CTF Adoption Protocol

What CTF is
CTF is any system that confines all field machinery to the least possible area of permanent traffic lanes.

Assumptions
This protocol assumes that the practitioner has adopted a CTF mindset. This means that he or she is aware of the benefits that accrue from:

1. Confining compaction to the least possible area and allowing the surrounding soil to achieve its full potential.
2. Delivering field treatments more precisely and efficiently through accurate machine guidance that keeps vehicles in exactly the same place year in year out.

Protocol aim
The protocol aims to help potential practitioners achieve CTF reliably with the greatest potential for additional returns and cost savings. Presently, this protocol relates generally but not exclusively to combinable crops.

Summary of CTF Adoption Protocol
1. Decide future cropping, including rotation
2. Identify what machines you will need to reliably maintain this cropping within a CTF scenario. You will need to remember and consider:
   - CTF will generally preclude any need for deep soil working to maintain structure, but some headland repair may be needed.
   - What is the most difficult crop establishment scenario on your soil? For example, will your proposed system work with wheat after wheat on heavy soil, particularly if straw has not been chopped or spread efficiently?
3. How well do any of these machines fit together in terms of their working and track widths? Remember:
   - Some non-matching implement and track widths can work reasonably well together (look at the various options in the spreadsheet), but you may need to try them out on paper.
   - The “OutTrac” system can work well, particularly if the narrower track can be widened without great cost, now or in the future.
4. Decide what guidance will be used to keep the vehicles “on track”.
   - The more tracks you have per unit width, the greater the advantage of accurate guidance
   - Whatever guidance system you are using, if you are working across slopes with trailing machines, the area of wheel tracking will increase. Consider working straight up and down if you can.
5. Calculate costs and returns over a realistic timescale:
   - Include all costs for machinery adaptation and guidance as well as additional crop returns, revenue from sales and savings on labour and materials through more accurate operations.
The Protocol in more detail

Planning procedure
This is likely to be an iterative process requiring a few attempts to achieve an optimum solution. In the future this will be helped by a spreadsheet into which measurements are entered and answers automatically calculated.

Cropping
Plan and log your likely future cropping programme and rotation

Machinery
- Decide which machines (including tractors, harvesters and trailers) you need to maintain this cropping programme reliably without the constraints of random soil compaction (e.g. excessive clodiness, regular need for deep loosening). You must be sure for example that if you grow the same crops consecutively, or grow spring crops on moist heavy soils, that you can establish them reliably with the proposed equipment.
- Recognise that you may need to carry out some repair of fields prior to adoption and field headlands after you have adopted CTF.
- Measure the track (gauge) and working width of these machines and note their tyre and/or track equipment. If you don’t have tyre data books, also measure the overall width of the tyres or tracks. This will probably be wider than the bit that touches the ground, but will allow for some error in the guidance system.
- Sketch the results to scale and consider what options are open to you by looking at the various systems shown in the accompanying Excel file. Two examples are shown below. Look at the cheapest options first. Also be aware that you are quite likely to come up with your own unique solution; there are many ways that an effective controlled traffic solution can be achieved.
- Estimate the costs and revenues (sale of machines) for this solution and calculate the net figure. Don’t forget to consider:
  - length of harvester unloading augers to reach the adjacent permanent traffic lane, or an alternative interim solution.
  - the cost of standard track width adjustments to your machinery.
**AdTrac.** A CTF system with two standard track widths, the narrower using one track of the wider, resulting in an additional track. Implements can be any common width or direct multiple. This is a flexible system because any gauge of narrower standard track width can be chosen and it has no influence on the implement width.

**Ad2Trac.** A CTF system with two track and two implement widths. One wheel of the narrower track coincides with the harvester track on a regular basis, providing the following holds true:

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2 \times \text{implement width} = \text{harvester cutting width} + \text{harvester track width}
\]

**Fig 1. Example of two CTF systems that use standard equipment and conventional track settings**

**Machinery guidance**

Be pragmatic about guidance. The aim is to set up a permanent set of wheelways that are used year in year out and whose cost of installation and maintenance are cost effective. Although physically-based systems such as marker arms suffer from cumulative errors, if
you minimise this error when setting up the CTF system and then maintain their initial position from season to season, this can be a reasonable starting point.

If you choose a satellite system:

- remember that without a local base station correction, you will need a reliable means of returning exactly to your tracks in each field (see separate guidance protocol, *hold down the Ctrl key when clicking link to avoid closing this file*);
- assess the potential for signal loss in fields with surrounding buildings or trees;
- remember that satellite guidance also provides you with accurate mapping and the ability to measure outputs and inputs.

**Costs and returns**

Decide what method of guidance you wish to adopt and estimate the total cost. Calculate costs and returns over a realistic timescale:

- Include all costs for machinery adaptation making sure that you have considered such things as getting grain into a trailer running in a parallel wheel track. Equally, don’t forget revenues from machines no longer needed, tractor power lost off the farm and fuel saved. In time, there could also be savings on tyre equipment.
- Assume a yield increase of 8% on the completely non-trafficked soil area and no change on the cropped wheelways (providing they are not heavily wheeled, e.g., more than twice a season in moist conditions.
- Don’t forget the advantages of accurate guidance, such as savings on chemicals, seed, labour and fuel (an accompanying spreadsheet will calculate these for you, see below).

Enter this information in the guidance spreadsheet together with the predicted accuracy and the period over which the equipment will be written off.

**Setting up CTF in the field**

**Orientation of wheel tracks**

This will almost certainly be decided by what you are doing at the moment, particularly in terms of chemical or fertilizer applications. The decision must be dominated by field efficiency and practicalities. It is probably wise however to review your current system in terms of water movement. Ideally wheel tracks should go up and down slopes, or at least avoid dips in low places. When this can’t be avoided, we may need to “engineer” water out of the wheelway into the surrounding bed. Also be aware that crabbing might be a problem with trailed machines, so look at the section later in this document to determine how to deal with this.

**Deep soil loosening**

When entering into CTF, each field should be assessed independently. Is there a compaction problem within subsoiling depth? There might be a pan at plough depth, or severe compaction in the top 20 cm. This is not always easy to tell from soil inspection when you have no “good” structure to compare it with, but the following suggestions may help you:
• Did you observe that crops were suffering at any stage of their growth – showing signs of yellowing or stunted growth and particularly during rapid growth periods?
• How easy is it to get a fork into the soil in the field in question? How does this compare with soil that you know to have good structure and which is at about the same moisture content? Differences may be obvious just from the soil’s resistance to penetration with a fork or spade.
• Does water tend to stand in this field and if so, over what proportion of the area? Inspect the soil in these bad areas and compare it with the surroundings. Look at the examples below that show differences in soil structure at similar moisture content.

Finally, be aware that different soils behave very differently. Some clays expand and contract with wetting and drying and over a 6 – 12 month period with a vigorous crop and variable weather, can exhibit a good degree of recovery from compaction to around 20 cm (8” depth). If you are inspecting the soil after harvest, be aware of this and concentrate more on the profile below 8” (20 cm). Sandy and silty soils on the other hand may not recover much structure during a cropping season and an inspection at any time will reveal trends through the whole of the profile.
Actions

Subsoiling should only be considered if you have identified a problem and the conditions for loosening are correct, i.e. soil moisture content at loosening depth is low enough to initiate cracking rather than smearing and compaction. If soil moisture is too high (clay soils exhibit plasticity), you may do more damage than good.

Pay special attention to those fields that are destined for a second consecutive crop or a spring crop. Reliability of direct sowing of 2\textsuperscript{nd} wheats for example can be enhanced by deep loosening beforehand, and this may also be the case for spring sown crops.

When deep loosening prior to CTF, make sure that you don’t loosen in exactly the same direction as your planned CTF wheelways. If you do, there is a danger that drilling in particular will be compromised by tines or discs dropping into the same lines as the subsoiler.

If the field has been deep loosened before entering into CTF, pay particular attention to the condition of the permanent wheelways and follow the guidelines in the next section.

Maintaining a CTF system

Now that you have set up your system, how do you make sure it works and continues to work? There are a number of critical areas that we can identify and we will deal with these in turn.

Machine crabbing

Crabbing of trailed machines on side slopes is inevitable. The ideal solution is for the machine to have some steer that will offset any tendency for it to move downhill, but until this feature is widely available, we must deal with the problem as effectively as we can in another way. Fig. 2 shows that the tramline set up by the drill is not where it should have been. The only option here is to ignore the non-sown tramline and keep to the correct spacing because this will be where most operations are carried out, including harvesting, where misses will be unacceptable.

Crop residues

The key issues

There are a number of issues with crop residues but only one that is less easy to deal with when using CTF and this will be considered in its context below. The others are highlighted here purely as background information.

The issues are:

- Physical interference with a cultivator or drill, or both.
- Harbouring of pests and diseases.
- Not allowing the soil to dry out, particularly for spring sowing in temperate regions.
- Chemical application carry-over that has a detrimental effect on the following crop.

The degree to which physical interference is an issue is influenced by many factors, including:


c. Soil type and condition when cultivating or drilling.
d. Design of cultivator or drill.

Fig. 2. Effect of trailed drill crabbing on a side slope. A subsequent pass with a tractor spraying on the correct spacing shows a significant offset.

a. This largely determines the quantity of residue that will be encountered and also the amount that might be missed by the harvester. Higher yielding above ground crops tend to leave more residues and others, such as hemp or linseed, are extremely “stringy” and wrap around soil working tools.
b. The performance of a harvester when it is spreading residues is critical in terms of the degree of chop imparted and the evenness of distribution across the cutting width. The wider the cut, the more variable these factors are likely to be. Additionally, the height of cut may have positive or negative effects. Where residues are removed, interference problems are less likely.
c. Moist condition of either soil or residue is likely to make the problem far worse particularly on clay soils due to stickiness.
d. Machine design and type have a large influence on how well residues can be dealt with and these interact with soil and residue conditions.
**Impact of CTF on residue management**

The principal challenge imposed by CTF on residue management is the need for parallel working. In conventional practice, most farmers cultivate at angle to the crop rows, this generally being more effective in minimising blockages and dealing with the crop root ball. Equally of course, most re-drilling of crops will generally be parallel to the previous crop rows, largely because this direction will have been chosen to maximise field efficiency for subsequent crop chemical or fertilizer applications.

With CTF we need to choose cultivators that are generally impervious to direction of working in crop residues. Rolling cultivators are usually in this category and include disc and rotary harrows (soil driven) and twin rotors such as the “Dyna-Drive”. Equally, a power driven rotary harrow used shallow and with a high forward speed can be effective and energy efficient and imparts limited damage to the soil. Tine cultivators can also be successful, but dry conditions are needed and they must have at least 0.75 m spacing between elements in the same row. As with conventional practice, levelling and firming are just as important, particularly rolling for reducing slug problems and retaining moisture.

Another approach that we might adopt with CTF is to leave longer stubbles and sow between last year’s crop rows. This needs precise guidance and attention to detail, but is achievable and can deliver many benefits, including low inputs and less promotion of weed seed germination.

**Wheelways**

How much have these sunk in the first or second pass? If this is significant (3”/75 mm or more), consider a levelling pass between harvesting and sowing. The aim of the levelling pass is to bring soil from the surroundings into any sunken tracks. In reality the track may look something like that shown in Fig. 3, where sinkage has occurred just locally. An ideal machine for levelling is a power harrow used shallow and fast. It should obviously span both wheelways, but does not have to be as wide as implements used in the CTF system. Another approach is to use a machine something like the one shown in Fig. 4, but this should be confined to where soil “flow” has occurred. The danger with this relatively narrow machine is that it can cause some rounding off at the edge of the bed, but it is ideal where only local disruption of the soil has occurred, as with soil flow. A levelling pass of this nature may not be required again for several years, if at all.

**Challenges**

You will have noted that these procedures primarily relate to combinable crops but we are gradually embracing other systems, not least of which are high value leaf and other crops. Mostly the challenges are associated with harvesting, but if we can get CTF systems in place before these crops are grown, their performance will be enhanced through improved soil structure, even if this is damaged during the harvesting process. The difficulty of matching all wheel track widths to that of the combine harvester have to a large degree been sidestepped, albeit with some compromise in terms of percentage area tracked.

Another aspect that has not been solved is the removal of residues following baling. Baling itself can be accommodated within the CTF system, but the equipment to remove the bales is mostly incompatible, requiring the tractor to run alongside the line of bales.
Fig. 3. On the left are new CTF wheelways established after the field had been subsoiled. On the right is a 2 year old permanent wheelway that was levelled immediately after establishment.

Fig. 4. The Blue-Jet Trackmaster can be a useful tool for repairing wheelways that have suffered from soil “flow”. This is a US machine, but similar designs can be found in many countries.

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