

1.1. The different types of kelp

Seaweed has often been used by coastal populations to improve the physical structure of the soil or to provide nutrients for flower beds. These are often algae washed up on beaches by storms and called wrecked kelp (see Figure 1.1(a)). The latter is very distinct from shoreline kelp (see Figure 1.1(b)) which is present on the foreshore and which is manually harvested during low tides. In addition to these two categories, there is also ground kelp which is harvested by dredging the bottom with boats (see section 2.1). Kelp has often been used as a soil amendment for crops. Depending on the region and time, the algal resource exploited for agricultural purposes has been given various and very different names (see Table 1.1).

Country or region	Old name	Traditional name
Brittany	<i>Gouesmon</i>	<i>Goémon</i>
Normandy	<i>Vraicq</i> or <i>Vraic</i>	<i>Varech</i>
Island of Oleron	<i>Gaymon</i>	<i>Sart</i>
Channel Islands	Vraic	Varech
United Kingdom	Wrack	Kelp

Table 1.1. Examples of the names of the algal resource used historically in agriculture according to regions and the time period (from Lami 1941, Blench 1966 and Desouches 1972)

The purpose of introducing algae into the soil is to change the composition and texture of the soil. This practice of soil preparation was used by the first inhabitants of the island of Aran off the coast of Galway (Ireland) to create a layer of humus necessary for the establishment of food crops (potatoes). This practice has shaped

the landscape of the island, which appears as a succession of plots protected from ocean winds and dedicated to potato cultivation (see Figure 1.2). The stranded algae is preliminarily mixed with sand and sometimes with manure before being spread in the soil.

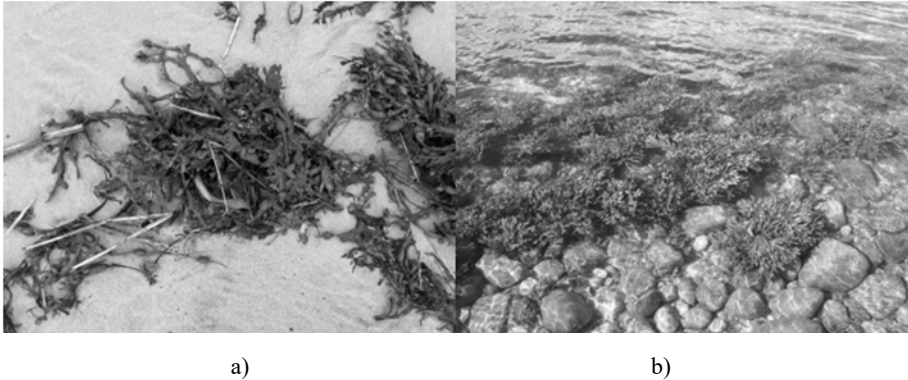


Figure 1.1. Wrecked kelp (a) and shoreline kelp (b) (photo credits © J. Fleurence, 2010, 2020). For a color version of this figure, see www.iste.co.uk/fleurence/algae.zip

This process of amendment is notably evoked in the 1934 documentary film by Robert J. Flaherty, *Man of Aran*¹.



Figure 1.2. Former plots dedicated to food crops on the island of Aran (photo credit © J. Fleurence, 2010). For a color version of this figure, see www.iste.co.uk/fleurence/algae.zip

¹ See http://www.film-documentaire.fr/4DACTION/w_fiche_film/6443.

1.2. Historical applications

The direct use of algae or composted algae for crops is often related to a need for soil amendment and crop fertilization. Seaweed manure was used as early as the 1st century CE for growing cabbage (Craigie 2011). The Roman writer Columella recommended that cabbage plants in the six-leaf stage of development be contacted at the root level with seaweed manure, also used to mulch crops. Another Roman, Palladius, in the 4th century CE, also suggested the early spring application of algal manure to the roots of pomegranate and lemon trees (Arzel 1994; Craigie 2011).

On the English speaking island of Jersey, algae have been used in agriculture since the 12th century (Blench 1966). The algal resource used is referred to as “vraic” or “wrack”, which appears to be a distortion of the French word *varech* or the Old English *wraec* (Blench 1966). The use of this resource by farmers was regulated by a Code of Laws, published in 1771 and supervised by two sworn officers. This code defines, among other things, the number of vraic batches that can be allocated according to the owner’s cultivable land area (see Table 1.2).

Cultivable area	Number of vraic batches
More than 60 borders	6
45–60 borders	5
30–45 borders	4
18–30 borders	3
8–18 borders	2
3–8 borders	1

Table 1.2. Allocation of batches of kelp or wrack (vraic) according to the 1711 Code of Laws of the island of Jersey (from Blench (1966))

In the 19th century, algae were the most important fertilizing agent in the island’s cultural practices. They were mainly used in the form of ash (Quayle 1815) and their use was subject to the seasonality of the crop. In the case of wheat, the vraic ash was spread on the soil before winter plowing (November–December). Summer vraic ash was particularly valuable for wheat cultivation, and many coastal residents increased their income by harvesting drift seaweed and burning it to ash. Until the middle of the 19th century, varieties of algae constituting vraic had not been identified. In 1860, Dally classified the algae used in the process into two categories: “sawn” or cut “vraic”, and “growing vraic” or washed up vraic (see Table 1.3, Blench 1966). For each of these categories, he established a taxonomic identification of the species concerned. The species making up the sawn bulk were mainly pale fucales belonging to the genera *Ascophyllum* and *Fucus*. On the other

hand, the algae constituting the washed up vraic were brown algae of the order Laminariales or red algae such as *Fucus palmatus* (see Tables 1.3 and 1.5).

Sawn vraic (wrack or shoreline kelp)	Washed up vraic (wrack or wrecked kelp)
<i>F. nodosus</i> (<i>Ascophyllum nodosum</i>)	<i>F. lareus</i> (<i>Himanthalia elongata</i>)
<i>F. vesiculosus</i>	<i>F. saccharina</i> (<i>Laminaria saccharina</i>)
<i>F. canaliculatus</i> (<i>Pelvetia canaliculata</i>)	<i>F. digitatus</i> (<i>Laminaria digitata</i>)
<i>F. serratus</i>	<i>F. palmatus</i> (<i>Rhododymenia palmata</i> *)

* *Rhododymenia palmata*; see Table 1.5.

Table 1.3. Algal species constituting the sawn vraic and growing vraic according to Dally (1860) (from Blench (1966))

In France and more particularly in Brittany, kelp has also been used for centuries in agriculture. In 1681, Colbert published a royal decree to regulate the harvesting of shoreline kelp (see article I) and from wrecks (see article V) with the following articles:

Article I “The inhabitants of the parishes situated on the coasts of the sea, will assemble on the first Sunday of January of each year, at the end of the parish mass, to regulate the days on which the cutting of the grass called kelp or vraicq, sart or gousesmon, growing in the sea in the place of their territory, must begin or finish.”

Article V “Nevertheless, let us allow any person to take indifferently at any time and in any place, the vraicq thrown by the waves on the shores and to transport them wherever they want” (Desouches 1972).

In the 19th century, wrecked kelp was a resource often used as fertilizer by coastal populations, whether they were islands or not. The nature of this kelp depended on the algal flora, the topography of the coasts and the strength of the waves, in other words the sheltered or beaten mode which applies to the coastal strip. On the Breton coasts, the wrecked kelp exploited by the populations was mainly composed of *Laminaria*, *Fucus* and *Ascophyllum*. On the other hand, in certain bays with a muddy inlet (e.g. in Belfast Bay), green algae of the genus *Ulva* constitute, almost by themselves, this type of kelp (Sauvageau 1920). The use of kelp on crops by coastal populations also had a phytosanitary advantage at a time when farming practices could not rely on agrochemicals. Indeed, algal manure, unlike farmyard manure, is free of weed seeds, pathogenic fungi and phytophagous insect larvae. This empirical knowledge of the benefits of using algae as a natural crop protection fertilizer has contributed to the development of many market

gardening areas along the European coast. However, the preferred use of wrecked or shoreline kelp may vary by region (see Table 1.4).

Geographical sites	Wrecked kelp	Shoreline kelp	Species	Types of crops
Belfast Bay	++++	–	– <i>Ulva latissima</i> – <i>Monostroma</i> sp. – <i>Enteromorpha</i> sp.	Potatoes
Island of Ré	++++	++	<i>Fucus vesiculosus</i>	– Vegetables – Barley – Wheat – Vine
Island of Noirmoutier	–	++++	<i>Rytidhalea pinastroides</i>	
Islands of Ouessant, Molène, Batz, Sein	++++	–	<i>Laminaria cloustonii</i>	Potatoes
Roscoff	++++	++++	– <i>Fucus vesiculosus</i> or <i>serratus</i> – <i>Ascophyllum nodosum</i> – <i>Laminaria</i> sp. – <i>Himanthalia elongata</i> (Fillit)	– Cauliflower – Onions – Potatoes – Artichokes – Parsnips
Alaskan Shores	++++	–	<i>Alaria fistulosa</i>	Potatoes
Basque Coast	++++	–	– <i>Saccorhiza bulbosa</i> – <i>Cystoseira</i> sp. – <i>Calliblepharis ciliata</i>	Not specified
Breton coasts (except Roscoff)	++++	+	– <i>Laminaria</i> sp. – <i>Fucus serratus</i>	
Danish Coasts	++++	–	Not specified	Potatoes
Irish Shores	++++	–	– <i>Fucus vesiculosus</i> – <i>Ascophyllum nodosum</i> – <i>Laminaria</i> sp.	Potatoes
Japanese coasts	++++	–	Not specified	Rice

Table 1.4. Type of kelp and constituent species used in different regions of Europe in the 19th and 20th centuries for agricultural activities (from Sauvageau 1920) (the names of the algae are those that prevailed at the beginning of the 20th century; some species may have changed names; refer to <https://www.algaebase.org/>)

On the island of Ré, ground kelp, mainly composed of *Fucus*, is widespread in layers on barley seedlings. The effect produced is spectacular, and the barley of the island is very appreciated by the brewery industry (Sauvageau 1920). Shoreline kelp or cut kelp is the object of a particular treatment. It is deposited in regular layers with fresh horse manure and left in the open air until the end of November. The manure obtained is then used for the preparation of cereal crops and vineyards.

The use of kelp on the island of Ré also concerns expensive market gardening, and the vegetables obtained are of excellent quality. No gustatory impact linked to the use of the marine fertilizer is to be deplored. On the other hand, the wine resulting from the culture of the vine with this type of fertilizer presents a pronounced marine taste, thus decreasing the market value of the product.

On the island of Noirmoutier in the 1860s, kelp was used to the exclusion of any other fertilizer for all crops. This resource known as red seaweed is considered by farmers as a very powerful fertilizer. The seaweed that composes it is *Rytiphlaea pinastroides*, a red seaweed of rather limited abundance.



Figure 1.3. Harvesting kelp on the Breton coast at the end of the 19th century (source: illustration by F. Gillot, photo credit © J. Fleurence, 2022). For a color version of this figure, see www.iste.co.uk/fleurence/algae.zip

The use of algae as fertilizer is an ancient practice in the Roscoff region. This use was at the origin, in the 19th and 20th centuries, of the exponential development

of the market gardening activity in this basin of production. In Roscoff, the shoreline and wrecked kelp were indifferently used as fertilizer. The shoreline kelp was mainly composed of *Fucus serratus*, and the wrecked kelp was composed of Fucales and various Laminariales (see Table 1.4). In particular, wrecked kelp was very abundant after a storm and in such circumstances that shore dwellers hastily left their occupations to collect and load the valuable sea fertilizer onto carts (see Figure 1.3).

On a more ad hoc basis, the brown seaweed *Himanthalia elongata* was harvested as shoreline kelp by farmers during the fall equinox. This seaweed locally called “Fillit” was, after draining, spread in the artichoke fields.

The algal resource, when spread fresh after draining, is referred to as green kelp (Sauvageau 1920). This type of kelp is excellent for potato production, but appears to be unsuitable for onion cultivation. More generally, farmers prefer to use partially fermented kelp before it is incorporated into crops.

In Roscoff, the kelp used for many market garden crops of economic interest (see Table 1.3) was the source of the prosperity of the Léon region until the middle of the 20th century.

In the region of Morlaix or Concarneau, farmers also used a particular kelp made of a calcareous alga, *Lithothamnium calcareum* or maerl for the amendment of cultivable grounds. This alga, which lives in the subtidal zone, could be pulled up by the currents and run aground in areas that were still emerged or be recovered by dredging operations at shallow depths via boats.

On the Normandy coasts, the inhabitants have the habit of collecting the old blades of *Laminaria hyperborea* (formerly *L. cloustonii*) (see Table 1.5) which detach from the thallus in spring and wash up on the beaches. This kelp, called “mantelet” by the Normans and “April kelp” by the Bretons, is used as a fertilizer for vegetable crops, apple, pear and peach orchards (Sauvageau 1920; Perez 1997, pp. 11–64).

On the Breton islands of Batz, Molène, Sein and Ouessant, the stipes of beached *Laminaria* (*Laminaria cloustonii*) are burned and the ashes are used locally or on the mainland for crop fertilization and more particularly that of the potato.

Historical uses of kelp for soil amendment and fertilization show that this resource can be used directly after draining (green kelp), after drying and partial decomposition (manure), or after burning (ash). The last process is practical for transporting this marine fertilizer over longer distances than those corresponding to the coastal strip.

The use of algae in agriculture has not historically been limited to plant productions. It has also been applied to the breeding of livestock, whether they are used for field work (cattle, horses) or for the production of meat.

In the treatise *Bellum Africanum* written in 45 BCE, it is reported that the Greeks in times of famine proceeded to harvest shoreline algae and, after rinsing, used the algae to feed their cows (Evans and Critchley 2014). In the text of the Icelandic sagas, examples of algae consumption by livestock are also cited. For example, during dearth periods, algae was eaten on beaches by sheep or collected by natives to feed sheep, horses or cattle for six to eight weeks per year (Makkar et al. 2016).

In the 18th century, the consumption of algae by livestock in the northern regions of Europe is well documented. In Scandinavia, for example, sheep and goats actively sought out *Palmaria palmata* (formerly *Rhodymenia palmata*) (see Table 1.5) for consumption. This behavior led the botanist Gunner to ironically name this species “*Fucus ovinus*” (Sauvageau 1920). However, it should be noted that the species *F. ovinus* is today listed in Algaebase as *F. vesiculosus*, which distances it from the description reported by Sauvageau (1920). On the Swedish island of Gotland (formerly Gothland), pig feeding relies on the supply of a preparation based on boiled *Fucus vesiculosus*, mixed with a coarse meal. In Norway, *F. vesiculosus* and *Chorda filum* are used as fodder for cattle feed.

In the 19th and 20th centuries in northern European countries, including France, kelp was used occasionally or systematically to feed ruminants (cows, calves, pigs). This practice was the result of the observation of the animals’ behavior towards the kelp washed up on the banks. Thus, in many Breton regions (Roscoff, Batz Island), cows willingly consume the species *Palmaria palmata* washed up on the shore. This species is elsewhere called “cow kelp” or “cattle kelp” by the local populations.

On the Scottish island of Lewis, cattle and sheep are allowed to roam freely and feed on the algae present on the shores. Sheep prefer *P. palmata* to the detriment of the brown alga *Alaria esculenta* although it is present in abundance. Cows, on the other hand, selectively consume brown algae of the genera *Alaria* or *Laminaria* (Sauvageau 1920).

During World War I, some countries used the algal resource to feed livestock. In Norway, seaweed was frequently fed to livestock after desalting by rinsing and boiling. These were mainly brown algae such as *Alaria esculenta* called “Kutara” (cow alga) or *Ascophyllum nodosum* called “Gristetang” (pig alga) (Sauvageau 1920).

In Germany, algae were integrated in the food of pigs, cows, ducks and sheep. In France, the army proceeded in 1917 to experiment with feeding horses brown algae belonging to the genera *Laminaria*, *Saccharina* and *Fucus*. These experiments, which followed the shortages of oats and fodder, were carried out on cull animals. Carried out over several weeks, they showed the harmless nature of the consumption of algae by the equids and in a certain number of cases a weight gain of about 6% (Sauvageau 1920).

However, after this world conflict, a gradual consensus was established that the contribution of algae in the nutrition of livestock was less than that of other plant sources. It was not until the second half of the 20th century and the advances in zootechnical and biochemical research that the use of algae in animal feed was revived.

Former name	Current name
<i>Fucus palmatus</i> <i>Rhodymenia palmata</i>	<i>Palmaria palmata</i>
<i>Laminaria cloustonii</i>	<i>Laminaria hyperborea</i>
<i>Fucus saccharinus</i> <i>Laminaria saccharina</i>	<i>Saccharina latissima</i>
<i>Fucus digitatus</i>	<i>Laminaria digitata</i>
<i>Fucus ovinus</i>	<i>Palmaria palmata</i> (?) <i>Fucus vesiculosus</i>
<i>Fucus canaliculatus</i>	<i>Pelvetia canaliculata</i>

Table 1.5. Correspondences between old species names and current names (from Sauvageau 1920, Blench 1966 and Algaebase 2021)

