Bulker Ratio for composting food waste:

Efficient composting requires of any material requires a moisture content of 45-60% (ideally 45-55%) and sufficient structure to permit effective aeration. In the HotRot system this means sufficient structure so the material can be lifted and turned by the tines on the shaft and allow air to be injected from below. Thus, food waste, seaweed and manures will need to be combined with a bulker/amendment.

Food waste typically as a moisture content of approximately 85% (80-90%) and there are two ways this can be dealt with:

1. Compost the food waste as received, and after draining any free liquid, with a large amount of bulking agent; **or**
2. Reduce the moisture content of the food waste by mechanical dewatering (squeezing) excess liquor and juice from the material.

As can be seen from the Table below the drier (lower the moisture content) of the food waste, then the less bulker is needed to mix with the waste to meet a target moisture content of 55% for the combined material prior to composting. Similarly, the drier the bulking agent the less of that is required.

Ratio of Bulker to Waste to provide a mix with appropriate moisture content and structure.

Food waste / sludge moisture content (% w/w)	Moisture content of wood bulker (% w/w)									
	10	15	20	25	30	35	40	45	50	55
55	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
60	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.30	0.50
65	0.20	0.20	0.20	0.25	0.30	0.33	0.45	0.55	0.70	1.50
70	0.33	0.33	0.33	0.45	0.51	0.51	0.60	0.70	1.10	2.00
75	0.40	0.40	0.50	0.57	0.65	0.75	0.85	1.20	1.75	3.00
80	0.50	0.55	0.60	0.70	0.80	0.90	1.20	1.50	2.10	4.00
85	0.55	0.60	0.70	0.80	0.95	1.15	1.30	1.75	2.60	5.00
90	0.70	0.80	0.90	1.00	1.20	1.40	1.60	2.00	3.00	7.50
95	0.80	0.85	0.95	1.10	1.35	1.60	1.85	2.50	4.00	9.00

Ratio of bulker to food waste needed to achieve a mix with 55% moisture

GLOBAL COMPOSTING SOLUTIONS LIMITED

PO Box 4442 Christchurch, New Zealand

p: +64 3 3778822 w: www.globalcompostingsolutions.com e: info@globalcomposting.com

What are Bulking Agents:

Bulking agents are woody materials (wastes) that help absorb moisture but also increase the space between particles (bulk the waste) to permit efficient aeration and agitation.

Woody materials such as untreated wood chips and bark, or shredded woody vegetation such as prunings are all appropriate bulker materials (see the accompanying document: *Amendments & Bulkers 2024*). Lawn (grass) clippings and leaves do NOT act as bulking agents as they do not retain their structure; these materials also do NOT reduce the moisture levels of the waste (indeed lawn clippings are often wet with a moisture content of 75-85% so behaves more like food waste)

There are materials that can help absorb moisture, but these do Not add bulk to the material and so cannot wholly replace woody materials, we call these materials amendments. Amendments include fine sawdust, paper and cardboard.

It is important to note the any wood, bark or woody green waste must be shredded or chipped to less than 50mm in size and ideally 10-30mm. These materials should also be kept as dry as possible both before, but critically after, shredding or chipping, failure to do so will reduce their effectiveness at reducing overall moisture levels in the material to be composted.

Understanding moisture content:

Moisture content is the opposite to “dry solids”, if we say 1.0 tonne of something has a moisture content of 85% it means it comprised 850kg of “water” and 150kg of dry matter, if the material is dried completely).

When we add two materials together, such as food waste and bulker, then the mixed material will have an average moisture content of the two materials combined. Moisture content is the % by weight of material that is “water”. For instance:

- 1.0 tonne of food waste at 85% moisture is 150kg of dry matter and 850kg of “water”.
- 1.0 tonne of bulker at 25% moisture is 750kg of dry matter and 250kg of “water”.
- When we combine the two materials, we will have 2.0 tonnes of material with 900kg (150 + 750kg) of dry matter and 1,100kg (850 + 250kg) of water.
- The combined moisture content of these two materials is 1,100kg divided by 2,000kg (2.0 tonne.
    - This equals 1100/2000 = 0.55
    - 0.55 x 100/1 = 55%

As you can see in this example 1-part wet food waste at 85% moisture, plus 1-part bulker at 25% moisture yields a mix with an equivalent moisture content of 55%, which is within the acceptable input moisture level for effective composting.

Reducing the moisture content and therefore amount of bulker required.

There are essentially two ways to reduce the moisture content of waste, we can thermally dry the material, or we can mechanically dewater (squeeze the material). While thermal drying, why allow us to produce a dryer material it also uses a lot of energy. This is why units that claim to produce a product (dehydrators) will use a lot of power.

The second and most efficient way to reduce the moisture content of something like food waste is to squeeze the material (mechanically dewater). Mechanical dewatering uses minimal electricity (power) and importantly reduces the overall mass of the material to be composted.

Going back to our example above:

- 1.0 tonne of food waste at 85% moisture is 150kg of dry matter and 850kg of "water".
- When we squeeze the material, we do not significantly alter the amount of dry matter, but we reduce the "water" content.
- Mechanical dewatering of food waste can readily achieve a product with 70% moisture content (75% if predominantly meat).
    - After dewatering we will still have 150kg of dry matter, but we will only have 2.33 times this amount of water (70/30 – the ratio of water to dry matter at 70% moisture.
    - Thus, we only have 350kg of "water".
    - 350kg of water plus 150kg of dry matter now means we have 500kg of product at 70% moisture. We have **halved the mass of the food waste to be composted.**

If we look at the earlier table and look across from "food waste / sludge moisture content" to moisture content of wood bulker at 25% moisture you can see that the ratio of bulker to food waste is now 0.45:1.

The impact of mechanical dewatering is therefore two-fold.

- It reduces the mass of food waste to be composted, and
- It reduces the mass of bulker need to achieve a mix with an average moisture content of 55%, suitable for composting.

In the example above, without dewatering we need a ratio of bulker to wet food of 1:1 and thus need a composting plant capacity of 2.0 tonne. With mechanical dewatering we need a composting plant capacity of 725kg

- 1.0 tonne of wet food waste at 85% moisture, becomes
- 500kg of "dewatered" food waste at 70% moisture, which needs
- 225kg of bulker (500 x 0.45)
- 500 + 225 = 725kg

Pros and Cons of Mechanical Dewatering:

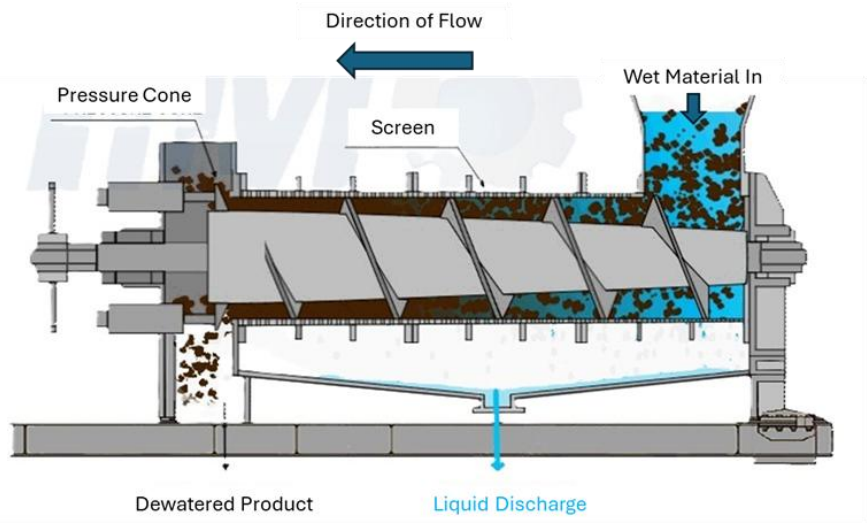
The advantages of mechanical dewatering are the size or capacity of the composting plant is reduced, and the amount of bulker required significantly less.

However, it must be remembered that the "water" released by mechanical dewatering will require some form of treatment or disposal. In some cases (i.e. arid climates), the liquor may be able to be used to compost moisten storage or maturation windrows/piles, in other situations the liquor will need to be discharged to a wastewater treatment plant. The volume of liquid is equivalent to the mass reduction of the food waste during dewatering; in the above example 500kg.

The dewatering unit Global Composting utilises incorporates a 1.0mm aperture screen meaning liquor is filter to this particle size. Finer screens down to 0.5mm can be used but these reduce the throughput of the dewatering system. Additionally, we can install an additional (separate) 200-micron (0.2mm) to further filter the liquor prior to disposal but this separates out a wet sludge that still needs disposal but can reduce the liquid BOD loading at the WWTP.

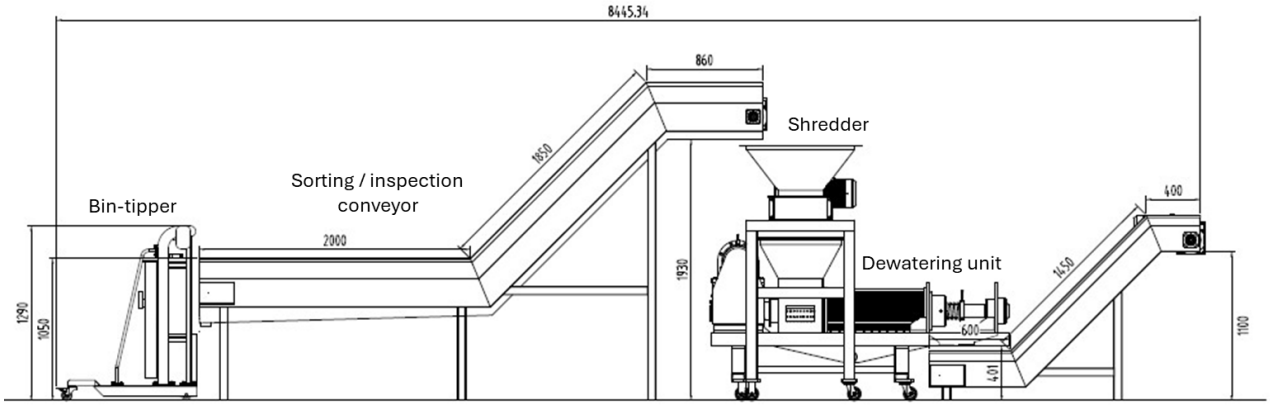
Principles of Operation:

A dewatering screw press incorporates a rotating screw (auger) within a perforated drum (screen) inside the body of the unit. At the discharge end is an adjustable pressure cone, this restricts the flow of material through the perforated drum causing compression and excess water to be expelled through the screen.



An Integrated System:

Our dewatering system can incorporate a sorting/inspection conveyor allowing operators to identify and manually remove any gross contaminants from the waste prior to processing. After sorting/inspection, the waste is automatically conveyed to an integrated shredder that sizes the material to promote efficient dewatering by the in-line dewatering screw press. Dewatered product can be discharge to a wheelie bin, bunker, or another conveyor for direct transfer to a HotRot system feed hopper.



Schematic of dewatering system.