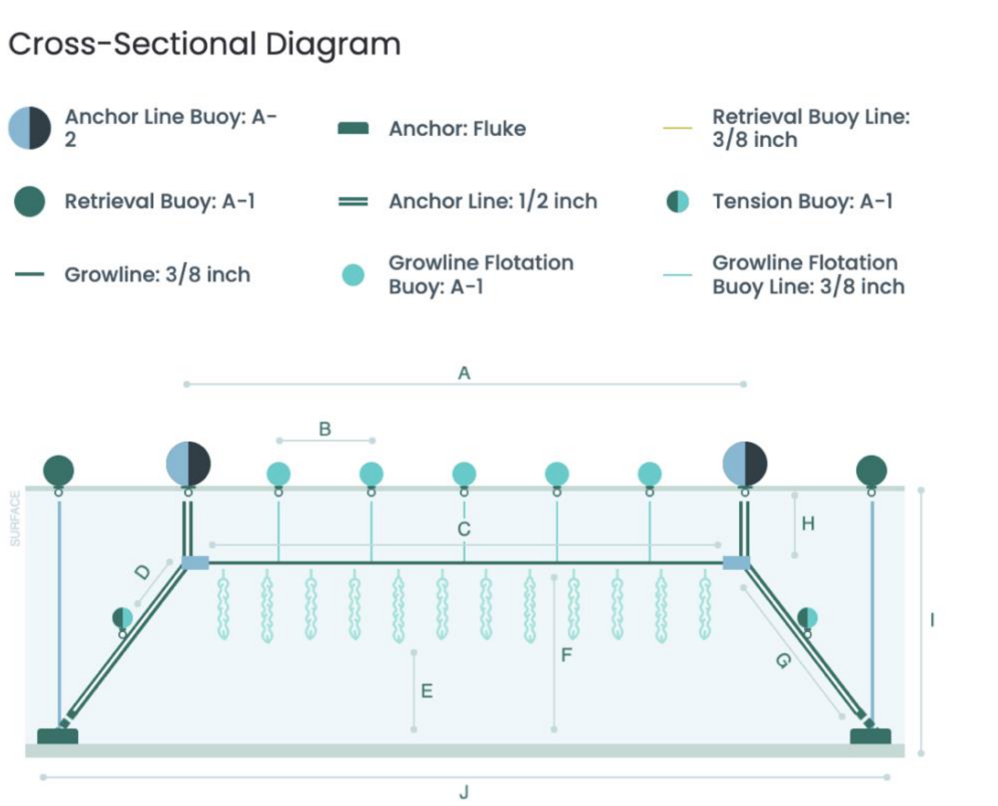
Exhibit 10

1 Harvest	3 Harvests	
40 minutes	120 minutes	Travel
750 minutes	2850 minutes	Harvest Time
790	2970	Minutes
	2180	**Time Savings**
33	137.5	Gallons
$138.60	$577.50	
	$438.90	**Cost Savings**
$4.20	price per gallon	
**Assumptions: fishing boat expends 5.5 gallon of gas per hour, boat is utilized half the time.*		

Exhibit 11

Process	Transportation (10 trips)	Outplanting	Monitoring (8 trips)	Harvesting
Activity Time (mins)	350	450	1200	825
# of workers	1	2	1	3-4
Total Available Time (mins)	400	*insufficient data*	*insufficient data*	900
Utilization Rate	**87.50%**			**91.67%**

Exhibit 12



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