TOWARDS FAIL-SAFE STAND ESTABLISHMENT WHEN NO-TILLING

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Introduction

Arable crops experience two critical periods – *starting and finishing*.

Pasture species experience one critical period – *starting*.

Finishing is partly in the lap of the weather-Gods but man can influence this with the amount of organic matter that he leaves in the soil, which in turn influences the soil's water holding capacity. Soil disturbance strips carbon from soil and has a cumulative negative influence on finishing.

But man has an even greater influence on *starting*. If no-tillage is done correctly, weather will have only a minor influence on stand-establishment. But if no-tillage is undertaken badly, weather can have a profound influence on crop stand-establishment.

It is as simple as that.

A perfect no-tillage opener should perform four clear functions:

1. Create a fail-safe germination and emergence environment for seeds and seedlings.
2. Place and cover seeds at a consistent depth.
3. Micro-manage crop residues to advantage.
4. Band fertilizer separately at seeding.

Since this paper is primarily concerned with stand establishment, we will focus on numbers 1 and 2.

Consideration of numbers 3 and 4 are equally important, but for another time.

The water-resources of soils

All soils have two resources of stored water. Water is held as both colloidal liquid films around soil particles (known as *liquid-phase* soil water) and as humidity within the soil air that is contained in the macro-pores between soil particles (known as *vapour-phase* soil water).

If *liquid-phase* soil water also fills the pore-spaces the soil has become saturated and most plants cannot live in saturated soils. Rice is the exception. A healthy soil therefore, has both humid soil air in the pore spaces and colloidal liquid films surrounding the particles. In this state, the soil water content is said to be in the "*plant available range*". *Field capacity* is the wet end of the *plant available range* and *permanent wilting point* is the dry end. *Permanent wilting point* is when the soil is so dry that plants wilt and die even when the soil is re-wetted.

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Every farmer has become used to harnessing *liquid-phase* soil water and recognising when there is sufficient to germinate seeds (i.e. is in the *plant available range*). The simple indicator is that moist soils are usually darker in colour and colder that drier soils.

But few farmers recognise, let alone utilize, *vapour-phase* soil water for the same purpose.

And yet, most seeds can germinate in an atmosphere of 90-100% relative humidity without any contact with soil or liquid water at all.

The problem is that farmers have been tilling the soil for centuries and tillage aerates the soil and lets much of the *vapour-phase* water escape. So they have become totally reliant on the *liquid-phase* water content of the soil to establish crops and pastures by tillage.

But when no-tillage came along, all of that changed – or did it?

Untilled soils contain 100% relative humidity within the undisturbed soil pores (known as *equilibrium pore space humidity*) even when the soil is at or close to *permanent wilting point* (for the purists, the RH is actually 99.8% at *permanent wilting point*, but let's not get too picky). When soil is tilled, the *equilibrium pore space humidity* quickly reduces to something approaching the ambient atmosphere, which might be 30-50% - far too dry to have any influence on seed germination.

But sadly, most designers of no-tillage openers and seed drills assume that tilled soil is something that seeds and seedlings have craved since man began growing cops to feed himself. So they design their machines to create mini-tilled-seedbeds in rows or strips. But all that this does is ensure that the seeds and seedlings sown in those rows experience no better germination and emergence environments than they would have in a fully tilled seedbed. Ironically, right alongside them but unused, will be undisturbed soil that contains the additional resource of *vapour-phase* soil water.

How dumb is that?

Many Americans have figured this out and no longer refer to seeding into untilled soils with aggressive openers as *no-tillage*. They call it *strip tillage,* which is exactly what it is.

Enter inverted-T shaped no-tillage slots.

These are designed to be non-inverting. They create horizontal shelves under the ground. Almost all other "no-tillage" openers create vertical slots, or at best, slanted slots. Horizontal slots avoid inversion of the soil, thereby ensuring that the 100% *equilibrium pore space humidity* remains within the seed slot zone as well as the undisturbed soil alongside.

This is no idle claim. Inverted-T shaped slots were discovered in the 1970s and explained why scientists had obtained 77% emergence of wheat seedlings from a dry soil, when they made inverted-T shaped slots. By contrast, the more common U-shaped and V-shaped slots in the same untilled soil managed only 27% and 24% wheat seedling emergence respectively.

In optimum soil moisture conditions, there was little or no difference between slot shapes but as soil conditions got progressively drier, the differences got bigger and bigger.

The same thing happened in wet soils, but in this case the residues that covered the inverted-T shaped slots attracted earthworms, which in turn aerated the slot zone in otherwise saturated and anaerobic conditions. So, although the results were similar for both wet and dry soils, the mechanisms at play were different.

The moral of the story is that if you can guarantee optimum seeding and weather conditions in Australia all of the time, you need not worry what shape of no-tillage slots you make. But if the conditions get sub-optimal from time to time, be aware that inverted-T shaped slots will always create greater and more assured seedling emergence than either V or U-shaped slots in sub-optimal conditions, regardless of what brand of machine they are created by.

The influence of consistent seeding depth

Regardless of how much soil disturbance no-tillage openers create, consistent depth of seeding is more important in no-tillage than in tillage. But again, many machine designers pay scant attention to this requirement.

Some plant breeders would like you to believe that they should be breeding crop and pasture varieties with greater seedling vigour and longer coleoptiles so that seeds can be sown deeper under no-tillage to be assured of germinating – when in fact seeds sown into inverted-T shaped (horizontal) no-tillage slots experience more (rather than less) favourable germination environments than any seeds sown into a tilled seedbeds or with aggressive no-tillage openers, have ever done.

Although an optimum seed or seedling environment is no substitute for uneven depth of seeding, it is also true that a humid seedling environment goes a long way towards ensuring that small seeds especially, will emerge from depths normally considered to be deeper-than-optimal in undisturbed (no-tilled) seedbeds.

Add to this, the fact that under no-tillage the surface of the ground does not get smoothed in the same manner as it does during tillage, and it is easy to see that the demands on the surface-following ability of individual no-tillage openers has to be superior to openers that operate in tilled soils.

But many are no better in this regard all.

Those that use springs to push them into the soil, for example, suffer from the fact that spring down-forces vary linearly with spring length. So too do resilient buffers such as rubber. Individual weights remain constant regardless of their vertical positions but few people want the inconvenience of adding and removing weights on every opener in order to change down-pressures for different soils.

Individual hydraulic cylinders do the same thing as weights with the added convenience of being alterable from the tractor cab. But obviously they cost more, although some of that cost can be offset if the cylinders are also used to lift the openers off the ground for transport.

And then there are the issues of trip-releases for tined openers, the amount of total travel of the openers themselves, the positioning of the gauge wheels in relation to the seed release point, the sensitivity of the system to changing soil hardness on-the-move, parallel-versus-single-pivot drag arms, and the nature of the slot-covering medium; all of which have effects on the consistency of seeding depth and entrapment of soil humidity.

Summary

One way or another, no-tillage is a short-cut. If you short-cut the short-cut - do not expect to get good or consistent results.