AGROCYCLE FACTSHEET

Sustainable agricultural production systems

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.

The need to transform agriculture

Agriculture is a critical sector of the EU economy, providing food, feed, products and biofuels that help sustain society, as well as being the ‘backbone’ of many rural communities.

In the next decades the agri-food system will face an unprecedented “confluence of pressures”, including a significant increase in global population, intensifying competition for scarce resources and the existential threat of climate change. Consequently, a 70 % increase of the world food supply is estimated to be required to close the “food gap” between the crop calories available in 2006 and expected calorie demand in 2050.

The technological innovations of the past have enabled significant improvements in agricultural productivity. Global agricultural production increased threefold in the space of 50 years, with only 12% growth in farmland area. However, these gains have also come with a significant environmental cost.

Agricultural production is primarily linear in structure utilising relatively high levels of inputs, a large proportion of which is not converted into edible products but instead results in wasteful and environmentally damaging outputs. In the last 50 years, agriculture has become more resource intensive, relying heavily on the availability of fossil inputs.

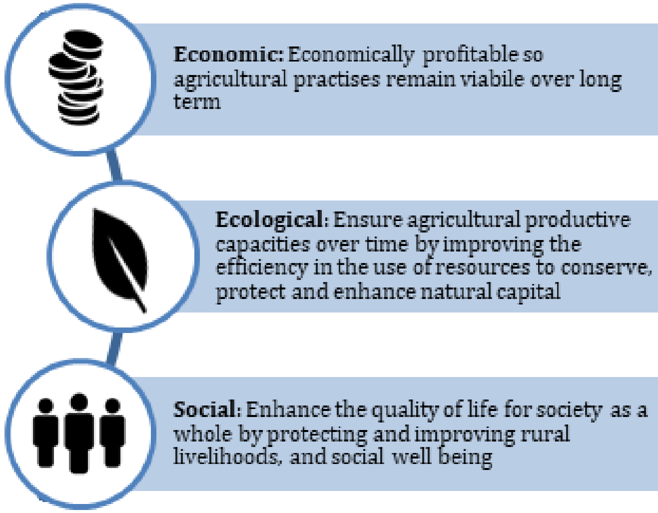
- Geological phosphate reserves have been extracted to produce fertilizers to feed the planet, creating a largely one-way flow of phosphorus from rocks to farms to lakes and oceans, damaging freshwater and coastal marine ecosystems.
- Large amounts of nitrogen have been moved from the atmosphere to the fields, rivers, and forests, disrupting the nitrogen cycle.
- 25% of total greenhouse gas emissions are directly caused by crop, animal, and forestry production, and deforestation.

1. Sustainable agricultural production systems

Sustainable Agriculture Characteristics

Any agricultural production activity will have some impact on the environment, but sustainable agricultural practices attempt to minimize the harmful effects on the environment and ensure long term productivity and social wellbeing.

The numerous definitions of sustainable agriculture share the common elements of being economically viable, meet society's need for safe and nutritious food, while conserving and enhancing natural resources and the quality of the environment for future generations.



Minimise resource investments

The first task of a sustainable production system is to minimise resource investment. The upstream investment in resources, such as fuel, phosphorus, soil, and natural capital impacts of production (e.g. land use, soil degradation) make improving efficiency in the use of resources a priority.

- Currently, most crops absorb just 30% to 50% of applied nutrients from fertilisers and absorb less than 35% of water applied to fields.
- Critical materials such as phosphorus are also wastefully applied, with an estimated 57% of phosphorus fertiliser input to arable soil being lost to inland and coastal waters.

Renewable and non-renewable resource investments should be governed by the following two rules:

- Renewable natural capital stocks should only be employed at a rate of less than the natural rate of generation.
- Non-renewable natural capital stocks should be exploited no faster than the rate of creation of renewable substitutes.

Prevention of avoidable waste

Avoidable agri-food wastes are material streams that have been mismanaged and disposed of and are typically a mixture of different components.

For the agri-food industry, the primary objective is efficient food production, with as little waste as possible. With the current progress in valorisation technologies and policy, waste and by-products are becoming more valued as a feedstock. This can force a move away from an efficient low waste agri-food system to one where agri-food waste is extracted for its high value. This increased demand for agri-food waste can lead to their increased production, and conflict with any prevention and reduction efforts.

Due to the invested resources embedded in agri-food products, prevention must remain the priority for all avoidable agri-food waste streams. The costs of decreasing food waste are low, but the returns are significant. Less waste means greater agri-food chain efficiency and more competitive goods and services.

2. Requirements for a more sustainable agriculture

Circularisation of unavoidable waste

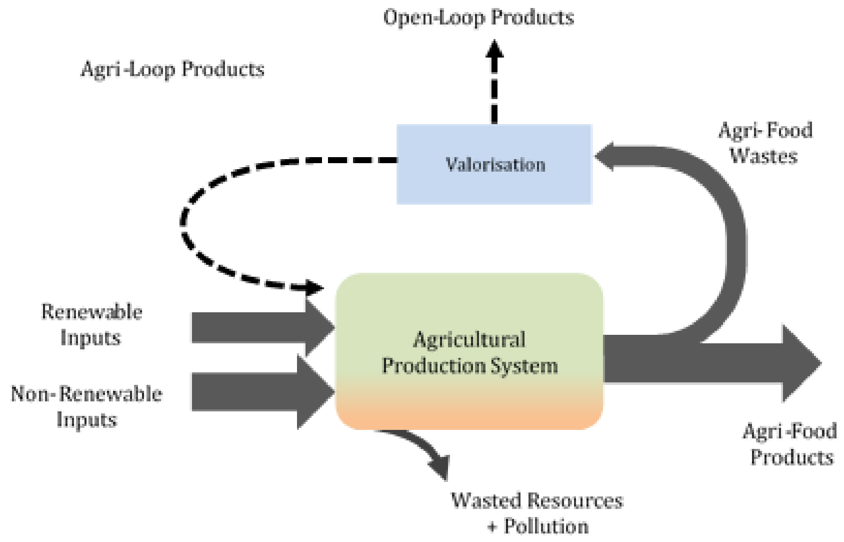
Unavoidable agri-food wastes are materials arising from food production systems that are not consumable. (e.g. manures, crop residues, leaves, peels).

In order to preserve natural capital, and minimise (and offset) non-renewable resource investment, the closed "agri-loop" circularisation of unavoidable wastes should be prioritised. This recycling of nutrients in the agricultural system will not only offset virgin resource use, but also plays a vital role in farm ecosystems, such as improving soil carbon stocks and overall soil productivity.

- Utilising unavoidable waste in agriculture, either in terms of keeping residues on land, or upgrading materials through valorisation to extract critical nutrients, can help keep the flow of renewable materials circulating in the agri-food system.

Surplus production can be used to generate other high value applications. Determining sustainable removal rates for agricultural waste produced on farm is crucial to identifying the most appropriate strategy for their valorisation.

The resource loop in the agri-food system



Social equity and wellbeing

Agricultural performance and economic viability are ultimately tied to the social wellbeing of the farmers and rural communities. Agricultural practices must benefit those whose livelihoods depend on it, by increasing access to resources and assets, participation in markets and job opportunities.

The community supports the enterprise (with employees, infrastructure) and the agricultural enterprise supports the community, with the food, fibre and materials that it can generate.

UN sustainable development goals - related to agri-food

Conservation and circularisation through space and time

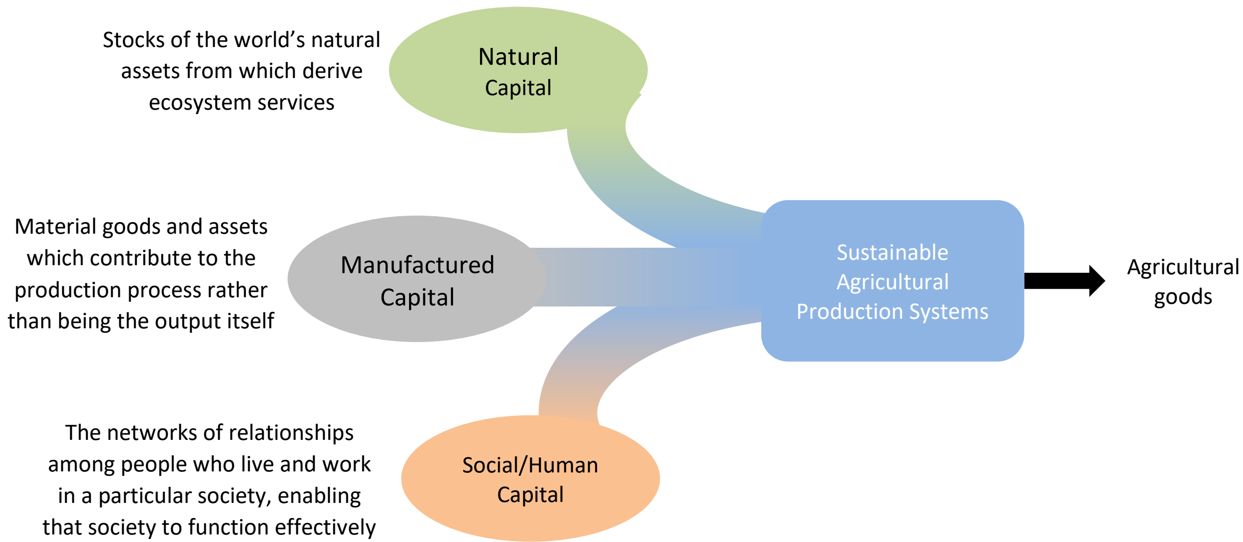
In addition to the efficient cycling of resources, sustainable agriculture practices must also directly conserve and enhance natural capital. Ensuring the long-term productivity of natural resources and resiliency of the enterprise means that value chains must operate so that there is no net loss of natural capital.

- Maintaining soil carbon levels and overall soil health are critical to this conservation. Practices such as reduced or zero tillage, cover crops, and diverse cropping systems help to protect ecosystems and conserve the productive capacities of the land. Utilising agricultural waste on land to cover soil further helps by reducing the risk of erosion and runoff.

Circularisation through space and time has also major impacts on sustainability. The primary production of crops employs many resources (energy, water, chemicals) and ecosystem services (soil fertility), yet the consumption may in a different location. Sustainable agriculture needs to address the scale of loops, in order to prevent the exploitation of resources in one area to satisfy demand in another.

- Creating and transporting meat or milk products from areas high on the water scarcity index to locations low on the water scarcity index, without addressing the 'circularisation' of water will only exacerbate scarcity issues at the point of production.

Capital investment in the agricultural production



3. Barriers and recommendations for more sustainable agricultural production systems

A constraints analysis has been conducted to identify the current barriers to the implementation of more sustainable agricultural production systems, accompanied by action areas and approaches to address these barriers. The scope of this analysis includes the uptake of sustainable production methods up to the production of agricultural waste, co-products, and by-products; either to 'farm-gate' or 'factory-gate', depending on where they are produced. Key findings of the analysis are listed below.

Description of key barriers

1. Lack of small-scale technologies suitable for implementation at farm level.
2. Lack of confidence for farmers to invest in small scale and novel industries.
3. Farmers don't get a fair price for AWCBs.
4. Small and medium farms don't know how to improve their sustainability and efficiency further, or there is not enough incentive to.
5. Lack of entrepreneurship and willingness to take risks in Europe, compared to places like USA (industry led) and China (Government led).
6. AWCBs are produced seasonally (high volume in a short period of time).
7. Farmers are not empowered to take on responsibility for novel production or value chains.
8. Most farms are small businesses - investing in facilities and bioprocessing equipment is too expensive.

Recommendations

1. Development of flexible and robust small-scale processes e.g. for pre-treatment.
2. Set up government grants or loan schemes for farmers investing in waste valorising/recycling technologies
3. Develop higher value opportunities to make it worthwhile to collect AWCBs.
4. Structured value chains governed by large companies/certification schemes can make production systems more productive, and sustainable.
5. Promote entrepreneurship (skills and willingness to take risks) in European farmers and stakeholders.
6. Technological solutions should be versatile to find application with a variety of different feedstocks, produced at different time periods within a year.
7. Present farmers with case studies to show how other farmers have developed novel products which have benefitted their business, the environment and society.
8. Mass production, servitisation, standardisation and other new business models could lower costs. Cooperatives and clusters that provide shared facilities and technical knowledge to farmers can also be supported

4. Barriers and recommendations for sustainable value chains

NNFCC, in collaboration with Agrocycle partners, identified the main limiting factors and constraints that prevent or slow the development of novel value chains and the commercialisation of new valorisation technologies. Recommendations on the actions required to overcome these challenges and maximise the value captured from the exploitation of agricultural waste, co-products, and by-products in Europe have also been developed. The most severe constrains are listed below.

Description of key barriers	Recommendations
1. Bio-based materials often do not have the same properties and functionalities as conventional fossil-based ones.	1. Improvement of performance of bio-based products and development of new equipment and applications that best match the properties of currently non-drop-in offers.
2. It is cheaper to develop products from petrol and the value chains are already developed.	2. Invest in industrial research to bring down costs of AWCB-based production.
3. Market is the most important barrier. If there is not enough market demand from consumers there is no demand for production.	3. Support market demand through public procurement (e.g. Bio-preferred USDA), public-private joint ventures, consumer engagement and educating
4. Absence of financial incentives. But we do not want to push market too strong as it could get flooded and reduce value, or incentivise waste valorisation over waste reduction and	4. Support bio-based products get to commercialisation stage or create financial incentives. b) Investigation of new business models
5. Relationships between actors in the waste valorisation industry are vital but not established, which makes it difficult to set up new value chains.	5. Facilitate actors across the supply chain to build relationships through clusters, events (e.g. AgroCycle Hub meetings) and projects like
6. Many agricultural wastes have low density, high moisture content and are thus not worthy for transportation.	6. Develop small and flexible pre-processing plants and implement them locally to increase transport worthiness. Development of higher value products to make the collection and transport worthwhile.
7. Many wastes and by-products are heavily regulated or cannot be valorised in certain markets.	7. Change policies to allow more wastes to be utilised with less ‘red-tape’. For example, allow insects fed on food waste to be feed for livestock and fish.
8. There is a high risk and cost to start new value chain.	8. Launch as a joint venture for each technology involved in the cascade to spread risk across new value chain.

Methane fuels in agricultural machinery

Barrier: All farms need tractors and machinery for various operations, but fuelling the machinery can be expensive, particularly with volatile fuel prices, and a significant source of greenhouse gas emissions in an already carbon intense industry. In addition, many farms are developing biogas facilities to treat their AWCB on farm. But the cost to connect to the electricity or gas grid can be very expensive, with profits lowering due to current low gas prices, and uncertainty over whether government incentives will continue to offer the same level of, or any, support for new plants in the future.

Action: Biogas-powered tractor. Prototypes methane-powered tractors have been developed. Bio-methane can be generated through anaerobic digestion facilities on the farm. When using bio-methane, the machine's carbon impact is virtually zero, and cost savings between 25% and 40% can be achieved when compared with conventional fuels. There are higher upfront costs than conventional tractors, but targeted investment subsidies could encourage uptake.

New Holland T6 Methane Power

Case study written by CEMA, European Agricultural Machinery

5. Case Studies: Novel agricultural production systems

In-field straw pelleting machine

Barrier: Bioenergy from straw is becoming increasingly popular across Europe. Large biopower plants and small scale on-farm biomass boilers often require standardised pellets to maximise efficiency of the boiler. However, there are limited pellet mills across the continent and the process of baling, transportation and pelletising can be the most expensive and time-consuming part of utilising straw.

Action: Machinery has been developed for an all-in-one automated straw harvester and pelletiser. The machine produces pellets from agricultural feed crops directly from swath in the field. The pellets can then be transferred to a waiting truck by conveyor belt and delivered straight to the end customers who use them as fodder, bedding or fuel for heating systems. It can also be used outside the harvesting season thanks to an optional bale shredder which converts it into a stationary pelletizer for year-round operation.

Photo credit: Gold for Krone Premos 5000

Case study written by CEMA, European Agricultural Machinery

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