

CONTROLLED TRAFFIC FARMING

Jiri Masek, Milan Kroulik, Frantisek Kumhala

Czech University of Life Sciences Prague, Faculty of Engineering

masekj@tf.czu.cz

Abstract. The GPS guidance systems are used almost in all field operations. In relation to the soil protection against erosion and compaction other possibilities are locked for guidance systems utilization in this time. Passages of heavy agricultural machinery across a field are a common practice nowadays but they are mainly random. As a result of this fact, soil is exposed very often to repeat passages and thus irreversible structural changes connected with soil compaction. According to literature sources and many experiments, the soil compaction caused by traffic reduces soil infiltrability, hydraulic conductivity, porosity, aeration and increases bulk density and impedance for root exploration. The guidance systems and Controlled Traffic Farming system, which is based on maintaining the same wheel lane for several years for each field operation, are one of the tools which can be used in soil protection against soil compaction.

Keywords: controlled traffic farming, soil tillage, soil compaction.

Introduction

Controlled traffic farming (CTF) is all about managing soil compaction – confining it to narrow strips across the land and maximizing the remaining undamaged soil area for cropping. In practice it means matching machinery tracks so they take up the least possible area. Although this is made simpler by satellite guidance, it can be achieved with conventional marking systems. Farm conversion to CTF in the first instance means adopting a CTF “mindset” – the belief that separating wheels and crops is a key method of reducing costs and increasing returns. From here on it is simply a matter of good planning and timely investment that ensures a minimum 15 % return on capital, an increase in crop returns and a substantial reduction in costs [1].

Controlled traffic farming cuts fuel, labour and machinery costs by reducing soil damage. This makes farming simpler, more reliable and less time consuming. It also delivers environmental benefits, such as reduced water run-off and soil erosion, improved fertilizer use efficiency, less risk of nitrous oxide and methane emissions and improved carbon sequestration. Overall, with reduced fuel, energy and machinery inputs and fewer greenhouse gas emissions, the carbon footprint of CTF is likely to be the lowest of all farming systems.

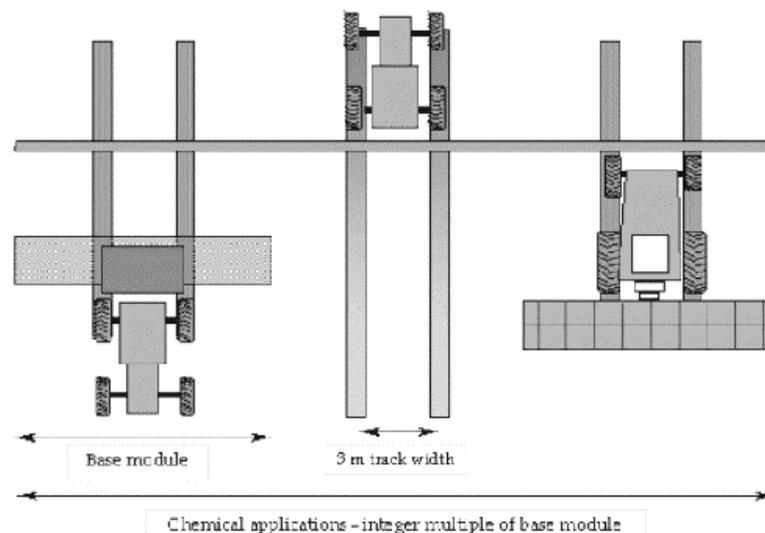


Fig. 1. CTF system with base module of 9 m and a 3 times multiple to give 27 m for chemical applications. The wheel track width is 3 m [1]

CTF is a simple way of reducing input costs (time, fuel and machinery) – and at the same time increasing crop yields – both of which are done sustainably and both of which increase farm profit. CTF is a whole farm approach to the separation of crops and wheels; it is a system that avoids the

extensive soil damage and costs imposed by normal methods. Controlled traffic is not rocket science – it simply involves confining all field vehicles to the least possible area of permanent traffic lanes.

Appropriate agronomy and management is used to maximize the potential of both the cropped and wheeled areas for their specific purposes. In practice it means the repeated use of the same wheel tracks for every operation, and although it is ideal for all machines to have the same wheel track (the distance between the left and right wheel centres) and for all implements to have a particular span (base module) or whole number multiple of it, this is not essential. The percentage area wheeled can be reduced to 30-40 % even with two different track and implement widths. The illustration below shows an optimized CTF set up with planter, harvester and chemical applicator [1].

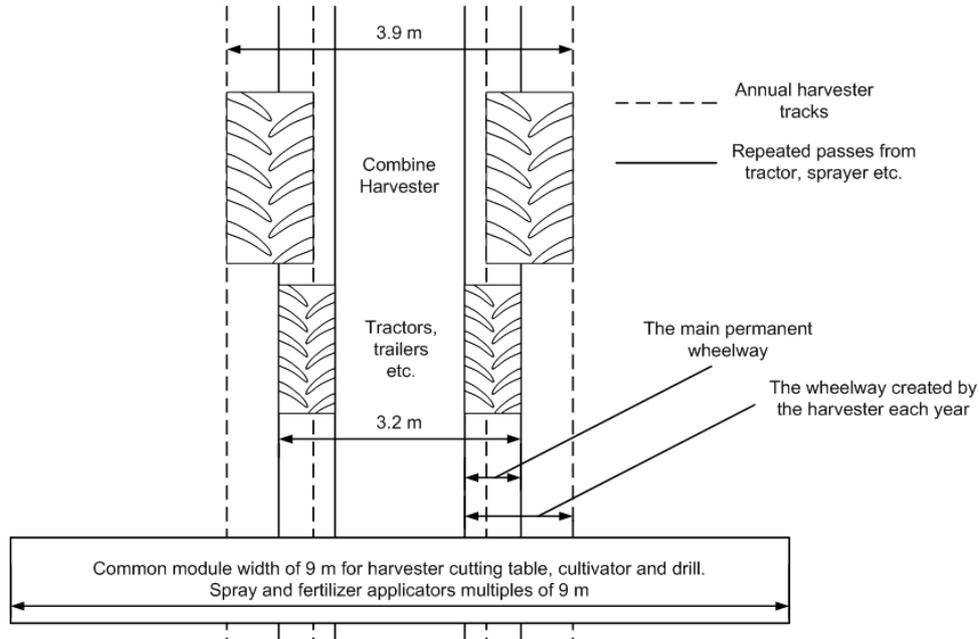


Fig. 2. Common module for different types of tractor, sprayer, trailer and harvester [1]

CTF is appropriate for anyone growing crops, whether these are grass, roots, energy, legumes or cereals, on any scale and whether with manual, semi- or highly-mechanised systems. It is a system that cuts costs at their source; it creates opportunities and avoids compromises associated with wheels, rutting and poor cloddy seedbeds [2]. It should be the goal of all producers. CTF is possible to be used in conventional soil tillage system based on ploughing, but ploughing removes some of the benefits and the hope is that it will not be necessary. Obviously ploughing will loosen all of the wheel ways and in many cases displace the compacted soil laterally. To minimise the damage caused by ploughing, the tractor hauling the plough should work on the land, not in the furrow, and the direction of ploughing should be at right angles to the wheel ways.

There are many benefits associated with CTF and they all help to deliver the two most important factors in farming operations – increased profit and improved sustainability [3]. These are delivered by improving soil health, which in turn lowers costs and increases crop returns but it also results in improved environmental conditions. Lower costs and increased returns are brought about by [1]:

- Lower energy for cultivation.
- Lower energy for driving over the soil.
- Lower machinery investment.
- Better seedbeds.
- Improved soil structure.
- Increased potential and accuracy for global positioning systems.
- Improved fertilizer use efficiency.
- Potential to retain more organic matter and soil living organisms.
- Improved water storage.

Converting to CTF does need some thought and once achieved, more discipline. No longer must growers think of their fields as open areas to sneak across when in a hurry; the soil becomes sacrosanct and is treated with extreme care. There is a perception that converting to CTF is costly but the reality is large savings in time, energy, labour, fuel and machinery investment. The more thought and the better the planning, the greater will the savings be. The first stage in conversion is a machinery inventory – what have you got and how does it measure up and how much of it will you use in the future when your soil may need little or no cultivation? These deliberations together with increasingly sophisticated tools to help growers make the transition, means that a CTF system customised to each farm will present itself [4].

Because machines have not so far been designed with CTF in mind, there will be constraints, but a 25 % tracked area is vastly different from annual 75 % random tracking. This is because damage takes many years to repair naturally, particularly deeper in the profile. Another way of reducing the tracked areas is to choose narrower but perhaps larger diameter tyres, making sure they can take the loads imposed on them. These narrower tyres are potentially less costly and it therefore pays to buy the best quality, but only experience will tell you how narrow in terms of maintaining the traffic lanes [5].

Materials and methods

In order to gain the enter data for further Controlled Traffic Farming systems observation, several measurements concerning the frequency and total area of machinery passages in a field were done. The experiment was prepared in real field conditions by a conventional soil tillage system used. The observed field is situated in the west part of central Bohemia. There were observed all working operations during a year from soil preparation until soil tillage after harvest. For the experiment we needed DGPS receivers and a data storage unit only. The DGPS receivers were placed into a machine for monitoring of all machinery passages across the observed fields with 2s logging time for position data saving. The total area covered by machine's tyres by passages we calculated according to the tyre width and their number on machines. The field experiment contains three different soil tillage technologies - conventional soil tillage based on ploughing, minimum soil tillage and direct seeding (without soil tillage).

Results and discussion

The whole working operation was observed during the year. On the field a conventional soil tillage system with ploughing as the main working operation for soil tillage was used. Figures 3, 4 and 5 show tramlines on the surface of the field plot in 1 ha segment. For better visibility we use trajectory of individual passages only. The total area covered/run-over by all machine's tyres was calculated with help of the software ArcGIS 9.

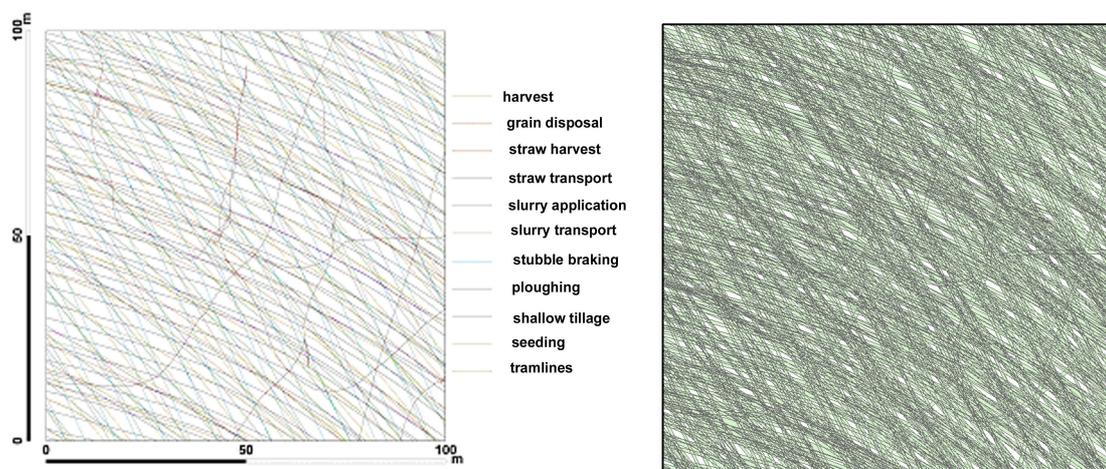


Fig. 3. Tramlines evaluation by conventional soil tillage (based on ploughing)

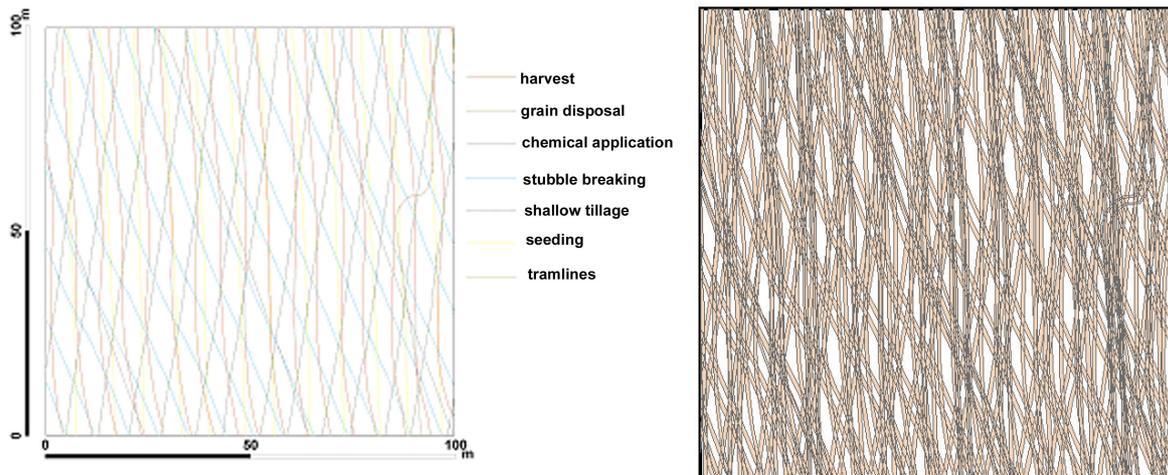


Fig. 4. Tramlines evaluation by minimum soil tillage (based on shallow tillage)

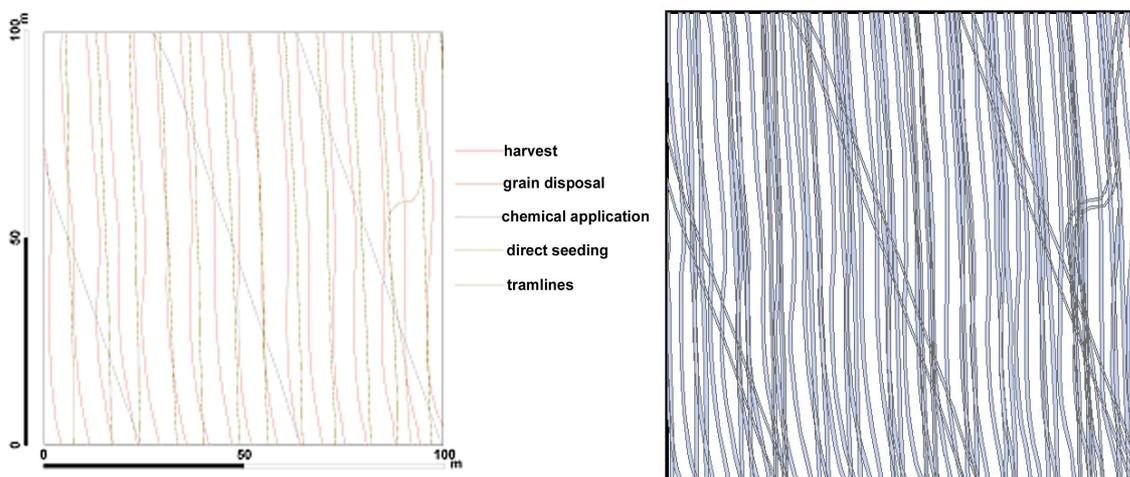


Fig. 5. Tramlines evaluation by no-till system (based on direct seeding)

The results show a considerably high number of tyre contacts with soil. The total area covered by tyre passages calculated for conventional soil tillage is in average 96 % of the total area of the field (Figure 3). By conservation soil tillage technology (Figure 4) the total area covered by tyres will be 65.5 % only and by using no-till technology (Figure 5) it is only 42.2 %. These numbers show the biggest benefit of controlled traffic farming. By using conservation soil tillage technologies and the system of permanent tramlines it is possible to achieve lower area compacted by tyres and lower soil structure destruction. The total area of passage is less than 30 %.

Conclusions

Reducing of soil tillage leads to lowering of soil compaction. Trafficking fields causes soil compaction which has many deleterious consequences in terms of crop yield, soil functions, nutrient uptake, energy demands and seedbed quality. If this trafficking is random, it creates enormous potential for in-field variability. Technology and good management now allow us to avoid this artificially created unevenness. Common sense tells us that if we are attempting to practice precision farming, it is logical not to introduce inconsistency. Controlled traffic farming is a relatively simple concept that uses best available guidance and auto-steer technology, together with machinery matching, to confine traffic loads to the least possible area of permanent traffic lanes. Wisely designed systems mean that no axle conversions are needed and fully integrated systems deliver significant cost savings, increased yields and vastly improved soil health. Improvements in soil health have large implications for reducing greenhouse gas emissions, lessening the risk of flash floods and reducing the potential for diffuse pollution.

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