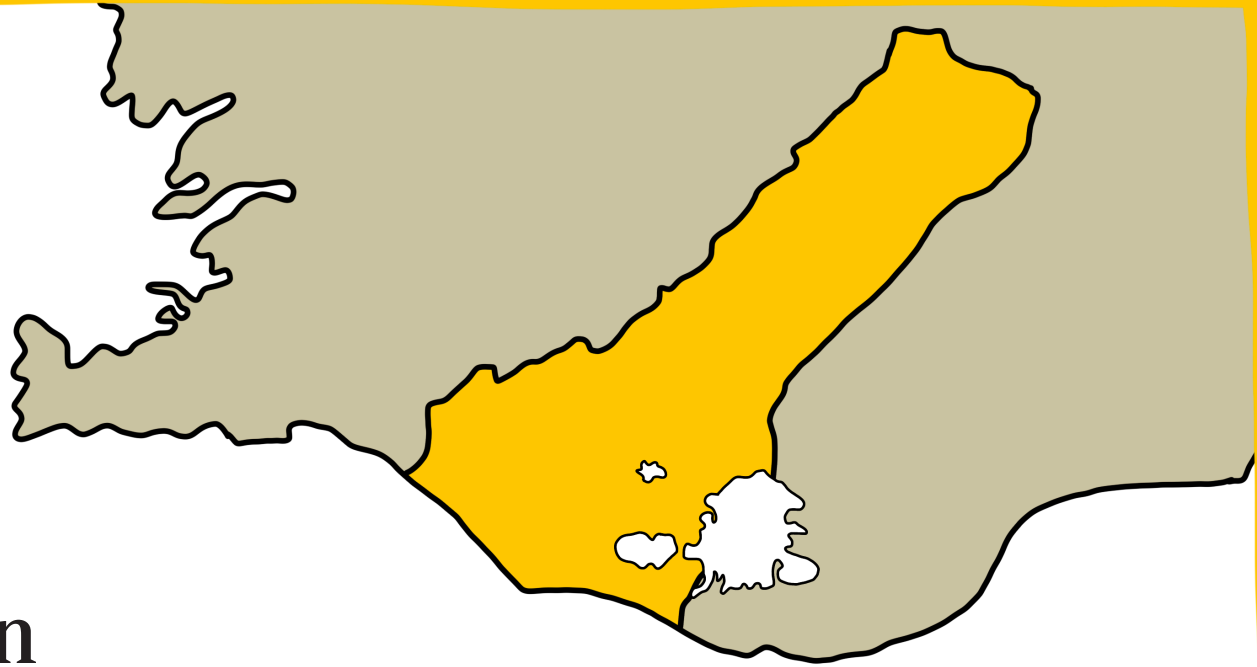

Bokashi composting in Rangárvallasýsla

Composting pilot project with Jarðgerðarfélagið, the Rangárvallasýsla waste-sorting facility, and Landgræðslan

First phase report
January 2021

Abstract

In the summer of 2020, Jarðgerðarfélagið started a pilot project in collaboration with Rangárvallasýsla and the Soil Conservation Service of Iceland (Landgræðslan) to test the viability of bokashi composting for organic household waste in the Rangárvallasýsla county. Bokashi refers to a method of composting in which organic material is broken down and fermented in an anaerobic environment with the help of microorganisms. The main goal of this collaboration was to explore the following questions: 1) is it possible to use bokashi fermentation as a means of treating municipal organic material?; 2) are corn bags a suitable material for collecting organic material?; 3) what are the physical and chemical attributes of the resulting compost?; and 4) what areas of the bokashi process require improvement?

In this project, 3 tons of organic material from the county were collected and divided into five 660L fish tubs for fermentation. Two of the tubs contained corn bags during the fermentation process, two of the tubs had corn bags removed before fermentation, and one tub had corn bags removed and paper bags added, to test paper as a possible alternative for corn bags.

After eight weeks of fermentation, the organic material in four out of five tubs had fully fermented, deeming the bokashi method a success. The nutritional value of the compost proved to be quite promising, with a carbon-to-nitrogen ratio of 15.7, indicating a high nitrogen content. Fresh bokashi compost contained 1% nitrogen. The average pH of the compost was 5.46, indicating acidic conditions that would suppress potential pathogens, making the compost itself safe and environmentally friendly. Corn bags did not break down during the bokashi process, and the work of removing them and other inorganic material proved to be a significant hindrance in processing efficiency. Paper bags had no issue breaking down.

Overall, bokashi composting proved to be a promising and efficient way of treating organic material. Nonetheless, there are opportunities for improvement both in residential waste sorting and in on-site processing, primarily via the following suggestions: 1) reducing the amount of corn bags and inorganic material that falls into the organic bin by adjusting home-sorting procedure; and 2) purchasing a motorized pulverizer to homogenize the organic material before fermentation, thereby ensuring a more consistent input and output. With these changes, the processing capacity of bokashi composting could be notably increased, making it a viable method in this and other municipalities.

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Introduction

Jarðgerðarfélagið is a composting company that uses a composting/fermentation method called "bokashi" to process organic material. In the summer of 2019, Jarðgerðarfélagið, Rangárvallasýsla, the Rangárvallasýlsa waste-sorting facility, and the Soil Conservation Service of Iceland (Landgræðslan) began outlining a plan to assess the viability of bokashi composting for: a) treating organic household waste throughout the county, and b) using the end-product as a fertilizer in soil reclamation projects. This assessment would take place in three phases, with the first phase commencing in the summer of 2020. In addition to the aid provided by Rangárvallasýsla and Landgræðslan, the project also received grant funding from the Women's Employment Fund (Atvinnumála Kvenna) and a donation of materials from Agriton UK.

The research questions for this first phase were:

- Is it possible to use bokashi fermentation as a means of treating municipal organic material?
- How much inorganic material ends up in the organic waste stream?
- Are corn bags (PLA plastic) a viable choice in bokashi composting? Would paper bags be better?
- How much of the bokashi inoculants are required for successful fermentation?
- What is the nutritional value of the resulting fermented compost?
- What is the loss of weight, following fermentation?
- How long can the fermented material be stored?
- How can the process be made more efficient?

The project board consisted of Ágúst Sigurðsson, Hulda Karlsdóttir and Ómar Sigurðsson of the Rangárvallasýsla and the waste-sorting facility, Magnús H. Jóhannsson of Landgræðslan, and Björk Brynjarsdóttir of Jarðgerðarfélagið.

A brief note

In this report the term "organic material" is used to describe what is often called "food waste," "garden waste," or "kitchen waste." This material is only "waste" when it is treated as such. In reality, when composted, organic material is a valuable resource, a nutritious fertilizer.

Sending organic material to landfills establishes a linear system: soil supports vegetation, vegetation is harvested, vegetation is landfilled. This not only causes greenhouse gas (GHG) emissions in the form of carbon dioxide (CO_2) and methane (CH_4), but it also abandons an opportunity to create a valuable, domestic, organic fertilizer. Instead, reliance on synthetic fertilizers means more mining, manufacturing, shipping, and transporting. The resulting fertilizer does little to improve the soil's microbiome. The linear system highlights lost opportunities, whereas a circular system can utilize organic material as a locally produced fertilizer.

There is value in organic material -- it can be used to improve soil health, increase cultivation yields, aid in revegetation and forestry, and contribute to overall ecosystem health.

It is with this spirit and appreciation for organic material that the collaboration among Jarðgerðarfélagið, Rangárvallasýsla, and Landgræðslan emerged.

What is bokashi?

Bokashi is a method of composting organic material via fermentation in an anaerobic (zero-oxygen) environment. The method was discovered and established by Dr. Teruo Higa in 1980, and has since been developed for home use/personal gardens and agriculture.

In home composting, the bokashi process begins by inoculating the raw organic material with a mix of effective microorganisms (EM) consisting of: photosynthetic bacteria, lactobacilli, yeasts, and actinomycetes. After inoculation, the material is sealed in an anaerobic container and left to ferment for about 2 weeks.

Larger bokashi composting, such as in a municipal context, begins similarly with EM inoculation, but also includes the addition of seashell grit (to regulate pH) and clay (to bind nutrients and form aggregates). The fermentation period is longer than in home composting, requiring 8 weeks.

In both small- and large-scale bokashi composting, once the sealed fermentation process has begun there is no need for further intervention. This "hands-off" period minimizes the amount of land and energy required for processing organic material.

Bokashi treatment also produces minimal-to-zero emissions. The fermentation process suppresses pathogen activity, and the airtight containers prevent the release of carbon (C) or nitrogen (N) in their gaseous forms of CO_2, CH_4, or nitrous oxide (N_2O). With no airborne losses, the finished product is rich in mineralized nutrients which can slowly release into the soil following application as a fertilizer.

Compared to landfilling, bokashi treatment can reduce GHGs by up to 99%. Table 1 further elaborates the diverted GHG potential of bokashi when compared to landfilling with methane capture, as well as traditional aerobic composting. This table only accounts for the on-site emissions of organic material while under these treatment processes, and does not include externalities such as transport emissions or carbon sequestration potential from fertilizer use.

Though bokashi composting has been used on small scales, for home use or on farms, it has yet to be applied in a larger context. The collaboration among Jarðgerðarfélagið, the Rangárvallasýsla waste-sorting facility, and Landgræðslan is the first in the country to develop a municipal bokashi treatment process for organic household material. The success of this project would provide an opportunity for Rangárvallasýsla to process organic material and utilize the resulting compost within their county, creating a self-sustaining, environmentally friendly alternative to outsourcing organic material processing.

	Tons CO_2-eq released per ton of organic material	Organic material generated in Rangarvallasýsla annually (tons)	Tons CO_2-eq released by organic material in Rangarvallasýsla under respective processing scheme	Reduction of CO_2-eq emissions versus landfilling
Landfilling	1.900[a]	104	197.6	0%
Landfilling with methane capture	1.170[b]	104	121.68	38%
Aerobic composting	0.172[c]	104	17.89	90%
Bokashi composting	0.026[c]	104	2.7	99%

a - Food waste greenhouse gas calculator; b - IPCC, 2006; c - Bosch et al., 2015

Table 1: Carbon dioxide equivalent (CO_2-eq) emissions of organic material from Rangárvallasýsla processed under different conditions. Note this table refers only to on-site emissions from organic material, and does not account for e.g. fuel usage in transport.

Methods

Current state

The Rangárvallasýsla county began sorting and collecting organic household waste in 2019. Residents would separate organic material from non-organic material, and place it in a small container (e.g. in their kitchen) lined with a corn bag. Items permitted into the "organic material" stream consisted primarily of leftover food and food items such as fruit rinds, cooked meat and fish, bread, coffee grounds, wooden toothpicks, tea bags, etc. Certain food items, such as large bones or raw meat, and inorganic items, such as plastic bags or cutlery, were not permitted in the organic stream. Once full, corn bags would be thrown into a small brown bin attached to the inside of the general landfill-waste barrel for pick-up. The contents of this brown bin would be collected by the county every two weeks. Every few weeks, the collected organic material would be transported to Terra, an industrial composting facility in Hafnarfjörður.

Start of pilot project

The pilot project began in July 2020 at the waste sorting facility, Strönd, in Rangárvallasýsla. The county purchased five 660L-capacity fish tubs with insulated lids for the anaerobic fermentation process.

The raw organic material was collected from residences during the week prior to the start of processing, and processing took place over three days during a two-week time period. The raw organic material was shoveled into the fish tubs using an excavator. At this stage, the individual fish tubs were separated into different sorting treatments so as to better analyze the break-down of corn bags under bokashi conditions. Three different sorting treatments were implemented:

- Corn bags left in organic material during fermentation (two fish tubs, CB1 and CB2)
- Corn bags removed prior to fermentation (two fish tubs, NB1 and NB2) (Image 1)
- Corn bags removed and paper bags added prior to fermentation (one fish tub, PB)

Once sorted, the raw organic material in the fish tubs was treated with liquid inoculant (3L/tub), seashell grit (10.8kg/tub), and edasil clay (12kg/tub). Each of the five fish tubs were filled to around 98% capacity, totaling about 3 tons of raw organic material. Digital thermometers were placed inside two of the fish tubs, and were programmed to measure internal temperature every 30 minutes.

Fish tubs were then sealed, weighed, and stacked on top of each other, with a large stone slab topping the uppermost tub. Thirty minutes after sealing, two of the tubs began to bulge due to over-filling, leading to leakage from the lids. The bulging tubs were reopened, 10-20kg of raw organic material was removed, and the tubs were then resealed. This was the only instance of bulging during the remainder of the project. At this point, tubs were left to ferment for an 8-week period.

Post-fermentation and sampling

Eight weeks later the fish tubs were re-weighed and opened. Determination of successful fermentation relied on visual and odor assessment. Fully fermented bokashi compost should smell somewhat sour and vinegary, but not rotten or foul. The organic material itself should not have changed significantly in appearance, with many food items still being somewhat recognizable -- similar to the visual difference between a cucumber

Image 1:
A tangle of corn bags is removed

Image 2:
The surface area of tub (NB2) post fermentation

Image 3:
Compost being sifted

and a pickle. White mold or mycelium are also a sign of success (Image 2), whereas black or green mold is indicative that putrefaction may have begun. Four out of the five fish tubs successfully fermented, whereas one began to develop a foul odor and dark mold.

Of the four successfully fermented tubs, three were further processed for analysis. The contents of these tubs were pushed through a 40mm steel mesh sieve using a 60cm steel squeegee (Image 3). Two samples were taken from each sieved tub (totaling 6 samples), and were sent to Efnagreining ehf for nutrient analysis.

Establishment of experimental plot

Due to seasonal limitations, a comprehensive study site was not created in full. Instead, a small planting experiment was created to offer a rough examination of bokashi compost as a fertilizer.

In early October, one month after the material had been sieved, birch saplings were planted in a degraded sandy-gravel soil site near the waste-sorting facility in Rangárvallasýsla. In total, 240 saplings were planted with varying fertilizer treatments. Forty-eight saplings were fertilized with bokashi compost, 48 were fertilized with chicken manure, 48 were fertilized with a bokashi compost-chicken manure mixture, and 96 received no fertilizer at that time. In the spring of 2021, 48 of these unfertilized saplings will have synthetic fertilizer added.

Results

Chemical analysis and interpretation

Temperature readings during fermentation

Shortly after the fish tubs were sealed, temperatures rose to just over 20° C (Figure 1). One week later, the temperature dropped back down to 13-14° C, where it remained. This is a good sign that the environment within the tub maintained a livable temperature for the active microorganisms, and did not begin to rot or decompose (as would be indicated by higher temperatures). The thermometers themselves reached data capacity after a month of readings. In future projects, the thermometers will be programmed to take measurements at less frequent intervals, ensuring values for the entire fermentation time period.

Moisture content (MC)

The bokashi compost moisture content was 64.5-67.7% (Table 2), a higher moisture content than the 40-50% commonly found in conventional composting. A high moisture content in this case is a good indication that the added microorganisms had a good medium for mobility, and that the tubs themselves were well-sealed, preventing any evaporative moisture loss. The drawback of a high MC is that the compost itself is heavier and harder to spread, though it does have a reduced risk of blowing away in high winds.

pH
Bokashi compost in this trial was quite acidic, as was expected, with an average pH of 5.46. The acidic conditions of the compost are a favorable indication that pathogens were suppressed during the fermentation process. Using acidic compost as a fertilizer is generally acceptable, but care should be taken per ecosystem depending on its regular in situ pH, so as not to disrupt or burn plant roots following application. If the pH of the compost is too acidic, it can be raised by adding more seashell grit, or other alkaline products.

Organic matter (OM)
Organic matter made up 90.5-93.3% of the compost's total dry weight. In conventional composting, this value ranges from 50-70%. The high values in this instance are due to the input source, kitchen waste, which is generally low in mineral-heavy products. High

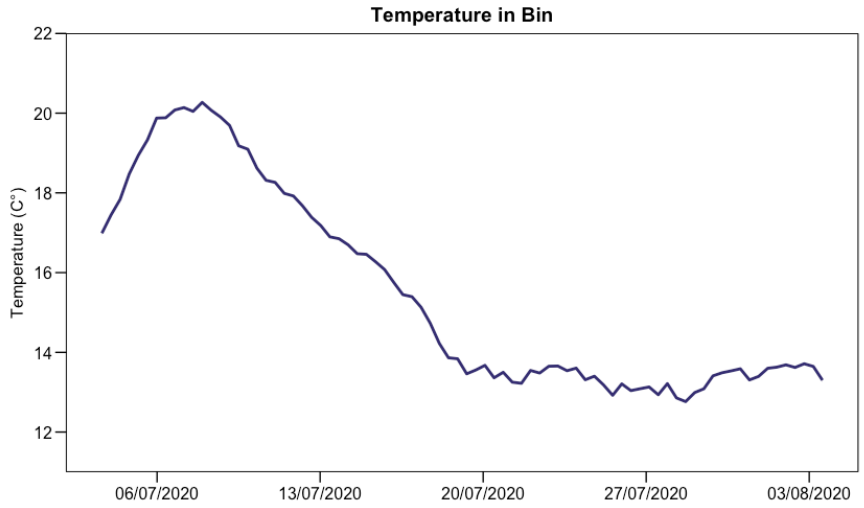


Figure 1: Temperature in fish tub from July 3, 2020 to August 3, 2020

OM can be quite useful for degraded sandy-gravel soils, which have very low content of OM due to erosion. In conjunction with the high MC, high OM also has the potential to increase the water holding capacity of sandy-gravel soil, which struggle to retain water due to large pore spaces and reduced water-binding surface areas. With such a high OM, however, it is crucial to ensure full fermentation of the product before application to the soil, so that it does not begin to rot in the area it is applied.

Carbon-to-nitrogen (C:N) ratio
The C:N ratio of the bokashi compost was 15.7 -- for every 15.7 units of carbon (C), there was 1 unit of nitrogen (N). Composts that are made primarily from kitchen waste typically have a C:N ratio from 10-15, as food items are high in nitrogen. The C:N ratio for compost made from yard waste tends to be higher, around 20. A low C:N ratio and high N content

	pH	C:N ratio	C	N	P	Conductivity	OM	Moisture
			%	%	g/kg	mS	%	%
Bin 1								
I	5,85	16,7	43,4	2,60	11,0	3,04	92,2	66,3
II	5,74	16,6	41,7	2,52	10,6	3,63	92,2	67,9
Bin 2								
I	5,25	14,9	44,1	2,95	10,3	4,25	93,6	67,7
II	5,44	15,4	40,1	2,61	7,8	3,17	90,5	63,8
Bin 3								
I	5,20	14,2	38,9	2,74	9,2	4,31	90,0	62,8
II	5,31	16,4	44,2	2,69	13,7	3,03	92,9	64,4
Mean	**5,46**	**15,7**	**42,1**	**2,69**	**10,4**	**3,57**	**91,9**	**65,5**
Std. dev.	*0,27*	*1,03*	*2,20*	*0,15*	*1,97*	*0,59*	*1,40*	*2,13*

Table 2: Select physicochemical characteristics of the bokashi compost. Carbon (C), nitrogen (N), phosphorus (P), and organic matter (OM) are all based on the compost dry-weight. Moisture content (Moisture) is based on compost wet-weight.

is desirable for fertilizer use, but too much N in compost can run the risk of leaching or destabilizing the end-product, making it more likely to rot after fermentation. Therefore, straw, sawdust, and/or other high C materials should be added to the raw organic material in future iterations to increase the C:N ratio and stabilize the end product.

Total nitrogen (N)
Total N of dried compost was 2.69%, equating to about 1% N in wet, fresh compost. This amount accounts for both organic and inorganic forms of N, though only inorganic forms are available to plants. On average, about 95% of total N in soil is estimated to be in organic forms. Nitrogen-fixing microorganisms within the soil or compost can digest organic N, converting it into inorganic forms -- ammonium (NH4), nitrite (NO2) and nitrate (NO3) -- which are available for plant uptake. In this case, >2% total N in dry weight compost indicated a healthy, stable supply of organic N, which microorganisms can steadily convert to inorganic N over time. Slow, microbial release of inorganic N reduces the need for synthetic N fertilizers, and limits the risk of N leaching into waterways.

Discussion

The primary question of the pilot's first phase was simply, "Is it possible to use bokashi fermentation as a means of treating municipal organic material?" The answer is: Yes.

Before the pilot was carried out, there was concern that the age of the organic material (1-3 weeks) and the lack of a mechanical pulverizer would lead to an early onset of aerobic decomposition before fermentation could be established. The risk of non-fermented organic material would mean a rotted, unusable end-product. Despite these concerns, the organic material successfully fermented in four out of five bins.

The first phase of the project utilized minimal tools, with the aim of learning how the process could be carried out in its most basic form. The next phase(s) of the project will aim to determine the most efficient, thorough means of processing, with the most consistent results possible.

How well was organic material sorted?

Overall, organic/inorganic material was well sorted by residents. Nonetheless, inorganic material did make its way into the organic bins, including: aluminium foil, coffee pods, plastic containers, ear swabs, plastic toothpicks, glass jars, plastic bags, plastic sausage wrappers, and cutlery.

Two practical theories as to why these unwanted materials end up in the organic bin have been established: 1) The location of the organic bin inside the home -- if it is near to the larger rubbish bin, it is easy for material to accidentally fall into one or the other; 2) The location of the organic bin outside of the home -- its placement within the larger landfill bin makes it easy for landfill-destined material to fall into the smaller, organic bin.

However, it ultimately comes down to basic human error: there is no such thing as 100% success, all humans are capable of accidents, misplacements, or moments of distraction. Nevertheless, there are ways to reduce human error and improve the sorting process so that mis-sorted material does not cause issues during treatment and compost application. Suggestions for sorting improvements are outlined in the "Next steps" section of the report.

Are corn bags (PLA-plastic) a viable option for bokashi composting?

No. Although corn bags are labeled, broadly, as "compostable," they would be better described as "conditionally compostable." PLA-plastic only decomposes in industrial composting conditions, in which the compost reaches temperatures exceeding 50°C. In all other environments (landfill, home composting, bokashi composting, littered in the sea or on land), these bags take as long as plastic to break down: 100-500 years. The corn bags that remained in the fish tubs during the fermentation process did not break down, and confirmed that they were not a suitable option for organic material collection for bokashi composting.

Conversations with residents elucidated other potential drawbacks of corn bag usage. Corn bags are prone to tearing if they are dry, or prone to leaking when they are wet, making them too messy to tie up and bring outside. Therefore, residents often take the entire bin outside to dump the contents into the brown bin. When the corn bags get wet they become stretchy and elastic. In addition to being messy, this makes them a tangling hazard for any pulverizer or homogenization machinery that may be used in the future.

This first phase of the pilot project did not include any machinery; instead, corn bags and inorganic material was hand-picked out of the tubs either before or after fermentation. For every 660L fish tub that was filled with organic material, one entire 120L trash bin was filled with corn bags and inorganic material. Of the entire bokashi treatment, hand-picking corn bags/inorganic material was by far the most time-consuming task (Table 3). While it was technically effective in removing large amounts of unwanted material, it is not a sustainable means of processing organic material. It is both time and energy-intensive, and poorly sorted material could be a hazard to machinery, such as a pulverizer, and to the finished compost.

	Net weight (kg)	Hours to process material pre-fermentation	Hours to process material post-fermentation	Total hours to process material	Hours required to process one ton of material
CB1	650	2	13,5	15,5	23,8
CB2	590	2	13,5	15,5	26,3
NB1	600	5	5	10	16,7
NB2	610	5	5	10	16,4
PB	640	5	5	10	15,6

Table 3: Time required to process organic material based on different treatments: corn bags left in organic material, and removed after fermentation (CB1, CB2); corn bags removed prior to fermentation (NB1, NB2); corn bags removed prior to fermentation, and paper bags added (PB).

Are paper bags a viable option for bokashi composting?

Yes! Paper bags are an excellent choice in bokashi composting. The paper breaks down, and also adds carbon to the mix, helping to raise the carbon-to-nitrogen (C:N) ratio and stabilize the finished product. There is, however, the potential to establish a sorting system that requires neither corn- nor paper bags, as will be discussed in the "Next steps" section of this report.

How much of the inoculant is needed for successful fermentation?

Typically, 1000L of freshly sorted organic material would require 2L of liquid microorganisms, 10kg of edasil clay, and 10kg of seashell grit for successful fermentation. However, because the organic material in this study was 1-3 weeks old, it was important to increase the inoculant amounts and ensure that the anaerobic bacteria had a strong chance of establishing dominance in the tubs. Therefore, each 660L tub received 3L of the liquid effective microorganisms, 12kg of edasil clay, and 10.8kg of seashell grit.

Is there any loss of weight following fermentation?
Weight loss was minimal. Loss of weight was determined by comparing tub weights before and after fermentation. Average weight loss averaged about 43.75kg, or a loss of 6.6%.

Does the compost store well after fermentation?
Bokashi compost is very stable while it remains in anaerobic conditions. Due to the high nitrogen (N) content of these pilot tubs, the fermented raw material was less stable once the tubs were opened and interacted with oxygen. Increasing the C:N ratio to 20 would ensure a more stable product that would be less sensitive to the opening and closing of the fish tubs, following fermentation. Additionally, sorting and homogenizing the material before fermentation would circumvent the need to sift through the compost after fermentation, further reducing oxygen exposure and increasing shelf life.

Next steps

The next phase of this pilot project will involve shortening the processing time and increasing efficacy of fermentation to produce consistent, usable, compost. This phase will be addressed from two angles: 1) the user - improving home-sorting; 2) the process - improving processing equipment.

Home Sorting Improvements
Before processing can be addressed, it is important to consider the upstream inputs that lead to processing delays. Accidental additions of inorganic material, or use of corn bags, both hinder the processing capacity down the line. Therefore, the next phase will include a user-oriented approach to addressing these speed bumps.

The proposed experiment will require the collaboration of volunteer residents, who will opt in to test out a new sorting approach. This will include ongoing interactions between Jarðgerðarfélagið and participants, so that feedback can be swiftly addressed. Participants will be given two or three 10-20L airtight buckets for sorted raw organic material, as well as liquid inoculant and a spray bottle. Upon adding organic material to their buckets, participants will spritz the raw material with the liquid inoculant, starting the fermentation process at home (Image 4).

This adjustment encourages the user to slightly slow themselves down when making decisions regarding their rubbish. If they have to stop for a moment and think about spritzing inoculant on the contents of the bucket, it will likely make the addition of inorganic materials seem more obvious and less prone to accidental inclusion. In addition to reducing the amount of inorganic material that may make its way into the bucket, it will also reduce the number of trips that participants must take to their outside barrel. Instead of 1-3 trips/week, it would be as little as one trip every 1-2 weeks. The airtight bucket will prevent any unwanted odors, and make corn bag usage obsolete.

Once the bucket is full, participants will take it outside and place it next to their other bins. Rather than dumping the organic material into a hanging bin within the landfill bin, it will remain separate. At this point, volunteers will contact Jarðgerðarfélagið and schedule a pick-up. This will be done separately from the municipal waste pick-up, so as not to burden the county during the experiment.

The improvements to home sorting will benefit both the participants and the bokashi process:

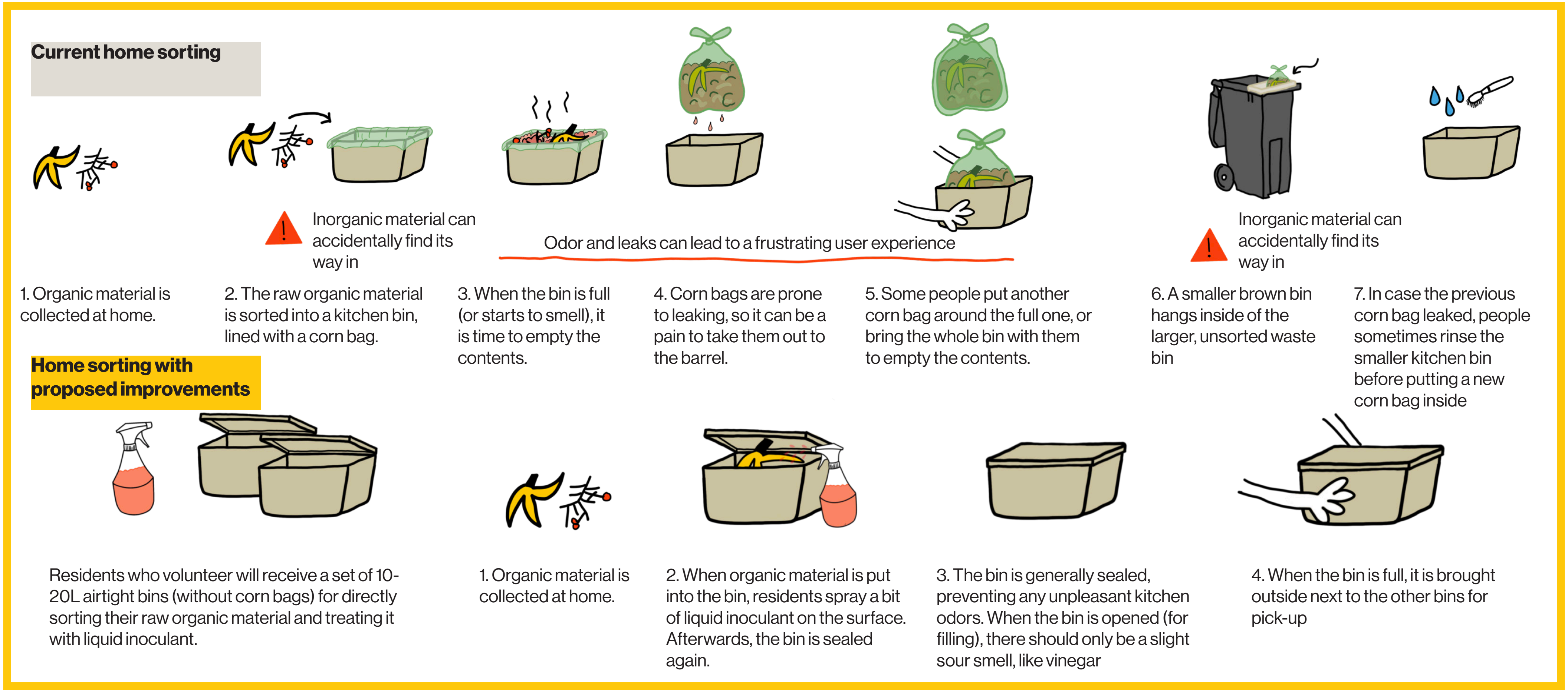
Benefits for participants

- Reduced odor from organic materials that would otherwise begin rotting
- Fewer trips to outdoor bins
- Reduced spending on corn bags, and no risk of bags leaking
- Personal impact on local environment
- Increased confidence in home sorting procedures

Benefits for bokashi processing

- Reduced amount of inorganic material in organic bins
- Absence of corn bags
- Earlier start of fermentation reduces risk of putrefaction and failed fermentation
- Shortens overall processing time at waste sorting facility

Image 4: Current home sorting versus home sorting with proposed improvements



Processing Improvements
Installation of new processing tables will increase the efficiency and ease of the pre-fermentation sorting procedure, which in turn will speed up post-fermentation sorting (or remove the need for it entirely). Additionally, a recently acquired pulverizer will be put into action for the next batch of composting. The pulverizer will help to homogenize the raw material, creating a larger, more consistent surface area for the inoculant to interact with. This will increase the likelihood of successful fermentation, and create a more consistently-sized end product (Image 5).

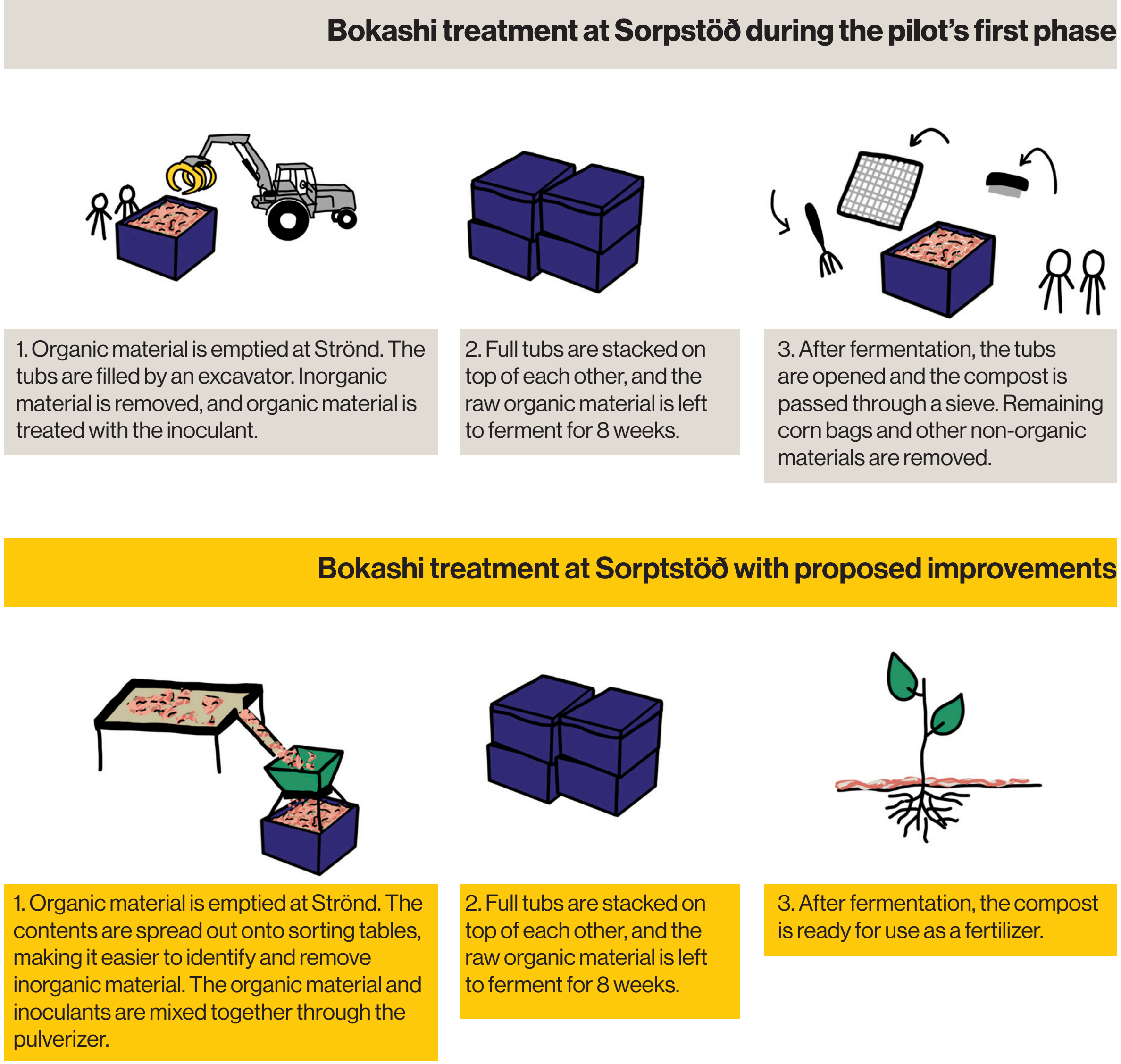
Overall Impact
Home-sorting and processing improvements will significantly shorten the time required for processing raw organic material, and make bokashi composting a viable option for Rangárvallasýsla. Rather than transporting the organic material to Hafnarfjörður, the material will be processed locally, reducing the carbon footprint. Furthermore, using the resulting organic compost as a fertilizer within Rangárvallasýsla lessens the need for imported fertilizer, and can improve soil health and its carbon storage capacity.

Conclusion

The first phase of the pilot project was undoubtedly successful. Raw organic material was fully fermented and the compost was rich in nutrients.

There are opportunities to further improve and streamline sorting and fermentation, and deliver a more stable, consistent fertilizer as an end product. Purchasing a pulverizer and reducing the amount of inorganic material that gets sorted into organic bins will notably speed up the process. Further discussions with project management and residents of Rangárvallasýsla will help to map the necessary steps towards achieving these goals.

Image 5: Bokashi treatment at Sorpstöð during the pilot's first phase versus with proposed improvements



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