Responsible for Product Managements, Ole Dall looks at how advances in wheel design and technology are delivering improved farm machinery efficiency and performance by eliminating slippage between the tire and wheel.

The issue of force transmission and its impact on soil protection has become an increasing concern for farmers and contractors over recent years, with the trend for ever larger tractors, increased horsepower, larger implement machinery and heavy loads, compounding the problem.

The issue can manifest itself at different stages of the power train from hub to soil (the power train essentially being the flow from hub to wheel, wheel to tire and tire to soil), with machine operators, original equipment manufacturers (OEMs) tire manufacturers, fitters, resellers and integrators all striving to optimise this critical element of performance and efficiency.

The requirements of each of these groups though are all slightly different. For example, whereas OEMs look for weight reduction and improved tire mounting performance, machine operators seek improved soil protection and effectiveness.

The issue of slippage between the tire and soil is being combatted through the development of VF and volume tires which operate at low inflation pressure tires and the introduction of central tire inflation systems (CTIS), which together will help maximise the tire's footprint, reduce vertical soil compaction and deliver efficiency gains in terms of force transmission. This in turn will reduce horizontal soil compaction. The addition of ballast will also increase the load over the wheels and improve traction. But an inevitable consequence of all this is that the interaction between the tire and wheel rim will be compromised, particularly when operating in extremely heavy, clay-like or dry soil conditions, where traction is increased.

With torque transmission a key measure for efficiency and performance, by reducing slippage between the tire and the soil surface, then the torque between the tire and rim will increase. So, having addressed the problem between the tire and soil, then our objective as a world-leading wheel manufacturer is to deliver further efficiency improvements through the power train by addressing the issue of slippage between the wheel and tire.

Tire and rim technology, and specifically the interface between these two essential components, is a key element of overall performance, not only for farmers and agricultural contractors, but also for OEMs, tire manufacturers, fitters, resellers and integrators.

The wheel is firmly at the heart of the power train flow and so has a crucial role to play in performance, with the interface between the wheel and tire particularly important in enabling torque to be transmitted without slippage. Any slippage between the wheel and tire would not only be inefficient, but could seriously damage or even destroy the tire, at significant cost.

To assess the causes and effects of slippage between the wheel and tire, we need firstly to understand that there are three main stresses that are placed on the wheel, one of the key safety-critical components of any machine. These are: vertically through the wheel load and suspension; laterally through axial force; and rotationally through the applied torque. The interface between the tire and rim is impacted by all these forces and so the design of this interface is critical, with manufacturers striving to optimise the bead distribution between the tire and rim.

Arguably the most important area within the interface is the bead seat, where a traditional bead design will see an application of approximately 75% of the force vertically to the rim and 25% laterally. However, different bead designs can influence this distribution, with, for example, the Hexa bead creating even force/pressure distributions between the tire and rim, with this more even pressure enabling higher toque to be transmitted.

As well as influencing force distribution, the bead shape is also a key element in improving torque transmission. Effectively, the bead operates like an elastic band. Designed to have a circumference smaller than the rim, the bead is stretched during tire mounting so that after being fitted, it creates a clamping force between the tire and the rim. This force, together with the inflation pressure and knurling friction, transmits the torque, such that the higher the clamping force from the bead, the higher the torque that can be transmitted. This will be further improved by designing the rim to reduce the amount of deflection; the lower the deflection, the better the traction.

Standard rim profiles like “W” and “DW” do not have the right amount of stiffness for high torque transmission and so can risk elastic rim deformation in the footprint area. This reduces the clamping force and the torque transmission generates slippage due a micro movement in the tire – not dissimilar to the wave-like motion of a caterpillar moving along a plant stem.

Some see the solution to this lying in the addition of extra materials to the rim to improve stiffness, indeed some manufacturers have tried this, but this option only adds weight and cost and so is simply not viable. Some have also introduced welding to add a reinforced ring to the flange, but this results in shrinkage and the ring being unable to be controlled in this critical area of the wheel, so that although the ring may be strengthened, the contact of tire and wheel is no longer optimal.

Introducing higher knurling doesn’t reinforce the rim either, nor does it prevent elastic deformation; it only increases the friction between the rim and the tire in an attempt to compensate for lower clamping force, reducing performance. Also, if slippage occurs, higher knurling will inevitably lead to increased tire damage. Higher knurling also makes it more difficult to mount the tire correctly, with a greater risk of misalignment.

So how can the farmer increase efficiency, maximising the tire footprint and therefore traction?

Operating CTIS and adding ballast over the wheels helps prevent soil/tire slippage, but while some rim manufacturers recommend increasing the inflation pressure to address this, moveeros’ innovative and patented Profi-Grip solution features increased rim stiffness to completely solve the problem. By focussing on an optimal, stiffer rim design a higher clamping force is achieved, improving traction and preventing tire/wheel slippage.

The traditional DW rim profile, which is still favoured by many manufacturers, has been shown in field tests to lead to over seven centimetres of slippage between the tire and wheel in a typical working day, whereas under exactly the same conditions, moveeros’ Profi-Grip solution had absolutely zero slippage.

The Profi-Grip rim design features a strong flange which both minimises rim-shrinkage and serves to protect the tire when used at low pressure. The wheel also incorporates moveeros’ patented Profi-Fit TW design, which allows high-load capacity tires, with very stiff sidewalls, to be mounted easily and with no risk of tire damage (which can often be the case when DW profile rims are used).

Profi Grip enables tires to be mounted 25% faster and with 30% less inflation pressure, driving both efficiency and safety benefits. The rim design, including standard knurling, mean the tire bead sits correctly within the rim, which in turn eliminates tire damage.

Kai Brandhofe, Head of Engineering at CLAAS, said: “The growing need for efficiency in farming sets high demands for agricultural machinery. The Profi-Grip wheel with its stiffer rim flange optimises the fit friction between tire and rim and ensures the transmission of power to the soil.

“The unique wheel design protects the tire in field operation, and ensures a smooth tire mounting process. These features add to long term performance and provide a lower total cost of ownership for the customer.”

Designed to ETRTO (European Tire and Rim Technical Organisation) standards, the Profi-Grip wheel has been developed to deliver significantly improved contact pressure between any brand of tire and the rim - which not only eliminates slippage, but also makes the fitting of high-load capacity tires faster and more straightforward and provides enhanced durability. Extensive tests, both on-track and in-field, have confirmed that the rim design eliminates tire slippage completely.