Appendix 1 – Case Studies

Case Study 4:

Machines for soil management

UK agricultural engineers, working with international partners, are leading development of farming systems to improve yields and meet environmental and sustainability goals. The challenge is to move away from current largely random vehicle traffic over fields to a more controlled regime. The benefits in decreased soil damage, improved soil water and air transport and better crop growth can be considerable. Yield improvements could be obtained relatively quickly with phased investment in new machinery, if manufacturers can be persuaded to support equipment development. The agricultural industry can mobilise resources to address these issues – but good engineers and applied scientists are needed to develop appropriate systems.

The increasing weight of farm machinery is a cause for concern because soil compaction can impede crop growth and yield, and also reduce water infiltration, leading to runoff, pollution of water courses and enhanced flood risk. This was recognised in the Strutt Report[20], following the disastrous harvest conditions in 1968, and led to research to alleviate and repair damaged soils. Work was conducted on methods to reduce contact pressures and repair compacted soils by improved soil loosening. Unless special care is taken following loosening, by using vehicles with low contact pressures, the soil easily re-compacts and yield benefits are lost. In the 1980s and 90s, gantry farming was developed in the UK, demonstrating the benefits if traffic could be minimised. More recently, following the practice of growing high value root crops in beds to give improved yield and quality, work in Australia[21] on controlled traffic farming systems (CTF) showed improvements in wheat yield of up to 15%. The principle of CTF is to limit wheel tracks of field operations to about 25% of the field rather than the 90% of "conventional" random traffic. This has become easier with automatic steering systems on field machines, and reliable and affordable real time kinetic (RTK) global positioning systems (GPS). In addition to yield increases, the energy for tillage is reduced, simpler more timely tillage systems are possible and improved rainfall infiltration rates of up to 400% have been recorded[22].

Replication of the Australian method, based on 3m track centres, is difficult here due to restrictions on road transport of equipment. A group of leading farmers, working with the organisation CTF (Europe), are developing novel methods to overcome these issues. CTF Europe is seeking to establish a Soil and Water Management Centre at Harper Adams to address a broad range of practical soil and water issues. Their first goal is to address soil compaction by establishing a long term experiment on alternative traffic management systems (conventional random, lower ground pressure and CTF) and alternative tillage operations. The main problems are that machinery must be re-engineered to work within system constraints (e.g. wheel track and harvester widths). For some farm systems, CTF is too complex but reduced contact pressure (LGP) can deliver benefits after further development and communication to farmers. Though improvements in tyre design have been very significant, smarter systems to reduce wheel slip would be beneficial. Rubber tracks have provided significant advances in vehicle manoeuvrability and in overcoming deep compaction[23], but development to reduce peak pressures offers further benefits. Improved design methods and new high-strength materials to reduce the axle load across the range of farm machines can further reduce compaction. Already benefits in yield, fuel use and time of operations of greater than 10% have been demonstrated in the UK.

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[21] Tullberg, G, Yule, D F and McGarry D. (2003) 'On track' to sustainable farming systems in Australia. 16th Triennial Conference – ISTRO, Brisbane

[22] Chamen, W C T. (2011) The effects of low and controlled traffic systems on soil physical properties, yields and the profitability of cereal crops on a range of soil types. PhD Thesis, Cranfield University

[23] Ansorge, D and Godwin R J. (2007) The effect of tyres and a rubber track at high axle loads on soil compaction, Part 1: Single axle studies. Biosystems Engineering, 98, 115-126

Minimising Soil Compaction

Controlled Traffic Farming

The Challenge

Unplanned largely random field traffic can result in soil damage over significant areas of the field. Any soil compaction can impede crop growth and yield. It can also reduce water infiltration, which in turn can lead to runoff, pollution of water courses and enhanced flood risk.

The Solution

Use of controlled traffic farming systems (CTF) has shown improvements in wheat yield of between 5 and 15%. The principle of CTF is to concentrate wheel tracks of field operations to about 25% of the field rather than the 90% of “conventional” random traffic.