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Plants by design: towards a bio-society

In order to reverse the negative effects of the fossil economy, society will have to progress towards a post-fossil fuel society driven by sustainable biological processes. In such a society, which can be referred to as the "bio-society", plants are the primary source of all our organic materials, fibres, food and feed, and also of that part of our fuel demand that cannot be met using electricity.

Fossil history

For centuries, human civilization has thrived on plants as the sole energy source; plants delivered all the food, building materials, fibres for clothing, feed for the production of animal proteins and heat to warm houses and to prepare food. Society largely relied on plants until the 19th century when the exploitation of fossil fuels sparked the Industrial Revolution. Although fossil fuels are also derived from plants and other biological materials, the large scale use of coal, gas and oil hallmarked the advent of a new economy; the fossil economy.

From then on, fossil fuels became our main energy source and the role of plants diminished primarily to being a source of food, fibre and feed. The unprecedented success of the new economy led to increased welfare in society, manifested for instance, by an increased food supply, improved hygiene and advanced medical care. So doing, the fossil economy allowed the continued exponential growth of the human population.

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However, the vastly expanding human population causes an ever increasing stress on the Earth's ecosystem. Resources are also running out. Society's dependence on fossil fuels has caused atmospheric CO_2 to peak to dangerous levels, triggering global climate change. Simultaneously, food and feed demand has caused large-scale deforestation and loss of biodiversity as greater land areas are required for agricultural production.

Bio-society

In order to reverse the negative effects of the fossil economy, society will have to progress towards a post-fossil fuel society driven by sustainable biological processes. In such a society, which can be referred to as the "bio-society", plants will once again become the primary source of all our organic materials, fibres, food and feed, and also of that part of our fuel demand that cannot be met using electricity.

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Solar power is plentiful, durable and accessible on a global scale as the earth receives a staggering 162.000 TW of solar energy. To put this into perspective; one hour of received solar radiation equals the total annual energy consumption of the entire global economy. The main challenge for the bio-society will be the capture and storage of this energy. Plants play a crucial role in this as through photosynthesis annually 2.8 ZJ (2.8×10^{21} joules) of solar energy is converted and stored as chemical energy. During this process, 130 Giga-tonnes of CO_2 are fixed from the earth's atmosphere.

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Current agriculture will not be able to meet future demands for the plant biomass required for the envisaged 'total use efficiency model' proposed here. Agricultural production levels already have maxed-out in some global production areas and cannot be increased further without irreversibly damaging the Earth's ecosystem. The only solution facilitating a global transition from a fossil society to a bio-society is to redesign our plants. Only this will allow the production of vastly increased amounts of biomass from the same production areas currently in use. At the same time, double the amount of CO_2 will be sequestered.

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Redesign

Redesigning our plants implies the development of superior varieties by optimizing plant traits like photosynthetic efficiency and resource use efficiency. This new generation of plant materials will allow increased production with reduced input of precious resources like water, nitrogen and phosphorus. Plants are an essential ingredient in the circular food production system, and hence they will also have to be optimized for feed applications to support healthy livestock production, and to use more efficiently the nutrients that can be found in animal waste products. Furthermore, in parallel, RUE of plant waste streams can also be included in the design strategy and fully optimized. Importantly, plants must be designed to cope with the already imminent negative effects of global climate change, such as increased temperature, drought, mineral and water stress.

The required plant traits will be identified by exploring and exploiting the naturally-occurring biodiversity and superior alleles will be introduced into our current elite varieties by either modern plant breeding and/or by advanced molecular technology.

The design and development of these future plants is bold, inspirational and a daunting task. They shall be a true game-changer and will positively impact all levels of society and will instigate desirable disruptive effects on all our ways of life. To succeed we must unify virtually all sectors and all disciplines across the board – in the Agri sector from farmers, distributors, processors and breeders; in the transport sector from distributors, logistics experts, shipping and storage; the energy sector, regarding both energy supply as well as energy usage; the health sector regarding aspects of food quality, food safety, nutrition and healthy diets; in waste valorisation and the bioeconomy and last but not least, supermarket and consumer organisations. European agricultural scientists are ideally suited to pick up and take the lead for this challenge and to organize a Mission aiming at designing smart plants to provide future feed- and foodstocks in a resource use efficient circular and climate smart food production system.

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Our Mission is clear:
we need to design multipurpose plants to establish a solid basis for a healthy and sustainable food security in the forthcoming decades, a great challenges that the world is facing and must be solved.

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