CTF in Australian grain production: Less emissions and better economics

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Most of the funding of CTF research in Australia has been provided by organisations with a major focus on environmental issues: energy, soil and water or climate change. On-farm adoption, on the other hand has been driven by considerations of economics and practicality, where farmers see CTF as a more productive and easier farming system. This paper illustrates the close relationship between good environmental outcomes and good economics, quoting CTF-related impacts (%) where published evidence is available. These will obviously vary in different environments.

CTF = LESS ENERGY, LESS SOIL DEGRADATION & FUEL.

In conventional farming tractors rarely transmit more than 75% of axle power to an implement, so "what happened to the lost 25%?" was the starting point CTF research in Queensland. The lost power is obviously used to compact soil under the tyres. This increases its strength and so roughly doubles the power requirement of de-compacting (tilling) that soil. Without CTF, heavy wheels drive over and compact 50 – 80% of field area in each crop. Compaction will ameliorate naturally with biological activity, wetting and drying or freezing and thawing, but these effects occur very slowly. Under non-CTF farming, compaction can't usually be seen – because it's everywhere.

Power used to propel machines is substantially reduced when wheels stay on permanent compacted traffic lanes in CTF (e.g. 2 – 3l/ha harvester fuel saving). Less power is needed for seeding and none for decompaction, so CTF can reduce fuel use to 25% of that of tillage agriculture and 50% of that in non-CTF no-till. The important point is that fuel saved by CTF would otherwise have been used to damage soil structure.

CTF = MORE HEALTHY SOIL WITH BETTER POROSITY & PRODUCTIVITY.

Wheeling increases bulk density, but the impact on porosity is more important. Compaction affects the larger soil pores that allow the movement of water and air, which is important to soil biota. Earthworm numbers in long-term, non-wheeled soil were greater than those in tilled and no-till wheeled soil by factors of 4 and 2 respectively. The disease-suppressive effects of CTF have also been noted. Wheel compaction also affects the pore size range responsible for water storage, and the top 30 cm of CTF soil has been found to hold >40% more water in plant-available form. This is probably the major factor accounting for 5 – 20% yield improvements found in side-by-side tests. The ameliorative effects of roots, soil biota, wetting/drying or freeze-thaw activity can spread progressively down the profile in CTF, uninhibited or reversed by the effects of heavy wheels.

CTF = LESS SOIL LOSS & WATERWAY POLLUTION WITH LESS RUNOFF

Increased infiltration rates and internal drainage in CTF will substantially reduce run-off volumes (3-year cumulative effects: 22%–Australia, 8%–N. China). This in turn will reduce surface movement of soil, nutrients (N&P) and pesticides into waterways, an effect likely to be significant in terms of nutrient damage to (e.g.) the US Great Lakes and Australia's Great Barrier Reef. The complimentary effects of crop residues and controlled traffic also allow greater cropping intensity, another important factor in reducing run-off, soil erosion and pollution. In most environments, run-

off will still occur during intense rainfall events which might be occasional, but can nevertheless cause major soil loss and system damage. Permanent traffic lanes will always modify overland water movement, so layout design for optimum water management and cropping logistics is an essential of effective CTF.

CTF = LESS GREENHOUSE GAS = LESS WASTED FERTILISER

Compaction increases the duration of waterlogging and high levels of water-filled porosity following rainfall. These are the conditions when nitrogen fertiliser is lost as gas, a small proportion of which is nitrous oxide – cropping agriculture's biggest contribution to global warming. Nitrous oxide emissions from CTF soil are less than 20% of those from wheel tracks, suggesting that CTF (15% wheeled) should roughly halve soil emissions compared with random-traffic soil. Less nitrous oxide emissions mean less loss of nitrogen fertiliser, but other CTF effects such as improved soil health, reduced loss in runoff and greater water storage would also influence N fertiliser efficiency. These probably account for farmer and consultant claims of increased yield with 15 – 30% less N from both E and W Australian grain growers.

CTF = MORE TIMELY OPERATIONS.

Trafficability is often the main constraint to operations occurring at the optimal time after rainfall events, and hard compacted traffic lanes allow CTF operations to start earlier after rainfall. Evidence on this is largely anecdotal, but starting 1 – 3 days earlier can provide substantial benefits. The most obvious benefit is economic, because machinery expenditure reflects the need to complete tasks before significant loss occurs. CTF allows more fieldwork to be completed at the optimum time, providing better agronomic outcomes. Alternatively, the same results can be achieved with less machine capacity. In either case a better outcome is achieved, regards of whether it's assessed in terms of economics or the environment.

CTF = A BETTER SYSTEM.

You don't need much science to understand that crops grow better in soft soil, but wheels work better on roads. The science reported here all confirms this idea, but the impact of any specific CTF benefit will vary with the environment. Soil and hydrology effects, for instance are particularly significant to crop yield in semi-arid environments where yield is commonly reduced by water-stress.

All the effects of controlling field traffic are positive for both crop yield and the environment, but its important to see that the overall impact of CTF is greater than the sum of individual effects. This applies particularly in its relationship to removing most of the reasons for tillage, facilitating weed management, precision and no-till interrow seeding. In Australia, CTF in grain is almost all no-till, and CTF farmers regard it as an easier and more productive farming system.

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