"Agricultural Mechanization and Sustainability"

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Key Note Reports Extended Abstracts

SESSION 1 – AGRICULTURAL MACHINES - SUSTAINABILITY ASSESSMENT AND CIRCULAR ECONOMY ***CHAIRMAN: Prof. Peter Pickel (John Deere)***
1.1 – Importance of sustainability assessment and circular economy in agricultural machinery production *Giuseppe Gavioli* (GAVIOLI CONSULTING LLC)
1.2 – CO_2 savings of agricultural machinery until 2030 *Fabienne Seibold, Axel Kunz, Peter Pickel (JOHN DEERE)*
1.3 – Agricultural Machinery and Smart Agriculture. Which Contribute to Achieving "Sustainable Development Goals (SDGs)" *Muneji Okamoto (KUBOTA Corporation)*

1.1 – Importance of sustainability assessment and circular economy in agricultural machinery production

by Giuseppe Gavioli (GAVIOLI CONSULTING LLC)

Sustainability of human activities on the planet is now a serious "must". The rate of consumption of the planet resources is such that we have no alternatives.

This means all economic activities have to scientifically assess and measure their real sustainability, for what concerns environmental and social impact, energy efficiency, and resource consumption. It is clearly too late for any qualitative approach. Several sustainability metrics and indicators exist, together with established international standards like ISO 14001 and 14031.

To become more and more sustainable, in particular from an environmental, energy, and resource point of view, a very powerful approach is to adopt the circular economy system. This is based on 3 principles: 1) design out waste and pollution, 2) keep products and materials in use, 3) regenerate natural systems.

In this article sustainability of agricultural machinery production and use is analyzed, as well as some of the direct impact this may have on supporting sustainable agricultural practices.

The focus will be on: materials used to manufacture machines, re-manufacturing approach, product as-a-service business model, design to limit waste and pollution, smart logistics and inventory management, collaboration with partners, implementation of Artificial Intelligence and digital twin.

1.2 – CO_2 savings of agricultural machinery until 2030

by *Fabienne Seibold, Axel Kunz, Peter Pickel (JOHN DEERE)*

Based on the UN agreements from COP 21 in Paris, EU and German national laws on CO_2 or equivalent greenhouse gas emissions and with these, the saving targets to be expected for Ag industry in Germany are becoming outlined. Prior to availability of these cascading laws, Ag industry in Germany selected an approach for reducing CO_2 emitted by their machinery through fossil fuel usage, which is presented in contrast. The available results out of related, publicly funded research project EKoTech for cultivation of wheat, corn and grassland on model farms representing region typical farming in Germany will be represented. For verification of these spotlight results, the plausibility was checked by forecasting fuel and arable land usage on national economic scale by making use of various agricultural statistical data for year 2015.

After the forecast did reflect enough arable land and fuel usage for being considered representative for Germany, the EKoTech fuel savings predicted to happen in year 2030 on spotlight level could be transferred to national economic level too. These figures allow easily to be expressed as CO_2 savings between 2015 and 2030, which can be related to previously presented governmental expectation. The comparison of prediction with saving target allows to validate the approach of Ag industry as well as to identify further room for improvement.

1.3 – Agricultural machinery and smart agriculture. Which contribute to achieving "Sustainable Development Goals (SDGs)"

by Muneji Okamoto (KUBOTA Corporation)

Kubota is carrying out programs to address 3 issues working towards the SDGs goal year of 2030.

1. Focus on development of agricultural machinery for work in large-scale fields in order to meet the continually growing global demand for food.

2. Improve productivity through mechanization of agriculture to address the growing populations of Asia and Africa.

3. Utilize Smart Agriculture to support agriculture in Japan, where the farming population is declining.

This report describes in detail the Smart Agriculture that will be needed worldwide in the future. Kubota Smart Agriculture is composed of two elements: "Automated operation of agricultural machinery" and "Data-based precision agriculture".

Automated operation of agricultural machinery is composed of three steps. Step 1: Automated steering. Step 2: Automation and unmanned operation under human supervision. Step 3: Full unmanned operation. Kubota has developed and sold tractors, rice transplanters, and combines for Step 1 and Step 2. We are now also conducting studies for Step 3.

For data-based precision agriculture, we are working to minimize machinery downtime, improve productivity, and improve the quality of crops with an approach that centers on a FMIS known as KSAS (Kubota Smart Agri System). This system visualizes and links together many types of agricultural machinery and agricultural data.

Kubota will continue contributing to the achievement of SDGs by providing agricultural machinery and total agricultural solutions.

SESSION 2 – POTENTIAL FOR ELECTRIFICATION IN AGRICULTURAL MACHINERY CHAIRMAN: Prof. Paolo Gay (Univ. Turin – Italy)
2.1 – Electricity for tractors and tractor-implement systems *Peter Pickel (JOHN DEERE), Karl Renius (TU Munich – Germany)*
2.2 - Electric tractor perspectives *Stefano Fiorati, Alessandro Bernardini, Nicholas Hale, Paul Snauwaert, Francesca Protano (CNH INDUSTRIAL)*
2.3 – Visions on electric drive components for implements and trailers *Manfred Auer (ZF Friedrichshafen AG)*

2.1 – Electricity for tractors and tractor-implement systems

by Peter Pickel (JOHN DEERE), Karl Renius (TU Munich – Germany)

In front of the background of the societal demand to mitigate the climate change, drive trains of vehicles and mobile machinery need to be replaced by more efficient systems to reduce GHG emissions. Amongst other effects, this political enforced demand paves the way for electrification since electric machines provide greatest efficiency and in addition, they offer best controllability, dynamic response behaviour, and independency of control of single drives what is especially useful for highly precise, highly automated or even autonomous operation.

Electric drives offer highest application power at maximum power density. While this is true for all the actuators, the problem of energy storage capacity and related costs will stay. There hardly is a business case for (fully) battery electric agricultural machines except for smaller tractors, small robots and turf machines. Even hybrid systems need a set of additional business cases or application benefits resulting from electrified drive systems. E.g., boost power or increased working speed in different conditions could be a driver for electrification. For battery systems, delivering service to the power grid could form a new (secondary) business cases in agriculture.

Electric systems on the long run, principally, provide access to renewable energy to farmers as they are energy consumers and at the same time they are becoming more and more energy producers (mainly of electricity). Replacing fossil energy sources such as diesel by on or near by the farm produced electric energy will be supporting the idea of short circular farming and could also be an enabler for introduction of electrified mobile machinery.

Already in today realized systems, there are obvious benefits from electric power supply from tractors to implements. As a new power interface, tractors are providing electricity on different power, voltage, and frequency (in case of alternating power) levels. Tractor-implement-electrification is and will be the key driver for implementation of electricity on tractors.

2.2 - Electric tractor perspectives

by Stefano Fiorati, Alessandro Bernardini, Nicholas Hale, Paul Snauwaert, Francesca Protano (CNH INDUSTRIAL)

Electric drives are rapidly gaining importance in agricultural engineering. Current agricultural equipment is getting close to reach its optimization limits in terms of complexity and efficiency with the current technology. In the future, the expectation is a growing focus on the area of the electrification and electrical drives. Moreover, agricultural manufacturing industry, traditionally mechanical, is investing a lot of resources to test electric motors and batteries able to replace, over time, the conventional powertrain and hydraulic. Battery life and performance in harsh environment are still a challenge from a technological point of view, looking at off-road missions. On the other hand, merging electrification with more traditional thermal engine into hybrid systems can be an effective solution for the medium term and bring some big benefits to final user.

Without modern agricultural methods, it would not be possible to feed the current population of the world and certainly not the future population. Moreover, hybridization first and full electrification after, is going to be a strategic initiative for every OEM to not only achieve emission regulations and improve productivity and efficiency but also to position itself as a technology leader.

2.3 – Visions on electric drive components for implements and trailers

by Manfred Auer (ZF Friedrichshafen AG)

As opposed to on-Highway vehicles Ag tractors are designed to provide high tractive power in often fairly poor tractive conditions. In addition tractors with implements can often not use the combined weight for creating traction which can lead to tractors getting stuck.

Many particular solutions on tractors and tractor/implement combinations are on the market, that improve traction perfomance and to mitigate the effects of lacking tractive power from the tractor to the implement.

On the other hand, a trend towards electrification can be observed in agricultural machinery systems. Developments of electrical power-split continuously variable transmission (eCVT) and integrated generator systems for tractors provide electrical energy for the propulsion of the tractor, the process drive of the implements and the electrical implement drive.

As a result above, implements of all types of trailers will benefit from electric traction drives, almost regardless of the tractor size that is used by this type of applications. Another important target group of implements is represented by heavy, pull-type primary and secondary tillage equipment with combined seeders/planters when hitched to the tractor by a kind of drawbar with little or even no load transfer to the tractor.

These developments increase system efficiency, promote the flexible controllability and manoeuvrability of electrified axle- and wheel drive concepts. The functional integration of the electrified drivetrain (eCVT) and the electrical implement drive (ePTO) create various advantages for the overall system tractor/implement.

According to ZF, the market requires a modular system for multi-axle drives (eTrac). We conducted a survey of market and application demands in order to develop here the best solution within a possible technical kit. This was done in combination of the synthesis and analysis of various drivetrain systems.

A modular system for different application will significantly increase volume and reduce system costs which is one of the major challenges of drivetrain/system electrification.

SESSION 3 (SPECIFIC MECHANIZATION) - MACHINES FOR FORAGE PRODUCTION AND DISTRIBUTION CHAIRMAN: Prof. Peter Schulze Lammers (Univ. Bonn – Germany)
3.1 – Improvements and future prospective of forage production *Stefan Böttinger (University of Hohenheim – Germany)*
3.2 – Main drivers of customers and future trends of hay and forage harvesting machinery *Philipp Mümken (CLAAS Saulgau GmbH)*
3.3 – Forage distribution and TMR evolution *Andrea Ugatti, Jacopo Ferlito (FARESIN INDUSTRIES)*

3.1 – Improvement and future prospective for forage production

by Stefan Böttinger (University of Hohenheim – Germany)

Extended Abstract not submitted by the Author/s

3.2 – Main drivers of customers and future trends of hay and forage harvesting machinery

by Philipp Mümken (Claas Saulgau)

The analysis of future developments and trends begins with the consideration of the customers and their needs. Focusing on milk production, the connection between worldwide milk demand and the quantity produced becomes clear, which directly influences the market price. Thus, the first essential motivator is identified with the milk price. The milk price and its development, in combination with the production costs, determine the profitability of milk production. The production costs are directly related to the crop, characterized by quantity and quality and thus influenced by the forage harvesting technology. Based on this, the essential requirements and future trends of harvesting technology can be derived.

A global trend is the increasing demand for milk with declining farm numbers, causing an increase in herd size and the average milk yield. This requires powerful and crop-saving harvesting technology with a high degree of reliability.

The process chain of forage harvesting can be divided into three steps - mowing, tedding / swathing and e.g. baling. Mowing technology places high demands on reliability, low crop contamination and conditioner technology. Tedding will remain part of the process chain in many parts of the world in the future and will not be replaced by intensifying the conditioners. In addition to efficiency, reliability will also gain importance here. Various technologies are used worldwide for swathing - from finger wheel rakes to rotary rakes and mergers. In general, there is an increasing need for low crop contamination. Parallel to the optimization of the individual process steps, an overall view of the harvest chain and support through the analysis of data with the aid of digitalization is conceivable.

3.3 – Forage distribution and TMR evolution

Andrea Ugatti, Jacopo Ferlito (FARESIN INDUSTRIES)

Of all the costs associated with the livestock farm, the main one is represented by the feeding with percentages varying between 45 to 65% of the total expenses, depending by the geographical areas and the availability of self-produced feed stuffs.

As with any other industrial process, the feeding process requires also increasing attention especially aimed at reducing practice errors and the nutrients losses.

The feed costs depend only in part by the raw materials ones, but instead are strongly influenced by the correctness and the efficiency of the feeding process.

The TMR process (total mixed ration) has the aim of making a uniform distribution of the nutritional values for the whole herd, of preserving the physical function of the feed and of the limiting the choice of feed.

The role of technology in zootechnics is therefore to be able to optimize the processes by acting as a support element for the operator, and the new role of mechanics is that of being able to use intelligent and sustainable choices by integrating decision support technologies.

Up to 50% of the losses happen during mechanical TMR preparation. To improve the feeding process is necessary to measure every single phase from the loading process till the digestion control of the animal.