# Cereal Harvesting: The Start of Crop Establishment?

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Cereal growers are in the midst of a difficult harvest with the prospects of poor prices and weather damaged yields. Unfortunately the weather's impact does not stop with the current crop. Soil moisture levels are high and at this stage there is a serious risk of soil structure damage or compaction from harvesting traffic. Compaction should be avoided on all farms, but for those adopting a minimum tillage strategy, soil protection is vital. These problems are not easily addressed – solutions often involve expense and compromise – but with the increasing weight of machinery, action is necessary. We must consider that preparation for establishment starts with the harvesting of the previous seasons crop.

**Compaction at harvest**

Soil structure damage or compaction affects crops by impeding root growth and restricting the plants ability to take up nutrients. Many factors, over which the grower has little control, influence the risk or degree of compaction caused. Soil type, organic matter, crop type and rainfall are in this category. However machine weight, tyre size and traffic pattern are all factors that growers can influence. These are particularly important at harvest where very heavy machines (combines and trailers) must drive on the soil when the crop is fit for harvest.

**Minimum Cultivation**

Minimum cultivation offers many potential benefits. Cultivation to a depth of 50 to 100mm (2 to 4") is the aim with the system. To be effective, the stubble ground must be level. Combines, tractors and trailers (grain and straw) can all cause rutting and soil disturbance depending on machine weight, tyre size, soil type, its moisture content and extent of previous cultivation. Soils that have been min-tilled for a number of years are firmer and can support more traffic compared to soils ploughed to 200mm+. However in wet conditions they will also be damaged.

Soils that are minimally cultivated must also be protected from sub-surface compaction. While they may withstand more traffic, there is no routine operation like ploughing that will loosen the soil to 200-275mm depth before the next crop is established. Compaction avoidance will be difficult to achieve in a wet harvest, particularly on headlands. A combination of tyre choice and traffic control measures can limit the potential for damage.

**Trafficability**

If the weather deteriorates further the problems of trafficability and harvesting broken-down crops could become real on many farms. Trafficability problems imply that the combine or trailers may not be able to work at all, or may only work with a risk of sinkage or soil damage. The difficulties will depend on rainfall, and will vary widely according to location, drainage, soil type, crop and cultivation, and field topography (slopes etc).

The solutions to these problems are equally difficult, but similar, to those for compaction avoidance; big or more tyres, lesser loads if possible, and traffic control in the field. The measure of success is highly visible: a harvested field with no signs of machine sinkage!

**Combines**

The problems with both trafficability and soil compaction are caused by heavy machinery working in wet conditions. As there is little that can be done to change machine weight, **ground pressure** must be reduced, by increasing the contact area between the tyres and the ground. This can be achieved by fitting larger tyres working at lower pressures, or possibly dual wheels.

Combines are getting heavier as the trend of purchasing larger capacity continues (Table 1).

**Table 1:** Typical combine weights

| | **Straw walkers** | **Drum width (m)** | **Empty weight (t)** | **Front axle load (t) Full tank[1]** |
|---|---|---|---|---|
| Small | 4 | 1.0 | 7 | 7.2 |
| Medium | 5 | 1.3 | 8.5 | 9.0 |
| Large | 6 | 1.6 | 11 | 12.0 |

[1]grain tank full

With machines weighing from 7 to 12+ tonnes and grain tank capacities from 2 to over 6 tonnes, front axle loads can vary from **7 to 14** tonnes. The largest combines on the market weigh about 16t empty and can carry another 7 tonnes of wheat (front axle max load 16t+?)

**Tyre size**

Larger tyres are able to work at lower inflation pressures and, consequently, exert lower ground pressures. To select tyres, the axle load should be known and then tyres capable of carrying that load at low pressures should be selected (using load and inflation tables). If conditions are poor, tyres large enough to operate at 1.0 bar pressure or less are best. Tyre options for two sizes of combines are given in Tables 2 and 3. The 'loaded radius' figure indicates the height that the combine axle will be over ground level.

**Table 2:** Medium-sized combine - 9 t front axle load

| Tyres size | Pressure for 4.5 t wheel load (bar) | Loaded radius (mm) |
|---|---|---|
| 18.4 - 30 | 2.6 | 689 |
| 23.1 - 26 | 1.6 | 711 |
| 24.5 - 32 | 0.9 | 818 |
| 800/65 - 32* | 0.6 | 813 |
| 750/65 - 26 | 1.0 | 732 |

*or 30.5 - 32

**Table 3:** Large combine - 12 t front axle load

| Tyre size | Pressure for 6.0 t wheel load (bar) | Loaded radius (mm) |
|---|---|---|
| 23.1 - 30 | 2.0 | 771 |
| 24.5 - 32 | 1.5 | 818 |
| 800/65 - 32* | 1.1 | 813 |
| 1050/50R32 | <0.8 | 854 |

*or 30.5 - 32

Tyres fitted as standard to combines usually require 2.0+bar inflation pressure and consequently, high ground pressure is exerted.

Fitting larger tyres can offer greatly improved flotation and usually improved traction, but there are problems:

- Expensive to change, as it involves tyres plus rims. It is less expensive to select the larger size when the combine is first purchased.
- Wider tyres can increase the road transport width of larger combines. Indeed many combines are specified with narrow high-pressure tyres to reduce road width (e.g. NH TX 67etc). Rubber track systems may have to be considered if weight continues to increase<.
- In isolated conditions, e.g. greasy top surface on a slope with the header weight on the ground, LGP tyres may disimprove traction as they will not cut through the surface quickly.
- Changing tyre diameter can be problematic, as there may be problems with body clearance, header angle when cutting, and keeping the combine level from front to back. The 'loaded radius' figures in the tables indicate the changes in height involved. In Table 2, moving from an 18.4 - 30 tyre to a 24.5 - 32 tyre will raise the front of the combine by 124 mm.
- Rear wheels should also be upgraded to improve their floatation and to level the combine if larger diameter front tyres are fitted. Larger combines will require 400 - 500 mm wide tyres to make a significant improvement.

**Dual wheels**

Dual wheels are an alternative means of reducing ground pressure. While less expensive than replacing single wheels, they have certain problems. They would usually only be considered in extreme conditions where trafficability is preventing harvesting. The following is worth noting:

1. Duals can place extra strain on the combine axle, particularly in rough fields or on roadways between fields. Combine axles and transmissions are not specified to carry extra load. Certainly, owners of new machines should check that they are not invalidating their warranty by fitting duals.

2. Because of their width, duals would have to be taken off when moving the combine on the road. Also the header must be wide enough to cut greater than the duals total width (e.g. medium machine 4 m+, larger machine 5 m+).

3. While wheels/tyres of similar size would obviously work well as duals - other sizes with the same overall diameter can be fitted provided a suitable attachment mechanism, such as a stepped spacer is used. This allows available tractor wheels to be used.

**Table 4:** Possible tyre matches for use as duals on combines

| Combine tyre size | Possible matches |
|---|---|
| 18.4 - 26 | 18.4 - 26, 16.9 - 28 |
| 18.4 - 30 | 18.4 - 30, 13.6 - 38, 16.9 - 34[1], 520/70 - 30 |
| 24.5 - 32 | 24.5 - 32, 18.4 - 38[2], 20.8 - 38[3] |

Notes: [1,3]Preferably worntyres to match diameters
[2] A bit smaller in diameter

**Inflation pressure**

With all tyre options, correct inflation pressures should be used. Ideally, the combine should be weighed. Exact tyre pressures should then be determined from a tyre manual, taking into account that the axle will only be fully loaded at low speeds (<10 km/h). The full benefit of fitting larger tyres will not be achieved if the tyre is not allowed to deflect by using the correct pressure. Lower pressures give better floatation.

**GRAIN TRAILERS AND TRACTORS**

Grain trailers have got bigger and heavier and carry heavy loads. They can be the most serious cause of compaction and trafficability problems in cereal fields. Not that long ago, 70hp tractors weighing 2.5t were used to haul a 1.5t empty weight trailer with a 6t load on board. Today 5t+tractors haul 5t trailers with 15t of grain on board. The total weight has more than doubled with the trailers wheels probably carrying 3 times the load of the older combination. There are two approaches to the problems caused by tractors and trailers in the field:

1) Lower ground pressure by fitting larger tyres or reducing weight.
2) Limiting field traffic of heavy trailers

**Tyre selection**

Tyre selection for trailers is particularly difficult if both road and field demands are to be met. For road use, a hard wearing, low flexing relatively small tyre is best, while for field use a large flexible tyre with a field tread pattern is best. The tyre selection process is similar to that outlined for combines. Determine the axle load and select large enough tyres to carry the load at the required inflation pressure. Many trailers are unable to accommodate larger tyres without significant axle and body modification. It is easiest to choose the tyre size before the trailer is built.

To illustrate the tyre selection process, a tandem-axle 5.4 m x2.4 m trailer is chosen. With an empty weight of over 4t and grain capacity of14t, the rear axle load would be about 15t. Tyre options are given in table 5.The 20-20 and 600/55-26.5 options would require axle/ body modification.

**Table 5:** Tyre options for 5.4 m x 2.4m trailer (tandem axle)

| Tyre sizes | Inflation pressure(bar) |
|---|---|
| 13.0 - 17 | - |
| 15 - 22.5 | 4.0 |
| 18 - 22.5 | 3.2 |
| 20.0 – 20 | 2.0 |
| 550/45-22.5 | 2.1 |
| 600/55 - 26.5 | 1.4 |

Ideally, tyres requiring more than 2.0 bar inflation pressure should not be allowed on the land unless ground conditions are very firm. In poor conditions, tyres large enough to operate at 1.0 bar pressure or less would be preferable. Most of our trailers are under-tyred for use on the land.

Reducing trailer weight should also be as priority. Good trailer design and the use of aluminium bodies / chassis should be considered. This may not be as expensive as it appears when the benefits are considered.

**Tractors**

Tyres on tractors should be large enough to work at respectably low pressures. This will reduce the compaction and sinkage risk, and will help reduce wheelslip when starting loads from rest. A slipping tractor wheel creates problems for the following trailer wheel, quickly bringing the whole outfit to a halt! The use of 600/65R38 or better 650/65R 38 tyres on 120 to140 hp tractors reduces the required pressure compared to narrower options. A selection of tyre sizes and their carrying capacities is given in Table 6.

**Table 6: Tractor tyre sizes and load capacities (40kmh)**

| Tyre size | Axle load at 1.0bar (t) |
|---|---|
| 18.4R38 | 4.8 |
| 20.8R38 | 5.8 |
| 600/65R38 | 6.2 |
| 650/65R38 | 7.5 |
| 710/70R38 | 8.5 |

Suitable tyre options are expensive. Most farmers/contractors are reluctant to spend money on trailer tyres which will largely be used on the road. This attitude will have to be changed in

the long term as such investment is probably well justified. Other options which limit trailer traffic in the field should also be considered.

**Limit field traffic**

Limiting the extent of trailer wheel traffic in the field will reduce compaction and trafficability problems. It can be an alternative to the use of big and expensive tyres.

The practice of unloading the combine on the move imposes a lot of trailer traffic on the field. However, it is more time efficient than headland filling. Time is critical in difficult harvests.

1. If you have sufficient combine capacity, limit trailers to the headland. This will restrict soil damage. If you have good combine tyres, it's a shame to destroy the field with poorly shod trailers!

2. If you cannot afford to leave the trailer on the headland, consider only filling the trailer to 50-70% of its capacity while on the move. Fill the last couple of tanks with the trailer stationary on the headland - this avoids the worst compacting traffic.

3. If filling on the move - avoid unnecessary traffic. Stop the trailer tractor as soon as loading is completed and only move directly to the point where the combine will again off-load. Avoid driving the trailer to the headland after each load or following the combine around until it is ready to off-load again. If the combine grain tank is more than 50% unloaded on the move when the headland is reached, finish unloading in a stationary position - do not incur extra headland traffic for minimal gain in output.

4. Have tractor and trailer tyres correctly inflated and get all drivers to drive with a bit of sympathy for the soil. Plan all driving routes within the field carefully to avoid excessive traffic and to avoid getting stuck. In particular, only stop the trailer/tractor combination where it will be easy to start again (e.g. stop facing downhill etc.). Be particularly careful accelerating loads from rest – in poor conditions you will often only get one chance and smooth driving is essential. Plan the approach to gateways in advance of driving to them.

**Chaser Bin concept**

The chaser bin concept is quite simple. Instead of trying to reduce the ground pressure of road trailers, a single, high-capacity, transfer-trailer is used to ferry the grain from the combine to a road trailer or truck parked at the field edge. This trailer is fitted with large field tyres. The chasers currently marketed are US-style units with a funnel shaped body and a high speed pto driven transfer auger. Typically a 12-14t capacity unit fitted with 30.5R32 tyres would require an inflation pressure of about1.5-2.0 bar pressure. While this pressure is not exceptionally low, smaller grain loads can be carried and the large diameter combine type

tyres will rollout of any difficult situations. The current designs used are expensive and a little top-heavy for use on some Irish farms but alternative designs are possible. This approach seems sensible for the very high-output combine operator that is delivering over a long road distance.

**Time to consider change**

There is little doubt that wet weather concentrates the mind on wet-weather problems. We will all be interested in tyres when the combine or trailer is immobile! But that is missing the point. Harvest traffic is potentially causing damage to the soil every year. That soil is the growing medium for all future crops – alleviation damage by subsoiling is not the answer– it must be protected. If we are to continue to reap the benefits of higher capacity machines, we must be prepared to equip them with tyres that limit soil damage. These options are not easy but as machine weight increases, the stakes get higher. Can we afford to gamble with the soil?.