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Trends in tractors and transport vehicles

Below, some important trends in tractor development and transport are presented which are going to characterize the Agritechnica 2005. This preview only provides pre-information and cannot replace a trade fair visit. Completeness is not aimed for.

Since the last Agritechnica, no new spectacular takeovers or mergers among tractor manufacturers occurred. The corporate groups are busy integrating the companies which have been taken over and are trying to adapt their product ranges to the demands of the international markets. Significant cost savings can only be achieved if either components of sister brands are used or if the tractors of different brands are based on a common platform (e.g. at CNH).

Exhaust emission limits require new technologies

In preparation for the last Agritechnica, tractor manufacturers had already revised their engines and cooling systems in order to meet the exhaust emission limits of stage II. For tractors having more than 130 kW, the next stage (IIIA) is already going into effect on 1st January 2006. One year later, the same limits must also be observed in the power class from 75 to 130 kW, where unit numbers are large. While an electronically controlled injection system has so far been sufficient in some cases, the engine needs to undergo more significant modifications in order to fulfill the requirements of stage IIIA. Exhaust gas recirculation allows nitrous oxides to be reduced efficiently. This requires more efficient cooling and increased boost pressure. For the first time, John Deere uses turbochargers with variable turbine geometry in its tractors (model 8030). In contrast to the turbocharger with a bypass valve, this system provides efficient turbocharging even at high engine speeds, which has a positive effect on the consumption values. For the sake of these goals, extreme drive-off torque (torque at 1,000 min^{-1}), which in any case loses its importance in combination with a continuously variable transmission, is deliberately avoided.

If the new limits are intended to be observed while not allowing fuel consumption to increase at the same time, a whole bundle of technical measures is necessary, virtually all of which affect the cooling system. The charge air must be cooled down considerably because lower gas temperatures provide lower nitrous oxide values. Of course, this also applies to the recirculated exhaust gases, which are cooled down in an additional heat exchanger. High-pressure injection systems heat the fuel up so that additional fuel coolers become necessary.

Cooling systems are becoming a challenge for the engineer

More efficient cooling can be realized by means of larger radiator surface, more efficient heat transfer to the air, or increased air throughput. However, the demand for larger radiators contrasts with some current trends in tractor construction. The customer desires a compact, manoeuvrable tractor which is easy to handle and has large front wheels for more tractive power as well as sloping bonnets for good visibility and more mounting space at the front hitch. All these demands restrict the available space for the radiator and the suction surfaces. Therefore, entire „radiator batteries“ consisting of several heat exchangers are designed, which are sometimes arranged closely behind each other. Each element additionally heats the cooling air. In order to reach a sufficient temperature difference even in the last element, the air throughput must be increased. For this reason, the rotational speed of the fan reaches up to 3,500 rpm at rated engine speed in some tractors. This not only puts an additional burden on the engine, but it also makes the tractor noisier. With the usual fluid fans, the air throughput can only conditionally be

Fig. 1: The cooling systems of tractors are becoming more and more sophisticated in order to optimize capacity, mouting space, and exhaust emission reduction. Here, the cooling system of the new Agrotron K 100 is shown (photo: Dr. Metzner)

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Keywords

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Fig. 2: The new 8030 tractors from John Deere consume 5% less fuel despite more power. They conform with exhaust emission stage IIIA and produce 40% less NO_2.

adapted to the cooling capacity required by the tractor. If the largest cooling capacity is intended to be reached at approximately 90% of rated engine speed, i.e. usually the point where maximum engine power is delivered, the rotational speed of the fan is unnecessarily high at rated engine speed. The driving power requirements of the fan depend on its rotational speed in the third potency, which theoretically results in an unnecessary 33% increase in fan drive power. For the first time, John Deere uses a continuously variable transmission to drive the fan in its 8030 model. This allows the air thoughput to be very precisely adapted to the demand and enables fuel to be saved. The reduced noise emission not only protects the environment, but also the driver.

For cleaning, cooling elements arranged closely behind each other can usually be folded upwards or sidewards, and rigid elements have enough space between each other. The adjustable fan from the Hägele company, which was awarded a prize at the Agritechnica six years ago, has meanwhile been sold more than 10,000 times, which proves the demand for maintenance-friendly cooling systems. More and more often, the cooling air is aspirated not only through vertical suction surfaces, but also through horizontal surfaces on the bonnet. The air is then expelled in front of the engine so that less engine noise is emitted into the environment.

Automated powershift transmissions in all models

Virtually all manufacturers offer an automated variant of their powershift transmissions. At a sufficiently high speed, semi-powershift allows gears in a synchronized group transmission to be shifted without clutch operation (in New-Holland tractors since the middle of the nineties). Renault and MF automatically change groups when required. Except for Fendt, the unit numbers of the continuously variable transmissions do not entirely fulfill the expectations of the suppliers. In addition to Fendt/MF, John Deere now also offers a continuously variable powersplit transmission in the uppermost power class of standard tractors. Here, power is split in a planetary set like in the Fendt concept. However, four overlapping speeds lead to less power being transmitted hydraulically even at low driving speeds. The continuously variable transmission with the possibility of driving sensitively and very slowly under limit load control at full engine speed opens up many applications for powerful machines, which have so far been limited to special machines (e.g. rotary forestry cutters). In the new top model of the 300 series (312, 92 kW), Fendt introduces a simplified variant of the Vario transmission with just one gear range. This transmission is likely to be installed in smaller models in the future. The concept of higher engine power output at higher driving speeds or during PTO work (power boost) is now also applied in MF and New Holland models featuring a continuously variable transmission.

Standard tractors having 255 kW and a maximum speed of 60 km/h

Until recently, it has been the general opinion that the standard tractor concept was only suitable for an engine power of up to 220 kW and that more power was only appropriate for tracklaying or articulated steer tractors. However, the leading suppliers of top power class tractors have increased engine power again. At 227 kW (ISO), the MX 305 model from Case IH nominally exceeds the 300 hp limit. According to ECE-R24, John Deere reaches 234 kW, and Fendt's new model 936 produces a rated power of 255 kW. In the top power class, where annual operating times often reach 1,200 h and more, fuel consumption is a decisive sales argument. Given an assumed average capacity utilization of 65%, a 250 kW tractor consumes approximately 50 l of diesel per hour. Over 1,200 operating hours, fuel savings of only 5% result in a reduction of consumption by 3,000 l/year. This explains why all technical possibilities must be exploited in order to optimize the efficiency of the engine and the transmission. By means of different modifications of the engine, the transmission, and the rear axle of the new 8030 model, John Deere was able to reduce consumption by ~ 5% while meeting the requirements of stage IIIA of the exhaust emission regulations. Fendt guarantees that the very good consumption values of the previous top model will also be achieved by the new stage IIIA model. The first neutral DLG test results will be very interesting.

Fendt is realizing the first standard tractor which is able to drive 60 km/h. For this purpose, the brakes were adapted (dual circuit brakes with one independent brake for each wheel). Depending on the driving speed, the swing compensation of the single-wheel suspended front axle is reduced, which leads to better ride stability.

The largest model of the Challenger series (the tracklaying tractor MT 875B) features a maximum power of 438 kW and opens up a power range to this type of vehicle which has so far been limited to a few articulated steer tractors. The Harain company presents a new crawler chain track which allows contact length during turning to be shortened in order to minimize track damage. The carrying rollers and the front idler are coupled hydraulically and put an even load on the ground.

Documentation is part of field work

EC directives require the traceability of food back to the field. In plant production, the farmer or contractor should document all cultivation measures. So far, keeping such records, which would be necessary in any case for the sake of good field management, has been impossible due to the additional work requirements. Now, the ISO-bus has created

Fig. 3: The variable front weight (here on the Ares), which Claas also offers for tractor models from other manufacturers, is a smart solution

the basis for manufacturer-independent documentation software. The data are largely collected automatically without the driver having to interfere, and data transfer is also carried out fully automatically in certain intervals. On Fendt tractors (MoDaSys), the data are either stored on the on-board PDA using BlueTooth or transferred directly via the GSM network to the farm computer, where they are available for the farmer at any time without additional expense. Other systems store the data on central servers which the farmer can access via internet. With mandatory recording, a central element of precision farming is introduced quasi by law, which promotes the spreading of these future-oriented systems.

Fig. 4: JCB is travelling new avenues with its 185 kW Fastrac 8250, which has a maximum speed of 65 km/h and a modified Vario transmission

Hydraulic equipment according to the customer's wishes

As in the previous years, innovation in tractor hydraulics focused on electronics and sensor systems. The integration of the various hydraulic functions into tractor management requires electrohydraulic valves and sensors for the feedback of positions and pressures. Depending on the conditions of use, the demands on the hydraulic system are very different. For the volume models 6400, MF offers three different hydraulic systems which deliver 58 l/min, 100 l/min (LS valve), or 110 l/min (load sensing) to the operating hydraulics. Many large tractors can be ordered with additional hydraulic pumps (e.g. NH TG: 257 l/min) or often with larger pumps (e.g. Case IH MX: 201 l/min) so that they also meet special demands. In the new 936 model, Fendt adheres to its philosophy of separate oil circuits for the hydraulic system and the transmission with a maximum available oil volume of more than 60 l.

Comfortable and ergonomic cabs

Virtually every manufacturer offers cab suspension for almost every important model, at least as an option. Due to its pivoting front bearing, the cab, which is usually softly suspended only in the rear, makes a simple pitching movement in relation to the vehicle body. Thus far, only Claas/Renault has offered mechanical cab suspension including front spring elements. Fendt's cab rests on pneumatic elements at three points, and a distance of 1.25 m between the front and the rear bearing provides good kinematic conditions for efficient vibration insulation. The tendency of the cab towards unwanted pitching is counteracted by means of higher coupling of the front spring element. Hydropneumatic or pneumatic suspensions provide level compensation and lower natural frequencies.

New designs, which actively influence the damping (Sears) or the natural frequency (Grammer) of the driver's seat depending on the stimulation of vibrations, compete with the expensive actively suspended seat. This does not require hydraulic auxiliary energy so that these seats can be retrofit easily.

Suspended front axles make a decisive contribution towards ride safety and ride comfort. In the top power class (John Deere 8030, Fendt 936), the concept of a rigid axle suspended in the central swinging point, which is popular in the middle class, does not allow a sufficient steering angle and a compact front power lift to be realized. Therefore, these companies use sophisticated single wheel suspensions. Fendt's front axle design permits a total spring travel of 300 mm, and distance between the centre of the axle and the coupling point of the front power lift is only 1.32 m.

Efficient transports at 60 km/h

Especially in Central Europe, tractors and efficient transport trailers were used for the major part of agricultural transports in the past. Here, no trend reversal is in sight. Extremely efficient harvesting machines require sophisticated transport logistics, which must be organized at very short notice due to the weather conditions. In many cases, this excludes the use of non-agricultural transport capacities, e.g. those of haulage contractors. In addition, transport with the tractor generally leads to a significantly better utilization of tractor capacity, which results in advantages for farm management. The great importance of the tractor in particular for typically German solutions of transport tasks contributed to the introduction of 60 km/h standard tractors. In the past, standard tractors were insufficiently motorized. At 255 kW, the power dimensions of trucks are now reached.

A rigid drawbar trailer with a fifth wheel from the company SIGA Nova allows semi-trailers to be transported with the aid of a tractor. The fifth wheel can be shifted. For better traction, the vertical load on the tractor is increased, whereas the coupling is moved backwards for road transport.

The range of available push-off wagons is growing. They allow silage crops to be spread more evenly on the horizontal silo and pre-compress them. In contrast to the dumping truck, they can also be emptied on the horizontal silo without any danger of tipping. The Fliegl company expects easier emptying due to the conical shape of the transport container. Patented systems enable the sliding base plate and the sliding wall to be adapted during emptying so that even grain transport does not pose any problem.

Fliegl also presents hydraulic coupling of the supporting drawbar to the first axle. Via a hydraulic cylinder, forced deflection of the first axle puts additional load on the drawbars and the tractor. This makes it easier for the trailer to roll over rising ground. If, for example, the first axle is running in a plough furrow, the pressure in the system sinks, and the drawbar yields, which counteracts excessive load on the trailer coupling.

Among chassis, more and more sophisticated systems with single wheel suspension provide more ride safety and soil protection. In order to increase the loading capacity of the trailers, whose total weight is legally limited, light-weight construction is making its entry into agricultural transport trailers.