SUMMARY AND REMARKS - SESSION 2: Climate change and mechanization: what is needed and industrialized and emerging Countries.

by Andrii Yatskul (Rapporteur), Giuseppe Gavioli and Josse DeBaerdemaeker (Chairmen)

Introduction

Club of Bologna continues to explore and study the various aspects of sustainability under climatic changes involving agricultural mechanization. The main ways sustainability actions reduce the impact of agricultural activity on the environment can be deployed in energy saving, minimizing carbon emissions, and energy saving, and introducing of digital solutions for more precision and efficiency. A newly introduced term to complete sustainability in the present context is "resilience" which is defying as "being able to recuperate from shocks and negative impacts of climate change". Agricultural mechanization is now the big power to change. There is a great opportunity to evolve and transform how we do things in our lives and in business.

1. A.I. in agriculture and farm machinery: discover new correlations and trends in big data collected by machines

Starting with an Isobus and data exchange between machines 20 years ago, modern agricultural equipment is able to generate a huge volume of various data. These data could provide additional value when there is a tool to deal with. Nowadays, artificial intelligence (AI) has an important role to play in crop production and crop protection. Since the early 2010s, AI-based systems use computer vision and present quick, non-invasive, and non-destructive way of: weed identification, disease detection, phenotyping, harvesting, spraying, and navigation. Having traveled the hard way from the low-performing technics, through Deep learning, and Convolutional Neural Network (CNN), modern powerful technics such as Transformers, GANs (Generative Adversarial Network) can create a realistic synthetic image with high performance. Artificial intelligence is currently providing functionalities never seen before: i) better than human performances in disease detection, weed identification, yield prediction, etc. ii) ability to create new realistic samples of crops, plants, diseases, fruits, etc. iii) different farm machinery can integrate with these AI techniques as disease scouting and detection, fruit counting and forecasting, real-time spraying, navigation without GPS. Four use cases were presented as a concert example: early weed identification, Nutrient deficiency detection, plant phenology recognition, quality attributes prediction:

- *The **"Eden Library Viewer"** is our camera-based system for sustainable crop protection and effortless real-time plant monitoring through embedded AI models and machine vision;*
- *The Project "Optimised Pest Integrated Management to precisely detect and control plant diseases in perennial crops and open-field vegetables" **(OPTIMA)** will develop an environmentally friendly integrated pest management framework for vineyards, orchards.*
- *The multi-purpose application of drones **ICAERUS*** (Innovation and Capacity building in Agricultural Environmental and Rural Unmanned aerial vehicle (UAV) Services) *brings socio-economic, environmental and regulatory challenges that limit their current use across Europe".*

2. Fossil-energy-free technologies and strategies for EU farmers and solutions in the management of the farm

Energy consumption in all economic sectors has increased thoroughly since the 1950s. But whenever we meet an oil crisis, new technologies to escape from fossil energy dependence appear. When the oil prices go down, the fossil energies come back. Agriculture has followed the same route after the green revolution that significantly increased the mechanization of agricultural practices. Agriculture is responsible of 3,2% of total energy consumption, 56% and 14% of which is occur in oil and gas respectively. Despite significant variations between geographical areas the important energy-consuming practices are related to greenhouse systems (lighting, irrigation, heating and cooling process), and livestock production (manure management, milking systems). Fossil-Energy-Free Technologies and Strategies could play a significant role in the defossilising of farms and the achievement of clean energy production and better energy efficiency.

Renewable Energy Sources (RES) and energy efficiency solutions (EES) proved their efficiency, therefore wide adoption occurs sluggishly, but keeps certain dynamics. Most of the agricultural stakeholders across Europe agree to invest from the perspectives of energy cost reduction and reduction of environmental impact. Solar and biomass/fuel/gas systems remain the most popular. Geothermal sources will be interesting for livestock farms. Complementary effects on energy efficiency have the technics of precision farming and farming practices (such as agroforestry, no-tillage or conservation agriculture).

In a broader sense, the high-energy inputs are closely related to pesticide and fertilizer manufacturing. Employment of smart farming technologies with the synergy with increasing the share of locally produced organic pesticides and already mentioned sustainable farming practices could be a solution to minimize the consumption of manufactured pesticides and fertilizers, transiting to more sustainable production systems.

Regarding direct energy inputs, traction, tillage, harvesting and sowing stays the most energy-requiring farming operations. Various Fossil-Energy-Free Technologies and Strategies, such as using more efficient tractor-implement systems and settings, rational size of machines and switching to renewable on-farm produced energy sources are already implemented within numerous farms.

Despite the obvious prospects for using energy-efficient technologies, approaches and practices, the implementation in real production systems is more local than pervasive. The main reasons are novelty and insufficient awareness of the specific economic effects of their application. An important decision favoriting factor is the possibility to observe the technology in the action (demonstration or at another farmer). Nevertheless, they oppose the adoption of the low affordability of technologies, non-compatibility with the farm capacity, or have some doubts about technologies.

Well-organized Agricultural Knowledge Information System is needed, and teaming up of researchers, farmers, agricultural machinery manufacturers, advisers, and policymakers was highlighted.

3. Renewable and low-carbon fuels for climate-smart EU ag-machinery: circular agriculture in action

Manufacturers of field machines are ready to face support and contribute to the sustainable development of agriculture. Agriculture is about 10% of overall European carbon emissions. CNH's guidelines refer to the first European climate law to become climate neutral by 2050 and improve energy independence and to the EU Green Deal aiming to make food systems fair, healthy, and environmentally friendly. Technically, the CNH's decarbonization strategy deals with two streams:

- **Alternative** fuel: Biomethane-powered tractor (New Holland T6) and infrastructure for the energy-independent farm, producing biomethane on their own manure and waste. These make the farm fossil neutral in terms of fuels.
- **Electrification**, which distinguishes:
    - Light electrification: front PTO-driven generator is able to produce power up to 50 kW, provided to electric implement and able to save 35% of fuel (spraying operation), noise reduction at 45% (engine runs at lower rpm, hydraulics is turned off);
    - Medium electrification refers to the hybridization using electric power transmission which is parallel to the serial driveline, with the electrification of some functions, such as PTO;
    - Full electrification: battery electric vehicle, without the combustion engine, offering better traction control, drivability, smoother gear-shifting, shuttling

CNH company is conscious, that all showed technologies couldn't be solutions for everything (e.g. diesel fuel). For low-power demand applications, full electrification seems to be adequate. In case of high-power demand, hybrid powertrains running with renewable fuel such as biomethane would represent the optimal solution. In the next years, technologies will become more affordable for customers. Big manufacturers have a strategy to offer solutions for a complex range of agronomic tasks, integrating them into the overall system and production infrastructure of that particular farm, in their specific environment. They understand the need to team up the efforts of manufacturers, institutions, and other stakeholders to perform lobby after politicians in order to create a favorable legislative climate for the implementation of these solutions and satisfy farmers' needs.

4. Overall conclusion and general remarks from the session participants

The questions of energy saving, minimizing carbon emissions, energy saving, and introduction of AI or more precision and efficiency are the main streams and main challenges to front global climate change. In addition to the above-detailed points, there are a number of related technical and organizational aspects to consider.

Particular attention is paid to the evaluation and quantification of energy consumption and its efficiency. There is no single statistical methodology, and each scientific community has different approaches from each other, which makes it very difficult to see adequately the real situation of energy consumption within the farms, and there is a risk of taking the wrong direction for stakeholders.

It should not be an illusion that electrification, hybridization, or the use of hydrogen or biomethane will be the solution for everything, in view of their low energy density. Particularly, full electrification, given today's energy storage capabilities, would be interesting on low-power (up to 25 kW) tractors and on some towed implements. Neither should we expect the complete elimination of fossil fuels. For instance, in large machines such as harvesting machines, the substitution of fossil fuels is possible through the high costs and low efficiency. However, it is already obvious that there is a tendency to change of the share of fossil energy fuels with the respect to others. The type of energy used will determine the area of application and the requirements for autonomy.

It is also necessary to be open to new approaches and improvement of the existing ones. For example, modern electrified and hybrid tractors are designed by the retrofitting principle, in which only the motor part is replaced, while the transmission and other nodes are inherited from diesel technology. Adapting them will significantly improve energy efficiency.

Most experts agree that single attempts by one party or another are not able to solve the energy problem. The current legal framework, which should encourage farmers and equipment manufacturers to create and integrate energy-efficient, defossilized fuel technologies, is not conducive to this. There is a strong need for cooperation between various stakeholders and in a common agricultural Knowledge Information System, in order to better understand challenges and provide adequate solutions.

In addition, smart technologies stay a powerful tool to support a large number of solutions, using various digital models, enabling the use of big data, and contributing to the sustainability and profitability of agronomic practices.

To sum up, a well-thought farming system integrating adapted technologies has a large perspective to not only optimize the energy and chemical inputs but significantly reduce them. Energy saving, moving away from fossil fuels, application of circularity concepts and practices, maximizing carbon capture and implementing precision and smart agriculture technologies are the confident ways of agricultural mechanization development. Henceforth, mechanization has a lot of things to give to the sustainability of agriculture.