AGROCYCLE FACTSHEET

Vegetable waste production and value chains

This information is taken from an in-depth study; “Agricultural production systems and sustainable value chains”, written by the NNFCC as part of the Agrocycle project.

Availability of beet pulp, leaves, and peels

- Sugar beet pulp is by far the largest vegetable (processing) by-product, produced in the EU with an annual production of 57 million tonnes.
  - At least 12 countries produce over 1 million tonnes of sugar beet pulp per year.
- Leaves are the second largest vegetable by-product produced in the EU.
  - 7.2 million tonnes of cabbage outer leaves are annually produced, predominately in Poland and Romania (2010-2013 annual average).
  - 1.9 million tonnes of cauliflower and broccoli outer leave by-products (2010-2013 annual average).
- Potato peel is the next largest vegetable (processing) by-product produced in the EU, accounting for over 3 million tonnes.

1. Availability and Management

Cabbage (left) and sugar beet (right)

Typical Management of vegetable wastes

In general, outer leaves of vegetables are separated from the main product in the field during harvesting and processing, while vegetable residues like pulp and peels, are generally generated in factories.

- Outer leaves make up a large proportion of total cabbage, cauliflower and broccoli crops. Typically, the head is harvested, leaving the outer leaves in the field. In some places, the outer leaves in the field are used as animal feed, by allowing animals to graze the field, while in other places, such as the UK, the leaves left in field are ploughed back into the land.
- Vegetable AWCB like peel and pulp, are produced during processing and thus are easily collected and used downstream in a number of applications, depending on the location and the type of waste generated.

Cost to collect vegetable wastes

- Vegetable residues produced in factories, i.e. potato peel, onion peel, carrot peel, and sugar beet pulp, are collected during processing at a minimal cost.
- Outer leaves, i.e. of cabbage and cauliflower, are typically left in the field as it is uneconomical to remove them. Currently, this appears to be the best option due to the addition of nutrients and organic carbon back to the soil.
  - To make their removal cost effective and at the same time maintain soil health and structure, outer leaves need to go into high value markets, while soil carbon and nutrients need to be a replacement by using compost for example.

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2. Production systems resulting in vegetable waste

Sugar Beet production systems

Sugar beet is a root crop grown in rotation mostly planted in spring and harvested and processed in the autumn/winter. Once harvested sugar beet is transported to a biorefinery to be shredded into cossettes, from which the juice is extracted and then processed, yielding sugar and beet molasses. The residue left behind after juice extraction is known as wet beet pulp. Wet sugar beet pulp has a very high-water content, which limits its use to the vicinity of the sugar factory. In practice, less than 1% of the sugar beet pulp produced in the EU is used as wet pulp. Between 57 and 63% of beet pulp produced in the EU is mechanically pressed, dried and sold as dried beet pulp, or mixed with molasses to form dried molassed sugar beet pulp.

Cabbage (left) and cauliflower (right)

Potato production systems

Potatoes are only planted as a spring crop as it is so sensitive to frost. During potato cultivation, typically all vegetable wastes are returned back into the arable rotation for the benefit of the following crops. However, if processed, a number of residues are produced and are currently under-utilised.

- if processed into chips or crisps, the potatoes are sliced and then cooked, releasing starch, which is often removed by the processors and sold into industry.
- In the case of starch production from whole potatoes, the fibrous pulp left over after starch is removed and often discarded.
- Potato skins are also a processing by-product generated during peeling, and are often disposed of if there are no local animal feed markets willing to take them.

Cauliflower and Cabbage production systems

Brassicas cover a wide range of plants but cultivation mainly focuses on cabbage, cauliflower, broccoli and other hybrids.

Cauliflower are a major vegetable grown for their flowery heads. When heads are exposed ready for harvesting, they can only subsequently deteriorate. Curds are at risk from physical damage which can speed up post- harvest deterioration. The practice of field packing direct into the customer's container leaves trimming waste in the field, typically to be ploughed in to return carbon and nutrients to the soil for the next crop.

In the case of Cabbage, harvesting by hand is currently the only acceptable method. Loose outer leaves are stripped off before cutting commences. These leaves are left in the field and typically ploughed in.

Onion production systems

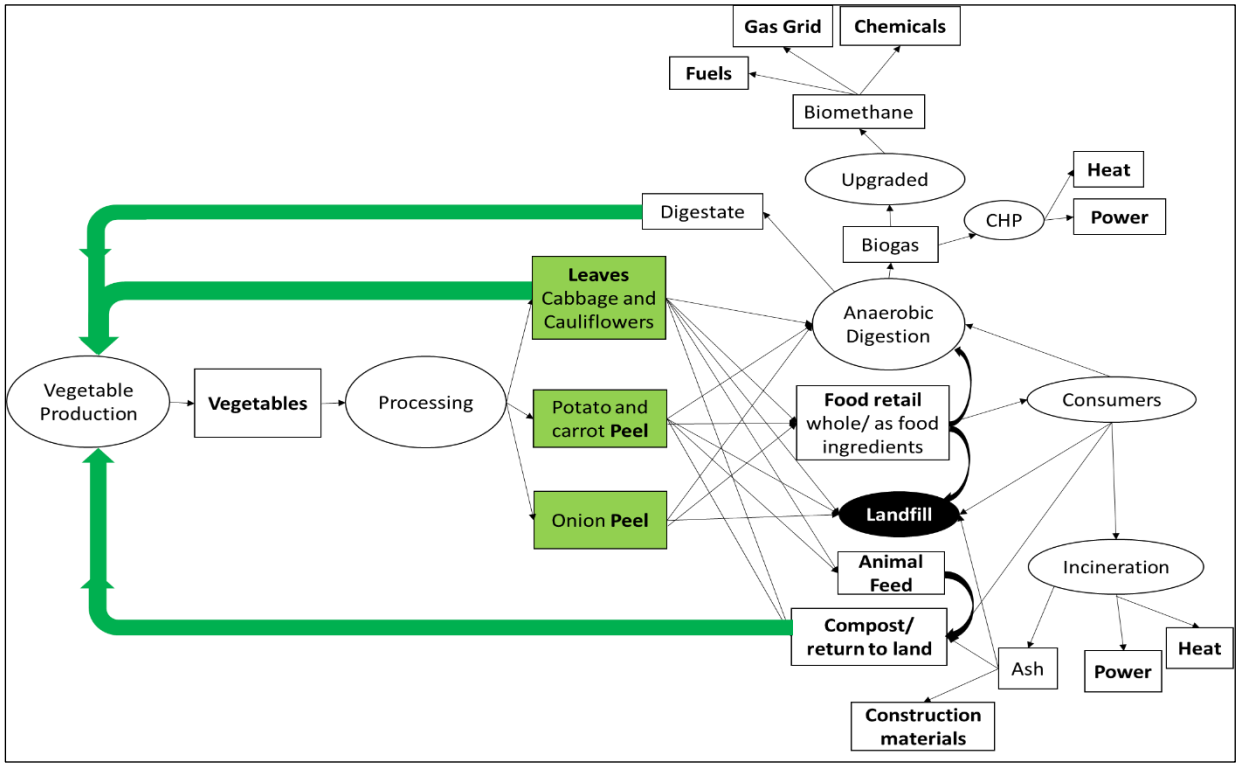
Onions are a popular bulb vegetable grown across Europe, in the same plant family (Allium) as garlic, leeks and chives.

After harvesting, Onions are typically washed to remove soil, and then directed to fresh vegetable markets or for processing into ready made products and soups for example. During processing peel and outer layers are removed and often discarded, as they are not suitable for animal feed.

Carrot production systems

The carrot crop is a major root vegetable across Europe, with the highest levels of production in Poland and the UK.

During processing peel and pomace are generated, equating to roughly 12% of the weight of the carrot. As these AWCB are generated in factories they are collected and require management, typically for animal feed, composting or disposal, and increasingly for AD.



3. Typical value chains

Composting of vegetable waste

Current uses of Outer Leaves

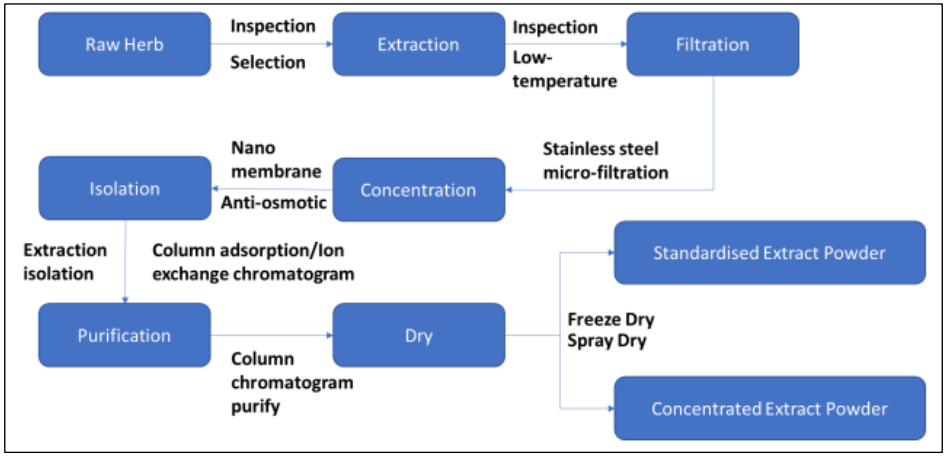
Outer leaves are ploughed back into the land to add nutrients back into the soil, as a common practice, but there are still a large amounts that are destined to landfills. To increase the economic potential of these vegetable waste, higher value markets can be targeted and are listed below:

- Cabbage leaves can be used as animal feed due to their high energy content and digestibility. However, they are low in fibre, phosphorous, magnesium, and trace element, and overfeeding can cause health problems such as iodine deficiency, anaemia, and poisoning.
- The outer leaves of cabbages and cauliflowers are edible. They can be used in soups or other recipes but are often not found in supermarkets or are thrown away by consumers due to lack of awareness.
- Alternatively, outer leaves can be processed via Anaerobic Digestion (AD) or Composting.

Current uses of Vegetable Peels and Beet pulp

The use of peelings and pulp depends on the vegetable it comes from, as their properties are quite distinct. For instance, carrot and potato peel, while onions peel is not suitable for fodder due to their aroma.

- Peelings and sugar beet pulp are often valorised as food ingredients. Potato peel can be used to produce potato flour and starch. Carrot powder is sold as a food ingredient, as a rich source of b-carotene, while sugar beet pulp until recently was used to make dietary fibre for human consumption.
- Sugar beet pulp can also be used as substrate for the production of microfibres, organic acids, special sugars and binding agents, or as filler in the paper industry.
- Alternatively, peels, and sugar beet pulp can be processed via Anaerobic Digestion (AD) or Composting.



Processing of Quercetin extraction from onion skins, by LSHERB in China

Onion waste – A problematic feedstock

Onion wastes are currently one of the more problematic wastes available as they are not used as organic fertilisers, they release phytopathogenic agents that can harm plant growth and cannot be used in animal feed.

Possible solutions could be the extraction of high value compounds from onion peel including antioxidants, dietary fibre, and flavonoids, and their use in various applications such as food ingredients, cosmetics, health-care and pharmaceuticals. One example already on the market is the onion peel extract, Quercetin, which can be used in pharmaceuticals, functional foods, and cosmetics.

4. Constraints and actions for further exploitation

Rabbit with brassica leaf (left), onions and onion peel (right)

Constraints to maximise utilization of vegetable waste

The main issues that hinder the development of high value chains for vegetable waste are that they degrade quickly, they have high moisture content, and they are low in value, all of which make them uneconomical to transport or process. For leaves produced in the field, there is the additional step of their collection, and it is often more sustainable to plough them back into the field to improve future crops.

To increase the value and economic potential of both field and factory vegetable wastes, high value markets need to be targeted, and particularly in human food ingredients, cosmetics, and animal feed. For example, Brassica leaves can used as animal feed, and the pet market is the most lucrative. Rabbit food is sold for around €1-7/kg, and Brassica waste can be included in rabbit mix or sold separately.

Acknowledgements

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