Round-up of non-food crop activity in the UK: construction materials

Introduction

In a previous article, we looked at non-food crops currently being grown in the UK for the production of goods destined for the cosmetics and pharmaceutical industries. We discussed market values and trends, and had a closer look at oilseed crops and herbs, which are two non-food crops of particular interest to these huge industries. In this second article, we will cover non-food crops – and their current impact on the UK economy – for the production of construction materials.

The History of natural building materials is as old as the history of man-made "buildings" itself. From the earliest shelters made from branches to stone houses which still stand strong centuries after being erected, plant-derived, waste and mineral materials have been used all over the world for construction for millennia. The first shelters were often made of forageable and easily moulded materials such as leaves, branches, mud and clay, and were built for the primary purpose of offering humans protection against harsh weather and animals. As humanity evolved and toolmaking improved, wood became a crucial part of the ancient world's construction industry. Ancient Greek and ancient Chinese civilisations built wooden temples to their Gods, one of them, Nanchen Temple, was built in 782 AD and is still standing today.

One of the most significant advances in building materials has been concrete. Made from mineral products, concrete quite simply refers to a composite material formed as a result of aggregates (e.g. sand, ash, crushed stones…) being mixed with a fluid "cement" which hardens over time. The earliest forms of concrete date back as far as Mayan times and are also a common occurrence in ancient roman sites. The quality of concrete has not stopped improving ever since, and underwent a big boost during the Industrial Revolution. The middle of the 19th century saw the development of reinforced concrete (i.e. a mixture of concrete and steel) which went on the become an instrumental element for the development of high-scale infrastructures such as bridges and motorways. Nowadays, concrete is the most widely used material for construction, surpassing all the other materials (such as wood, steel and plastic) by far. More recently, plastic has also become a very widely used construction material, providing lightweight, flexible and cheap components. However, both concrete and plastic have very high carbon footprints and often lead to a number of health and safety concerns throughout their lifecycles.

As society becomes more environmentally-aware, the construction and architecture industries are beginning a transition towards sustainable practices, and are reverting back to natural plant-derived materials. This article aims to summarise which non-food crops are currently being grown in the UK to serve as construction materials, and as raw feedstocks for the manufacture of construction materials (such as plant-derived plastics and concrete). Feedstocks such as agricultural residues from food crops (e.g. straw) and waste materials (e.g. waste wood) will be excluded from this summary article.

What is currently grown in the UK?

The market for construction materials comprises a variety of products, including materials for insulation, floor coverings, wall coverings, roofing, and even paints and varnishes. The global construction materials market reached a staggering $1 trillion in 2020, and is expected to reach as much as $1.5 trillion in 2027[i]. More specifically, the global insulation market was estimated at $52 billion in 2018[ii], the flooring market at $409 billion in 2020[iii], the wall covering market at $29 billion[iv], the roofing market was estimated at $111 billion in 2020[v], and the paints and varnishes market was estimated to reach $150 billion in 2021[vi]. The construction industry is also experiencing a high demand for sustainable goods and practices, with the global market for sustainable construction materials reaching $238 billion in 2020[vii] and expected to reach as much as $425 billion by 2027. Sustainable ("green") building materials are on the rise for both residential and non-residential buildings, however the non-residential sector is seeing a faster rise, for commercial and office buildings in particular. In addition, the Asia-Pacific region is experiencing most of the market boost, with an estimated 12.5% increase during the 2016-2022 period[viii].

Multiple non-food crops can be used as construction materials nowadays, in accordance with current health and safety regulations, and matching customers' expectations of modern buildings and accommodation. These include crops such as hemp, Miscanthus and flax, to name those that can be grown in the UK. These fibre crops are mainly used to manufacture insulation materials and construction boards for furniture, walls and floors.

Hemp

Several building materials and products can be manufactured from hemp. Hurds (also called shives) are made from the inner core fibres of the stem. These hurds can be used to manufacture products such as roofing tiles, wallboard, fibreboard, insulation, panelling, bricks and even structural timber. Longer fibres from the outside of the stems can also be used to form bales which are then used for wall construction[ix]. Perhaps more surprisingly, hemp can be used to make an alternative to conventional concrete, which is known for having a highly negative environmental impact. "Hempcrete", or hemp-based concrete, is produced from hemp, lime and water to produce a very durable material. As hemp locks carbon as it grows, and as lime turns into limestone once the materials are mixed, hempcrete is considered to have a negative carbon footprint[x]. An issue remains however, as hempcrete holds lower density and compressive strength than conventional concrete, meaning that hempcrete walls must still be supported by load-bearing frames.

The market for hemp-based insulation materials in the EU was valued at €13 million in 2020, and is estimated to reach €24 million by 2025. In addition, the EU hempcrete market is expected to reach €3 million by 2030, doubling from its value in 2020[xi]. The global market for hemp is estimated to currently be between $600 and $800 million. Considering the very wide range of applications for hemp, these numbers are expected to increase significantly in the next few years over several industrial sectors.

The extent of the hemp market in the UK was mentioned in the previous article, where we showed that hemp is being actively grown in the UK with a total of 12 licenses having been issued since 2014 for the

cultivation of hemp. There are currently only 800 hectares dedicated to the cultivation of hemp in the country, but funding schemes, such as the government's HEMP-30 project, are aiming to increase this area 100-fold within the next ten years[xii].

Miscanthus

Within the context of the construction sector, Miscanthus is mainly used to manufacture particle boards – medium-density boards in particular – for outdoor and indoor construction and furniture. It has also been used for thatching in Japan. Miscanthus fibres have been found to be lightweight and flexible, and to have excellent mechanical and thermal properties, making it an ideal insulation material[xiii].

Data recorded between 2009 and 2018 reveals that the area dedicated to growing Miscanthus in England has decreased from 9,213 ha to 7,149 ha (representing around 0.1% of arable land in England), leading to a decrease in total production as a result. Overall, in 2018, England produced 71 million tonnes of Miscanthus, 40 million tonnes of which were used for bioenergy production. Despite this decrease, the number of growers has nearly doubled during that time[xiv].

Terravesta, a UK company and world leading Miscanthus specialist, are working on showing that Miscanthus also has potential to be grown on marginal agricultural lands, which include areas subjected to heavy metals pollution and which are often not favoured by farmers growing food crops[xv]. This will be done under the banner of the OMENZ ("Optimising Miscanthus Establishment through improved mechanisation and data capture to meet Net Zero targets") project, and will look at the crop's entire supply chain. Similarly, the University of Glasgow are attempting to expand Miscanthus cultivation on harsh lands which are normally deemed "unfriendly" to crops, aiming to improve carbon consumption and yields.

Flax

Flax, or linseed, has been grown by humans for the manufacture of goods since ancient times. The Ancient Egyptians for example cultivated flax to produce fabrics, while the Romans used it to make sails for their boats. In the UK, flax was cultivated as far back as the Bronze Age and became a major economic driver during the Roman occupation. Flaxseed oil, or linseed oil, can be extracted from flax seeds to produce paints and varnishes. Fibres are also harvested from the plants stems to produce sound-insulating boards, particle boards and even reinforced concrete. Flax fibres have been found to be as efficient as glass and plastic fibres which are normally used to reinforce conventional concrete. Finally, flax is also used as raw material to manufacture "Flaxstic", a plant-derived alternative to petroleum-based plastics.

Linseed production in the UK reached 33,000 ha in 2020, more than doubling in a year from 15,000 ha in 2019[xvi]. This increase in mainly attributed to farmers introducing alternatives to oilseed rape. Most of the resulting harvest is used for animal feed, health food, oils and paints. The majority of the world's flax production (c. 85%) comes from Europe, with France being the world's biggest grower.

The global flax seed market was valued at $537 million in 2020 and is expected to reach $1.6 billion by 2028[xvii]. The market for flax fibre has remained fairly constant over the past decade, with a moderate increase since 2012. The overall increase in flax consumption and production is attributed to raising awareness of the health benefits of linseed, along with a rise in use of materials made from flax such as plastic and textiles.

Conclusion

Some of the specific market values presented in this article remain very low in the grand scheme of the international construction markets. This is often due to the novelty of a lot of plant-derived products and the need for the technologies to develop and improve enough to challenge the properties of fossil-derived materials. Thanks to mounting pressure from international organisations and consumers, industrial stakeholders and governments are providing more funding opportunities to develop sustainable building materials faster. New and improved products are being developed at an unprecedent rate to respond to both sustainability and health and safety requirements for such materials.

In the UK, the areas dedicated to growing non-food crops remains low. Considering that most of the production is directed towards biofuels and bioenergy, not much remains for other sectors such as construction materials – and cosmetics and pharmaceuticals as seen in the previous article. There are signs, however, that academic and industrial stakeholders are recognising the potential of non-food crops for the British economy, which will lead to a rapid increase in the non-food crops cultivation area within the next decade.

A perfect example of this would be the GRACE project which is funded by the Bio-Based Industries Joint Undertaking (BBI JU) under the European Union's Horizon 2020 research and innovation programme[xviii]. The project is a consortium of 22 partners from academia and industry (including SMEs and farmers) which aims "to secure the supply of sustainable-produced raw materials for the growing European Bioeconomy", mainly hemp and Miscanthus. The project is looking at the crops' production and value chains, aiming to demonstrate the value of 10 "demo" biobased products which are manufactured from the two model crops. These demo products notably include home insulation materials, particleboards, mycelium-based panels and lightweight concrete, showing that these are both economically and practically viable for a future bioeconomy, as well as becoming promising investment opportunities.

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