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Managing Soil Compaction

Soil structure and compaction

Soil compaction is seen as one of the primary causes of soil degradation worldwide and farmers in the northern cropping region are actively looking at how to manage it in their farming systems.

Compaction is a function of the mechanical strength of the soil. Soil strength is influenced by properties such as the clay content (soils with higher clay content tend to be more prone to compaction), moisture and organic matter.

Compaction occurs when the load applied to the soil exceeds its precompression strength, resulting in increased bulk density. Precompression strength is higher in dry soil, however it reduces quickly as soil moisture increases and the soil approaches field capacity. This means that soils with higher moisture content will be more susceptible to compaction.

With compaction, pore spaces are reduced; root growth is restricted and the availability of nutrients and water is impacted. Soil compaction can also increase denitrification, further reducing the availability of nitrogen.

Machinery size and weight

Both producers and manufactures are looking for efficiency gains in their farming systems, leading to a trend for bigger, wider and ultimately heavier machinery. However, with the introduction of heavier machinery, the potential for compaction is increased.

Some compaction is an inevitable consequence of using heavy machinery. The challenge is to balance the efficiency gains of this machinery, with the risks associated with compaction, the costs to productivity and the cost of addressing the compaction.

Research on the impact of the JD7760 cotton picker shows the effects a heavy machine such as the JD7760 can have on soil compaction. The research found that a single pass of the picker, fitted with single tyres inflated to the manufacturers recommended pressure and driven over previously non-wheeled soil, increased soil bulk density by about six percent on average compared to non-wheeled soil. Additionally, the study found that the cone index increased significantly, which infers higher resistance to penetration.

Importantly the JD7760's field footprint would be worsened if the machine was fitted with dual wheels on the front axle. In a field situation the dual wheels increase the area trafficked and compacted by 66 percent.

A range of research studies conducted in the last 15 years has found that crop yield is significantly affected by soil compaction. Additionally, as compaction is irreversible in the short term, it is important that producers implement good management practices such as minimum tillage and control traffic farming. This will help to maximise efficiency gains and minimise the possible negative impacts.

The degree of compaction will be influenced by the weight of the machine, the axle load, the individual wheel load, the tyre inflation pressure and the soil conditions. Tyre dimensions and inflation pressure have been found to have a relatively larger impact closer to the surface, but the wheel load has a greater impact at depth.

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Using Control Traffic Farming

Control traffic, and minimal or no till farm practices have been utilised across the northern cropping region for many years, although the adoption of true control traffic farming systems in Australia is estimated to be as low as 20%.

The primary objective of control traffic is to reduce the percent of the soil trafficked. In a fully implemented control traffic farming system all machinery has the same working and track gauge widths. Ideally there should be no more than a two cm variation in the wheel tracks.

The relatively low adoption to true control traffic farming is most likely due to the cost of fully implementing the system. Converting machinery can be expensive, and some existing machinery may be incompatible because of the existing track width or the implement width. There is also the challenge of integrating both the metric (European) and imperial (American) systems. Another important consideration for farmers is the issue of warranty, which may become void with some modification.

However, a study by Tim Neal demonstrated that converting machinery is not necessarily as expensive as growers think, and that the benefits can be significant. For example,

harvest traffic can reduce yield by as much as 15 to 30 percent, which can cost $160 to $350 per hectare. In most situations headers can be converted from two meter centres to three meter centres for less than $30,000, this means that the conversion would provide a good return on investment.

Alleviating Compaction

Prior to deciding how to reduce the impact of compaction, it is important to have a clear understanding of the problem. Is the compaction shallow or deep, how thick is the compaction layer?

Compaction in the top 30cm of the soil may be able to be alleviated by tillage. Subsoil compaction however requires deep loosening of the soil. This can be expensive due to high energy requirements, and will only be beneficial to the depth of deep tillage achieved. The best results will be achieved when the soil is dry to depth. However, deep tillage is not advisable as a long-term solution due to potential for incorrect moisture content for tillage, and it can undo the good of strategic tillage. Conversion to controlled traffic is the ultimate solution.

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