

Equipment Handbook



Kelp Stabilization for Rural Communities: Designing for Decentralized Processing 2023 AFDF Joint Innovation Project

Introduction

Fresh seaweed degrades rapidly after harvesting, preventing farmers and processors from bringing it to market in sufficient quantity and quality. To relieve this bottleneck, this project aims to develop an open-source primary processing line capable of size-reducing and stabilizing kelp at as close (physically and temporally) to the farm as possible. This specific stabilization method used in this project is a proprietary recipe that preserves kelp at ambient temperature, making it a viable option for deploying in rural communities across Alaska. However, the same pre-processing steps are also needed for other forms of stabilization including fermentation, drying, and freezing. Providing rural kelp farms with affordable stabilization technology is key to extending the shelf life of their product, and ultimately securing realistic access to markets.

This project was funded in part through a 2023 Alaska Fisheries Development Foundation (AFDF) Joint Innovation Project Grant. Partners include GreenWave, Alaska Sea Grant, the Kodiak Archipelago Leadership Institute (KALI), Alaska Ocean Farms, and Macro Oceans.

Supply List

- Vincent VS-8 shredder
- Shredder stand
- Kelp pusher (optional)
- Two 5-gallon buckets
- 55-gallon barrels with vented lids or other vessel for finished product
- Right-angle drill
- 55-gallon drum mixer paddle
- Floor scale
- Eye and ear protection
- Access to power
- Stabilization reagents and additional protective equipment as needed
- Fresh water source (for cleaning)

Equipment Details

Vincent VS-8 Shredder

The Vincent VS-8 shredder is a durable, compact, inexpensive machine that efficiently reduces whole kelp into a small particle size efficiently. It is manufactured by the Vincent Corporation, based in Tampa, Florida. It works by smashing (rather than cutting) kelp into pieces using fixed bars of hardened stainless steel attached to a rotor. A metal screen regulates the output, so material can't leave the



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chamber until it satisfies a particular particle size. The standard power pack is a 5 horsepower electric motor that requires 220V, 3-phase power.

Safety

The Vincent VS-8 is a powerful machine that will cause serious injury if improperly handled. Great care should be taken to ensure nothing comes into contact with the rotating bars on either the infeed or the outfeed. If a pusher is used to assist with the dog-leg infeed, it should include a hilt to ensure that it cannot reach the rotating bars. The machine must be completely disconnected from power before making any adjustments, including clearing clogs from the outfeed. Operators must utilize eye and ear protection at all times, tie back long hair, and should never wear jewelry, long-sleeved shirts, baggy clothing, or anything with drawstrings while the machine is in use.

Renting and Purchasing

The Vincent VS-8 shredder is available to purchase for approximately \$16,000 with an 8-week lead time. However, it can also be rented for \$178/week, which provides an inexpensive opportunity to try out the machine without long-term commitment. There is also an option to apply some of the cost of a rental to a purchase of the same machine. There is no liability for damage or modifications made to the machine during the rental period. To contact Vincent, email vincent@vincentcorp.com or call 813-248-2650.

Why We Selected This Machine

- Can handle whole kelp, without pre-processing
- No sharpening required
- No water needed for conveyance
- Output particle size can be controlled by changing output screens
- Relatively inexpensive
- Relatively compact
- Relatively light (~300 lbs)
- Larger models are available for purchase as harvest volumes scale up
- Ability to upgrade to a food-safe stainless steel model
- Difficult to break
- Motor is available in single-phase or 3-phase options
- No specialized or expensive tools or parts required to perform maintenance
- Can be operated by 1-2 people for an output of ~2,000 lbs per hour with no mechanization

Infeed

The motor that powers the Vincent VS-8 is high speed and low torque, so it will stall if too much biomass enters the chamber too quickly. As a result, kelp should be fed into the machine in smaller but consistently metered quantities.

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The shredder comes with a dogleg chute with a rubber flap that functions both as an infeed and safety mechanism. In order to achieve metered infeed, the kelp can be either hand-fed in compacted <5 lb. portions or an infeed table can be fabricated to allow for portions of kelp to be staged before they are pushed into the dogleg chute.

If kelp gets stuck in the chute, a pusher stick can be used to push the kelp into contact with the spinning bars. However, care should be taken to ensure that the stick itself does not enter the chamber, or a powerful kickback and possible injury will result. This can be avoided by fabricating a hilt that is wider than the chute at an appropriate distance (see photo at right). In an abundance of caution, pushers should be made of a soft material (e.g. PVC lumber), not wood or metal.



Infeed conveyance will be needed to maximize throughput, ideally with speed or metering capability to control how much kelp enters the shredder at one time.

Outfeed

Vincent offers several different metal screens to control particle size output on the VS-8. Tests of the screens with sugar kelp had the following results:

- 1¼-inch screen - Produced an approximately ¾-inch particle size
- 5⁄8-inch and ¾-inch screens - Produced a thick puree, which occasionally clogged the screen
- Comb - Produced a 1-3-inch particle size

For this project, we used the 1¼-inch screen, and 5-gallon buckets as collection totes under the shredder outfeed to catch the size-reduced kelp. When the buckets are nearly full, they weigh 30-40 lbs. and can be lifted by a single person and carried to the mixing/storage vessel. Just as automated infeed conveyance will be needed to maximize the throughput of any size-reduction processing line, the outfeed will also need to be automated in high-volume production scenarios.

Size Reduction Alternatives

A variety of size reduction machines were tested before arriving at our recommendation. The runner-up was a dual-shaft shredder, which works well but is heavier, bigger, and more expensive than the Vincent VS-8 shredder. Two examples of the dual-shaft model are manufactured by [Amerishred](#) and [JWC Environmental](#).

Size reduction machines that were tested but are not recommended include:

- Garbage disposals - require water to convey material through the machine
- Meat grinder - kelp wraps around auger and does not grind
- Wood chipper - kelp wasn't rigid enough to move through the machine, clogged

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- Urschel® Comitrol® - expensive cutting heads that dull easily, prone to clogging

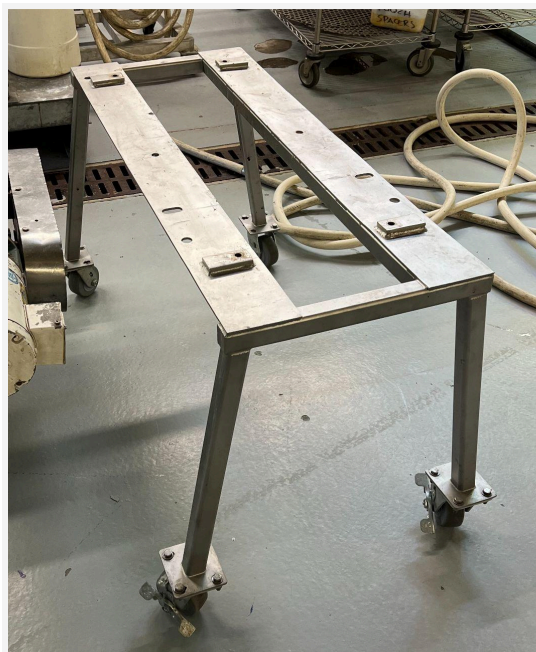
Shredder Stand

In order to shred seaweed ergonomically and efficiently, the shredder should be mounted on a stand that allows the operators to:

1. Feed whole kelp into the shredder infeed
2. Transfer size-reduced kelp from the shredder outfeed to the next step in the process

Vincent rents and sells stands specifically designed for their shredders — we used the 24" model for our demonstration (see photo at right). That said, the design is not complicated and could be easily fabricated by a knowledgeable welder. Key features on the Vincent stands include:

- A sturdy structure that can support 700+ pounds
- Base wider than machine to resist tipping
- Shredder securely bolted to stand
- Lockable wheels



Vessels for Mixing and Storage of Final Product

The type of vessel you will need to mix and store the final product should be determined by:

1. Your customer's specifications
2. The tools available for you to mix reagent into the vessel
3. The equipment available to you for moving heavy objects

For this project, we chose **55-gallon barrels** because they are widely available: new, used, and food-grade. They can have either fully-sealed or vented lids, the latter of which is useful for final products that off-gas or generate heat. When full of size-reduced kelp, they weigh about 440 lbs., which can be tilted and rolled by two able-bodied people.



IBC totes are the industry standard for liquid products. They also can have solid or vented lids and are available new, used, and food-safe. Unlike barrels, they can be stacked 3-high. However, because they weigh approximately 2,300 lbs. when full of size-reduced kelp, they require a forklift to move.



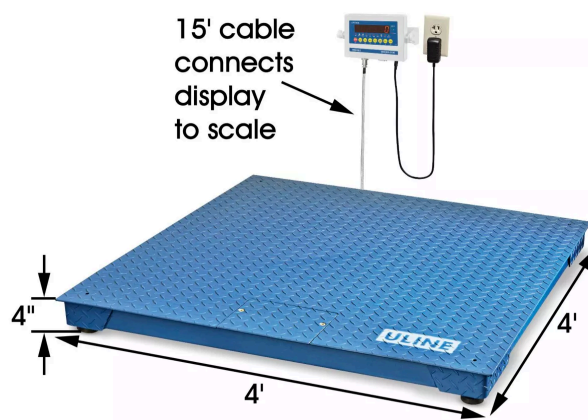
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Floor Scale

A **floor scale** is the best way to accurately weigh the size-reduced kelp and measure appropriate amounts of stabilization reagents. When shopping for a floor scale, look for the following features:

- Rated for the maximum weight of your vessels when filled with product
- Separate, external weight display
- Ramp or sloped sides, for easier loading
- Washdown rated
- Wheels on the edge, to make it easier to move around



Mixing Equipment

If the stabilization method involves chemical reagents or an inoculation, it will be necessary to mix these with the size-reduced kelp to ensure even distribution throughout. Communicate early and often with your customer to make sure you understand their precise stabilization process requirements.

For this project, we selected a **½-inch right-angle drill** fitted with a **55-gallon drum mixer paddle**. We chose these because they are inexpensive (less than \$250 total), easy to obtain, and get the job done. We also evaluated barrel and drum mixers, however they did not provide enough torque and were expensive (about \$1,000). Almost any right-angle drill rated over 12 amp should have sufficient power. Note that the paddle we selected is not food-safe, but a stainless steel model would be.



In extremely small-scale production environments, a brewer's **mash paddle** would be a good option for mixing reagent into kelp. Although it is not scalable, there are no safety considerations, and it is cheap and food-safe.

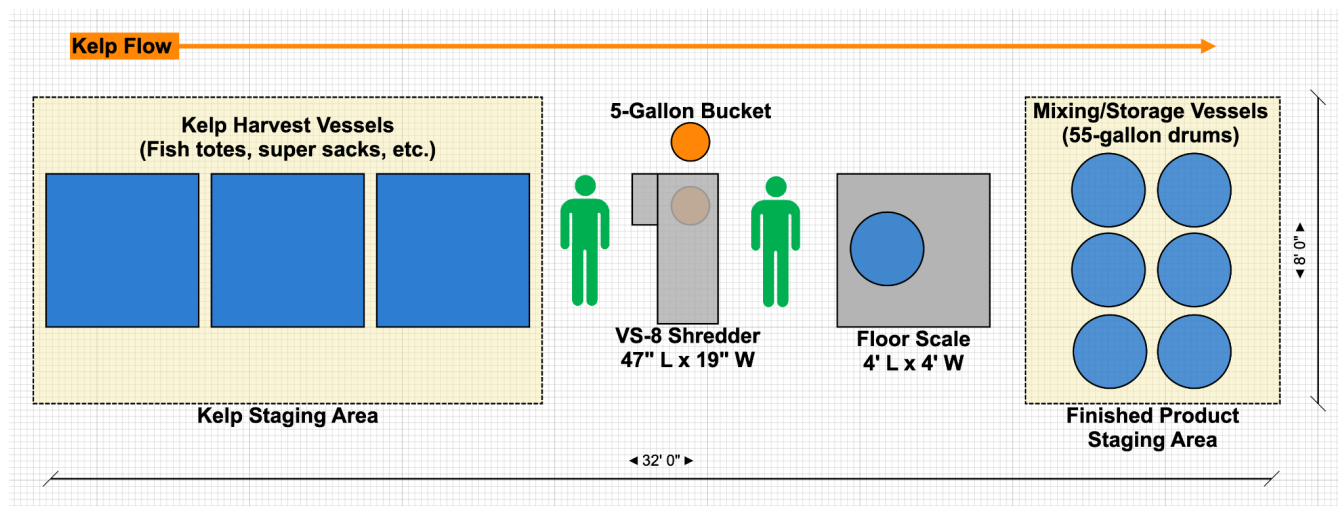
Safety

Mixing using power tools is a dangerous activity. Always use eye protection. Plug into a GFCI outlet to reduce the risk of electrocution if the drill gets wet. It is also important to start the mixer paddle spinning freely in the air, and slowly ease it into the material you need to mix. Never start with the paddle buried in the material. Hold the drill firmly, but if it starts to bind or jam, let it go and get back to avoid getting injured — it is better to have to buy a new drill than incur an injury.

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Process Flow



Standard Operating Procedures

1. Transport kelp to the staging area.
2. Place an empty mixing/storage vessel on the scale, and tare the scale.
3. Put a 5-gallon bucket beneath the shredder to catch the size-reduced kelp. Turn the shredder on.
4. Feed kelp into the shredder until the 5-gallon bucket is nearly full.

Tip: If kelp is stuck in the shredder chute, use a pusher as described in the equipment list above. Do not EVER use your hands to push kelp into the shredder; it is extremely dangerous.

5. Put the contents of the 5-gallon bucket into the mixing/storage vessel.

Tip: If you have two buckets and two people, you can operate the machine continuously, filling one bucket while the other is being transported to the mixing/storage vessel.

6. Repeat steps 5-6 until you have achieved the desired weight of kelp in your mixing/storage vessel, as required by your customer and their desired stabilization method. Turn off the shredder.

Tip: Stabilization methods are unique to the needs of the end customer. Make sure you understand your customer's ingredients, recipes, and process in detail, and ask questions if there is anything that's unclear.

7. Add the appropriate amount of stabilization reagent(s) as required by your customer and their desired stabilization method.

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Tip: In some situations, it may be better to add a fraction of the total amount of reagent along with each 5-gallon bucket, or half of the stabilization reagent when the mixing/storage vessel is halfway full and the remainder when the vessel is complete. Check with your customer for their preferred method. Make sure to use any recommended personal protection equipment when handling reagents.

8. Fit the drum mixer paddle into the right angle drill and turn on. Lower slowly into the kelp slurry and work through the material until thoroughly mixed, paying special attention to edges and corners.

Tip: Mixing can be dangerous! See our Safety tips in the equipment section above for more information.

9. Seal the mixing/storage vessel, record a final weight, remove it from the scale, and start back at Step 1.

Budget

For 10,000 lbs of seaweed

Item	Cost / Ea	Quantity	Total
Vincent VS-8 Shredder*	\$16,000.00	1	\$16,000.00
5-gallon buckets (transfer vessels)	\$5.00	2	\$10.00
55-gallon barrels (mixing/storage vessels)	\$105.00	20	\$2,100.00
Right-angle drill	\$170.00	1	\$170.00
Drill mixer paddle	\$84.00	1	\$84.00
Floor scale	\$1,650	1	\$1,650.00
Labor**	\$25.00	20	\$500.00
		TOTAL	\$20,514.00

*Shredder can also be rented for \$178/week plus shipping (~\$1-2k one way to Alaska)

**Based on a low-throughput estimate of 2 team members capable of processing 1,000 lbs per hour

Conclusion

Through our 2023 AFDF Joint Innovation Project, we established that the Vincent VS-8 shredder is a viable piece of equipment for rural processing of raw kelp using wet ambient temperature stabilization methods. Based on a low-throughput estimate of 1,000 lbs per hour processed by two team members, a farmer could process 5,000+ lbs of wet kelp in a single day. With some simple modifications to improve infeed and conveyance, throughput can be easily increased to 2,000 lbs per hour, making it feasible for processing hundreds of thousands of lbs of kelp in just a few weeks. While infeed, conveyance, and mixing technologies will need to be further developed for larger volumes, the system developed through this grant is a promising starting point for small-scale, beginning, or rural farmers seeking to access markets with limited up-front capital expenditures.