Enhancing Resilience and Reducing GHG Emissions in Australian Crop Production

SUBMISSION 43

Submission to the House Standing Committee on Primary Industries and Resources Inquiry into the role of government in assisting Australian farmers to adapt to the impacts of climate change.

by the **Australian Controlled Traffic Farming Association, ACTFA (www.acctfa.net)**

This document is submitted on behalf of ACTFA, the Australian Controlled Traffic Farming Association, an association of farmers and scientists concerned with the productivity and sustainability of Australian agriculture. It has been prepared by Dr Jeff Tullberg, executive committee member of ACTFA, Honorary Research Consultant, School of Land, Crop and Food Sciences, University of Queensland, and Director, CTF Solutions, Taringa, Qld.

Summary.

The machine tools of Australian crop production -- tractors, planters and harvesters -- are extremely heavy, applying axle loads in the range 5-20t to the soil. Prior to the development of precise (2cm) GPS autosteer systems, tractor/machinery operating patterns were of necessity random, which meant that heavy wheels compacted 50 -- 100% of field area per crop. Driving a 5 t tractor over cropping soil has been shown to:

1. Increase the power requirements of subsequent planting or tillage operations by 50%,
   increasing fuel use and CO_2 production.
2. Increase runoff by 40% under high intensity rainfall, increasing erosion and pollution
   increasing fugitive emissions from nitrate input to watercourses.
3. Reduce long-term average infiltration and crop yield by 15%, and plant available water by 40%,
   reducing biomass production and CO_2 absorption.
4. Reduce earthworm numbers and other indicators of soil health by 40-70%,
   reducing water use and fertilizer efficiency, increasing CO_2 from N. fertiliser manufacture.
5. Produce widespread soil compaction,
   increasing incidence of waterlogging and N_2O production.

These problems are avoided or diminished in controlled traffic farming (CTF), which now uses GPS autosteer to keep all heavy wheels on precise, permanent traffic lanes managed for efficient transport, and occupying ~10% field area. Permanent traffic lanes allow damage-free access to growing crops for timely and precise placement of fertilisers and agricultural chemicals, improving fertiliser efficiency and reducing inputs.

Conservation agriculture,(zero tillage, maximum residue cover and rotation) is much easier on soil undamaged by wheels, while cropping strategies to increase biomass production -- e.g relay cropping and rapid re-planting of economic or cover crops -- become feasible when operations take place from compacted permanent wheel tracks.

CTF enhances resilience by improving water use and fertiliser efficiency, and reducing fossil fuel requirements.
CTF reduces the direct and indirect CO_2-e emissions associated with crop production by 25 -- 35%.
CTF facilitates conservation agriculture, and will enhance carbon sequestration in cropping soils.

Recommendation

That the Federal government funding be provided via the CfoC program to quantify the impact of CTF on system water use efficiency, nitrogen use efficiency and soil emissions.

That CTF be recognized as an essential aspect of improving the resilience and greenhouse gas performance of cropping industries in Australia.

Note.

ACTFA is aware of and fully endorses the submission entitled "The benefits of Controlled Traffic Farming to assist adaptation to climate change for Australian crop production industries", prepared by John McPhee, Extension Leader, Vegetable Research, Development and Extension Centre, on behalf of the Tasmanian Institute of Agricultural Research, and appended below.

The present submission seeks only to emphasise and reinforce some aspects of that more comprehensive submission, particularly those related to nitrous oxide emissions. These aspects are summarized in the statements enumerated above, and by documenting the specific evidence to substantiate those statements, as set out below.

Evidence.

Preamble:

Visual inspection with the aid of a tape measure will demonstrate that the width of heavy wheels of most harvesters, and of most tractor/planter combinations, is approximately 20% of machine operating width, so these two operations wheel approximately 40% of paddock area. Wheels associated with sprayers and logistics (seed/fertiliser/grain transport) cover approximately 10%. Unless traffic is controlled, crop production involves driving heavy wheels over approximately 50% of crop area.

Statements:

1. Driving a 5 t tractor over cropping soil has been shown to -- increase the power requirements of subsequent planting or tillage operations by ~50%, *increasing fuel use (and CO_2 production).*
See Tullberg, J.N. (2000). Traffic Effects on Tillage Energy. Journal of Agricultural Engineering Research 75(4).375-382.pp.

2. Driving a 5 t tractor over cropping soil has been shown to -- increase runoff by ~40% under high intensity rainfall, increasing erosion and pollution. *increasing nitrate input to watercourses (and fugitive emissions)*
Tullberg, J.N, P.J. Ziebarth,and Y.X. Li, (2001).Tillage and traffic effects on runoff. Aust. J. Soil Res.39,249-7.
Xiaoyan Wang, Huanwen Gao, J. N. Tullberg, Hongwen Li, Nikolaus Kuhn, A. D. McHugh and Yuxia Li (2008). Traffic and tillage effects on runoff and soil loss on the Loess Plateau of northern China. Australian Journal of Soil Research Volume 46(8) pp 1-9.

3. Driving a 5 t tractor over cropping soil has been shown to -- reduce long-term average infiltration and crop yield by 15%,and plant available water by 40%, *reducing biomass production (and CO_2 absorption).*
Li Y.X, J.N. Tullberg, D.M. Freebairn (2007). Wheel traffic and tillage effects on runoff and crop yield. Soil and Tillage Research, 97, 282-292
McHugh A.D., J.N. Tullberg, D.M. Freebairn (2008). Controlled traffic farming restores soil structure. *Soil and Tillage Res, (accepted, in pres doi:10.1016/j.still.2008.10.010s)*

4. Driving a 5 t tractor over cropping soil has been shown to -- reduce earthworm numbers and other indicators of soil health by 40-70%, *reducing water use and fertilizer efficiency, (increasing CO_2 from N. fertiliser manufacture).*
Pangnakorn, U., D.L. George, J.N. Tullberg and M.L. Gupta (2003). Effect of tillage and traffic on earthworm populations in a vertosol in South-East Queensland. ISTRO Proceedings CD, University of Queensland.

e.g. Wylie P.(2008) High profit farming in Northern Australia, GRDC, Canberra

5. Driving a 5 t tractor over cropping soil has been shown to -- produce widespread soil compaction, *increasing the incidence of waterlogging and N_2O production**.
Tullberg J.N., D.F. Yule, D. McGarry. (2007) Controlled traffic farming—From research to adoption in Australia. Soil & Tillage Research 97 272–281
Tullberg J.N. (2009). Avoiding Soil Compaction in CA: Controlled Traffic Systems for Mechanised CA and their Effect on Greenhouse Gas Balances. 4th World Congress on Conservation Agriculture, Delhi. Lead Paper Proc. pp 185-190.
Rochette P (2008) No-till only increases N_2O emissions in poorly-aerated soils. Soil & Tillage Research 101 (2008) 97–100

* There is ample evidence that nitrous oxide emissions from compacted soil are much greater than those from non-compacted soil is consequence of the increased incidence of high levels of water-filled porosity. Greater nitrous oxide emissions certainly occur from compacted soil of wheel tracks, where those wheeltracks are freshly formed each year from soil in which organic matter and residual fertiliser have been thoroughly mixed by annual tillage.
e.g. Ruser,R, . Flessa,H., Schilling,R., Steindtl,H., Beese F. (1998). Soil compaction and fertilisation effects on nitrous oxide and methane fluxes in potato fields. Soil Sci. Soc.Am..J. 62; 1587-1595

Controlled traffic results in a much greater proportion of non-compacted soil, which might be expected to reduce overall nitrous oxide emissions. The only assessment carried out to date occurred in organic vegetable production with a "seasonal" controlled traffic system (controlled traffic only after annual ploughing). Controlling traffic reduced overall nitrous oxide emissions by 35%, and the methane balance changed from one of limited emission to limited absorption in this situation. Improved porosity was seen as the mechanism largely responsible for this improvement.
Vermeulen, G.D., Mosquera, J. (2008). Soil, crop and emission responses to seasonal-controlled traffic in organic vegetable farming on loam soil. In press, Soil Tillage Res., doi:10.1016/j.still.2008.08.008

These positive effects should be greater in a permanent controlled traffic zero tillage situation, where no soil mixing occurs, and fertiliser is not applied to permanent traffic lanes. It is applied only to the crop beds using the permanent traffic lanes to provide reliable access and allow more timely, precise application to improve efficiency and reduce the opportunity for N_2O emissions.