SOME ASPECTS OF DECARBONISATION AND MACHINES IN AGRICULTURE

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REVIEW ARTICLE

Abstract

Sustainability and environmental protection have become key concepts in EU agriculture mainly due to the regulations of the Common Agricultural Policy (CAP). As a key component of the Green Deal, in December 2021, the European Commission adopted a Communication on Sustainable Carbon Cycles (European Commission, 2021) in which it promotes the upscaling of carbon farming as a green business model and sets out a series of short to medium-term actions to address current challenges to achieve this. This paper presents some aspects related to decarbonisation and agricultural machinery.

Keywords: decarbonisation, sustainability, eco-schemes, agricultural machines
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INTRODUCTION

The Department of Economic and Social Affairs, Population Division, of the United Nations, (United Nations, 2019) has predicted that the global population will reach 8.55 billion people by 2030 and almost 10 billion people by 2050. In order to feed this growing population, according to FAO, food production must increase with 70 percent by 2050 and a 60 percent increase in demand for high quality protein such as milk, meat and eggs.

Agriculture is energy intensive and the pressure to produce more food requires more energy, an increasingly costly input to the production process. At the same time, the requirements for the use of sustainable methods and environmental protection for energy products have increased.

The European Climate Law (European Parliament) requires that greenhouse gas (GHG) emissions and removals are balanced within the European Union at the latest by 2050 with the aim to achieve negative emissions thereafter.

The agriculture sector accounts for 10% of the total EU27 greenhouse gas (GHG) emissions (from crops, livestock and soils), and an additional ~1% of total EU27 GHG emissions can be attributed to agriculture from the combustion of fossil fuels during the normal course of operating agricultural machinery. At EU level, methane (CH_4) represents 56 % and nitrous oxide (N_2O) 39 % of greenhouse gas (GHG) emissions in agricultural production, while carbon dioxide (CO_2) represents a minor proportion of GHG emissions.

One of the projects that studies the solutions needed to achieve sustainable energy without pollution is RES4LIVE (https:// res4live.eu/). This H2020 EU funded project, 2020-2024, with an overall budget € 5815206, have 17 partners from 8 countries. The strategic objective of RES4LIVE is to develop and bring into the market integrated, cost-effective and case-sensitive RES (Renewable Energy Systems) solutions towards achieving fossil-free livestock farming.

MATERIAL AND METHOD

The agricultural machinery industry was the first one to introduce the international sustainability standard ISO 17989 (Tractors and machinery for agriculture and forestry - Sustainability - Part 1: Principles). This industry initiated various developments with the intention to increase the eco-friendliness of machines and production. Examples are machine connectivity with ISOBUS, precision farming, alternative fuel technology, automated machinery operation, and International and European standards for the protection of the environment during the use of sprayers and fertilizer application equipment.

Agricultural machinery have very long life cycles. Agricultural mechanization can contribute in the short term to the EU climate targets as alternative fuels burned in combustion engines may be used as well in the existing fleet, depending on the fuel, the engine type/stage and engine conformity requirements. Also, they can

be mixed in various portions with conventional diesel. Hydrogen could be used directly in combustion engines (30 % efficiency compared to 35 % H_2 - fuel cell) providing a zero-emissions option for specific use cases, while supporting the growth of hydrogen infrastructure. On-farm produced alternative fuels (i.e. bio-methane, plant oil or H_2) would be the best solution from an economic point of view. A 2020 JEC study (European Commission Joint Research Centre, 2020) concluded that overall for the alternative fuels they investigated, almost all offer a better Well-To-Wheel performance than conventional diesel when used in Internal Combustion Engines.

EKoTech project (Götz, 2019) stands for efficient agricultural machinery fuel utilisation. In this large-scale research project funded by the German Federal Ministry of Agriculture, a highly qualified consortium of industry, scientific and association experts has succeeded in providing cross-manufacturer evidence that innovative machinery, intelligent process control and modern operating concepts can achieve considerably reduced yield-related fuel consumption in comparison with conventional processes.

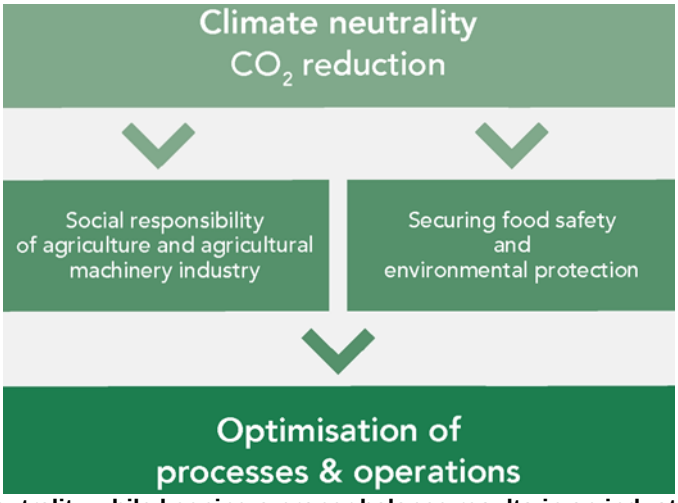

Figure 1 **Reaching CO_2 neutrality while keeping a proper balance results in an industry vision oriented toward optimisation of process and operations, possibly combined with usage of alternative energy sources**

For reaching the target of CO_2 neutrality, all aspects must be dealt comprehensively as presented in Figure 1 (CEMA, 2022). The outcome should be the optimisation of agricultural processes, which will preserve the balance between the necessary environment protection and agricultural production notwithstanding social responsibility.

Achieving sustainability in agriculture requires achieving carbon neutrality. Besides the reduction of fossil fuel consumption and the use of renewable energy, an important step would be the introduction of carbon farming. A good example is Carbon Action (https://carbonaction.org/en/carbon-action/) which is a Finnish platform that develops and researches ways of accelerating soil carbon sequestration and how to verify the results scientifically. It also introduces climate-friendly, regenerative farming practices to Finnish farms.

At the EU level, there is a lot of concern related to carbon farming, probably due to the global advance in this field. Themes like "Carbon farming" (European Parliament, Policy Department for Economic, Scientific and Quality of Life Policies, 2021) and "Agricultural potential in carbon sequestration" (European Parliament, Policy Department for Structural and Cohesion Policies Directorate - General for Internal Policies, 2022) are on the European Parliament table.

The main factors that limit carbon farming are:

- farmers' knowledge of the carbon farming and soil health,
- measurability and verifiability of carbon sequestration,
- profitability and incentives of carbon farming.

Farmers´ knowledge of the carbon farming and soil health can be deepened with advisory and education, trials and pilots on farms level.

Measurability and verifiability of carbon sequestration can be improved by including farmers in scientific research carried out on their farms.

Profitability of carbon farming can be achieved at the current stage, only through support based on subsidies from CAP eco-schemes. In the future, it is likely that the

regulation of carbon certificates produced in agriculture will constitute the main engine of development.

The set of relationships related to carbon farming are presented in Figure 2 (Joona, 2021).

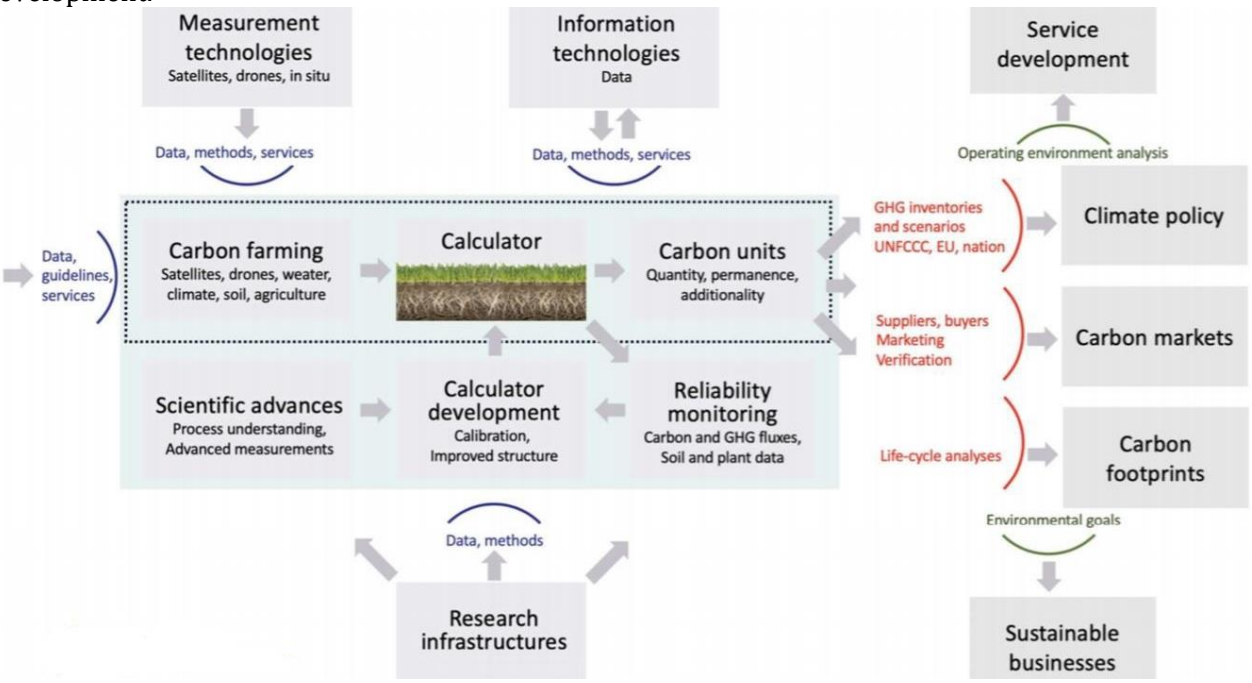

Figure 2 **Relationships related for carbon farming**

RESULTS AND DISCUSSIONS

In order for everyone to understand the processes related to carbon farming, several suggestive posters were made, such as the one in Figure 3 (Coopman, 2021).

For the study of carbon farming processes, many projects were financed, such as FiON (Nevalainen et al, 2022).

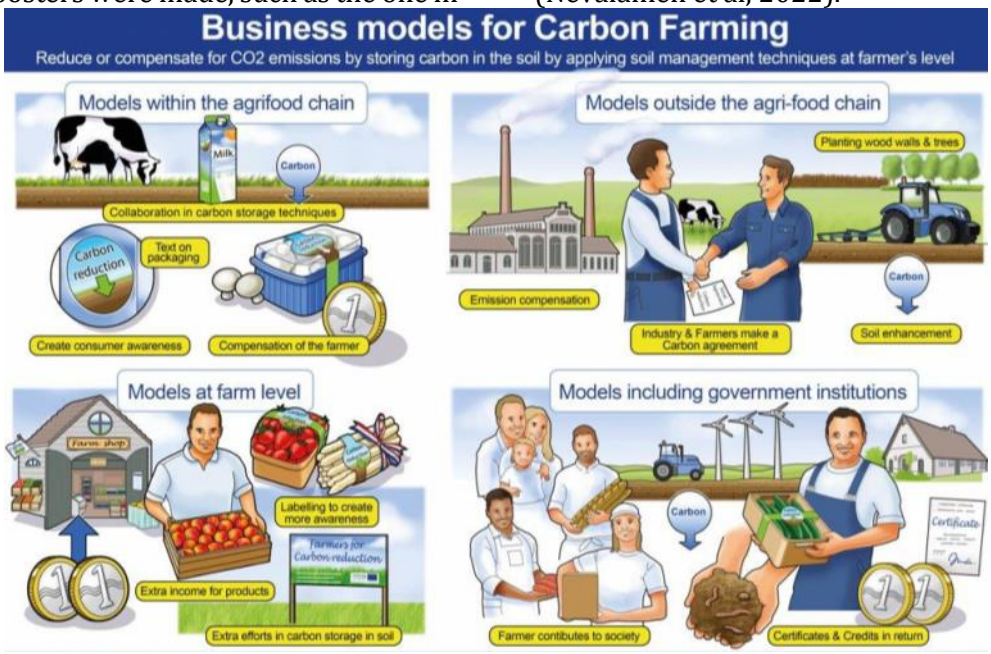

Figure 3 **Illustration of carbon farming models**

CONCLUSIONS

All civilized countries have understood that sustainable development is impossible without strong environmental protection, especially in agriculture.

The governing bodies of the EU have started and will continue with taking decisions to implement several environmental protection measures in agriculture.

In addition to using renewable energies and supporting biodiversity, technologies related to carbon farming will have an important

role.

Private companies also understood the role of carbon farming, for example, BASF Agricultural Solutions launch Global Carbon Farming Program enabling farmers to reduce their CO_2 emissions.

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