**Discussion panel on future tractors: summary remarks**
*by Karl Th. Renius, TU Munich*

The **standard tractor's design** will continue to be the leading model for the next generation. However, tractor-implement combinations and designs for driverless operations should be further **automated**. This will be driven not only by economic factors, but also by upcoming **labour shortages** in industrialized countries, as is already the case in Japan.

The **tractor cab** will generally not be removed for driverless versions in the near future so as not to lose the tractor's ability to transport goods (or robots), change fields, and travel to and from the farm.

**Joystick** steering may gain importance if problems of emergency steering can be solved economically. Chasis designs with **pull-in-turn** traction function improve mobility and save fuel on-road, are therefore gaining importance. **Automatic steering** in the field is well introduced; however, **automatic headland operation** is not. According to farmer comments, programming is too complicated, must be simplified.

There is still potential also for improving **tractor hydraulics,** saving energy by enlarged electronic control. Fendt announced replacing the analog hydraulic LS-line to implements by sensors and digital BUS signals.

**Communication** between neighboring machinery in the field is also not yet working well in general. The **ISO BUS** is widely accepted; however, it sometimes reaches its limits regarding BUS load and signal speed. Activities for the next generation are needed. The **AEF** (Agricultural Industry Electronics Foundation) collaborates on future projects and developments on electronics together with the related industry.

**Field robots** (usually with electric drives) are recommended, but there are doubts about including any ability for **heavy soil tillage** in the duty circles. Their development is mainly driven by simplifying seeding and replacing chemicals, for example by electro-mechanical weeding. Simple t**ransportation** to the field or an ability to be **pulled** or a **self-propelled mode** must be possible.

According to the experts, **electric tractors** have a future for rated power of up to **75-100 kW**. Fendt produces the e100 in small series. **Larger power levels** are not recommended as they require disproportionately larger batteries because of **higher average power usage** within the duty cycle (e.g. for tillage or heavy transport) and **more working hours per day**. Fundamentals are presented recently in the ASABE Distinguished Lecture Series No. 45 (2025) by B. Pichlmaier and M. Ehrl.

Future structures of **electric power trains** for tractors have been addressed in three categories: **A** individual electric **wheel drives**, **B** electric **axle drives**, and **C central** electric drives. **Replacing only the diesel engine** with electric components, as most companies do at present (in the first-generation saving investment), may result for mass production in too much of the expensive 'previous transmission' remaining. Therefore, most of the panel's experts favor a second generation with **central** electrics for drive and power take-off (PTO). Such a structure should be combined with a simple additional mechanical drive transmission with **at least two ranges** to allow higher electrical speeds, improve performance and reduce energy consumption – similar to some recent electrical power-train designs of commercial trucks.