MAXIMISING SOWING OPPORTUNITIES UNDER DRY SOIL CONDITIONS IN THE HIGH-RAINFALL ZONE

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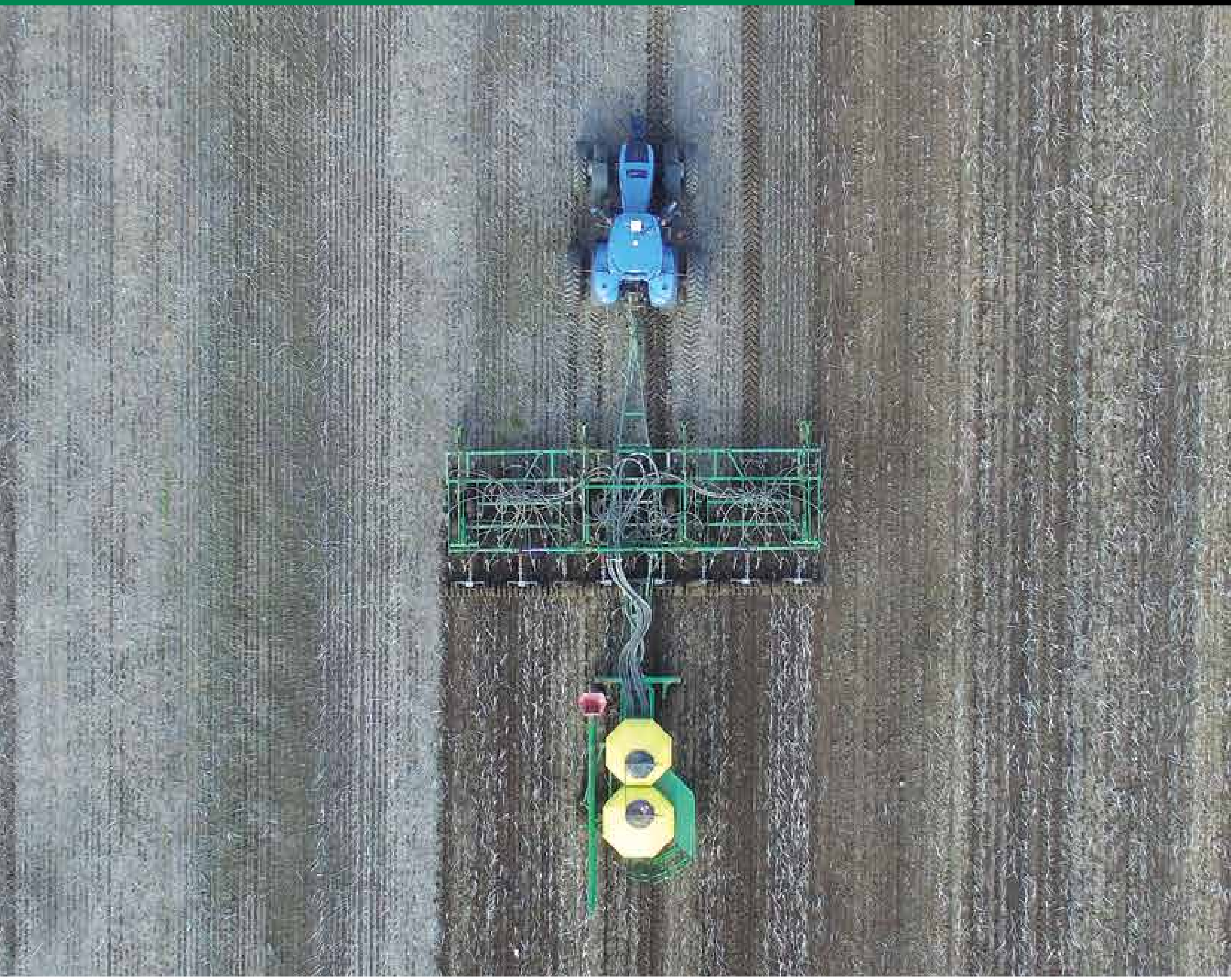

A SUMMARY OF RESEARCH AND DEVELOPMENT INTO SOWING UNDER DRY SOIL CONDITIONS IN THE HIGH-RAINFALL ZONE

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Maximising sowing opportunities under dry soil conditions in the high-rainfall zone – southern region

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COVER: A commercial seeder dry sowing ahead of the break of season in Victoria, 2020

PHOTO: Darcy Warren, FAR Australia

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Background

Southern region high-rainfall zone (HRZ) growers and Regional Cropping Solutions Network (RCSN) (now GRDC Grower Network) members identified a need to build confidence in starting sowing by a set date under dry soil conditions rather than waiting for season-breaking rainfall.

Dry sowing can be used in three main ways to manage seasonal risk.

1 The first scenario is to take advantage of early dry sowing opportunities primarily in early April and in some instances late March, ahead of forecast early rain. These opportunities are generally focused around fodder.

2 The second dry sowing scenario occurs before the traditional sowing window and before the break-of-season rainfall, which is usually in early to late April. This promotes yield benefits from early crop emergence and improvements in sowing logistics and forms part of many growers' yearly cropping program.

3 The third scenario arises where break-of-season rainfall is late, for example, sowing dry in May. This is an opportunistic seasonal risk management strategy when soil and weather conditions at the start of the season are dry. This is the 'dry sowing' scenario that occurred in many HRZ areas in the 2019 season, which has informed the development of this publication.

Traditionally, seeding has started after the breaking-season rainfall following a knockdown herbicide application. But if the break of season occurs late, the delay in seeding can reduce crop yields as well as increase the potential for waterlogging, resulting in paddocks becoming unworkable with machinery. Dry sowing before the break of season mitigates this risk and enables a greater proportion of the seeding program to be sown in a timely and efficient manner, resulting in crops establishing at the earliest opportunity and setting a higher yield potential.

Maximising sowing opportunities under dry soil conditions in the high-rainfall zone is an initiative of GRDC's southern region HRZ RCSN (now GRDC Grower Network) and has been developed following the extremely dry start to the 2019 growing season. The soil profile at seeding was uncharacteristically dry throughout, leading to uncertainty for many growers in sowing by the calendar date where these conditions had not previously been experienced.

This guide is designed to provide growers with access to consolidated research information and grower experiences. The growers and agronomists featured in this booklet have outlined their decisions to successfully implement dry sowing into their farming systems. We thank them for sharing their experiences, as grower-to-grower knowledge sharing is invaluable to the adoption of new practices. This booklet will help growers in the HRZ of the southern region feel confident in employing dry sowing as a seasonal risk management strategy.

Glenthompson Hills grower and agronomist Jim Zwar at a research site examining the impact of waterlogging on wheat. Photo: Clarissa Collis

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Introduction

In the high-rainfall zone (HRZ), dry sowing is a risk management strategy that can be used to increase the chance of establishing crops before soils become too wet to sow and too cold for vigorous early crop growth. Dry sowing capitalises on sowing opportunities before the break of the season, which allows crops to begin germinating immediately following break-of-season rainfall.

As a consequence, dry-sown crops can be days, or sometimes weeks, ahead of those sown after the break of season, especially in large cropping programs and/or operations with limited seeding capacity. Dry-sown crops germinate when the ground is likely to be warmer, promoting early vigour and reducing the likelihood of crops becoming waterlogged. Earlier establishment also provides a longer growing season, ultimately enabling crops to set higher yield potential. With the general reliability of winter and spring rainfall in the HRZ and the ability to adjust in-crop management to the unfolding season, higher yield potential is usually translated into increased yields and greater profit potential.

Break-of-season rainfall is defined as sufficient rainfall to germinate and establish a crop in the context of the soil type and environment.

In addition to yield benefits, spreading the sowing program over a longer window by dry sowing can also provide significant logistical, machinery and labour advantages. Starting sowing on a set date allows:

- planning of the sowing program with greater certainty;
- more ground to be covered by existing machinery before conditions become waterlogged and untrafficable; and
- improved timeliness of operations, reducing the strain on staff and machinery.

Dry sowing in the past has often been avoided due to concerns over effective weed control, but the risks of dry sowing can be largely overcome with careful planning and implementation. The good management required for dry-sown crops is not all that different to conventionally sown crops. This guide is designed to highlight some of these risks and describe management strategies that can be implemented to achieve the benefits of dry sowing.

DRY SOWING AND EARLY SOWING

There is often some confusion about dry sowing and early sowing as they are both tactics employed at the start of the seeding program.

Dry sowing is the practice of sowing crops before receiving sufficient rainfall to trigger germination; that is, sowing into a dry seedbed before season-breaking rainfall. Sowing is planned to start by a specific calendar date, for example, Anzac Day or earlier. Dry sowing is becoming more prevalent in the HRZ but is already common in drier zones where cropping programs are often larger and crops are more reliant on limited seasonal rainfall. In the HRZ, sowing where there is some stored soil moisture at depth but the topsoil is dry is often referred to as dry sowing. However, for the context of this guide, dry sowing relates to conditions where soil in the seed zone is dry at sowing, conditions that were experienced by growers in the 2019 season.

Early sowing is the practice of sowing crops generally into a moist seedbed before the standard sowing period after an early break in late summer/early autumn. Varieties suitable for early sowing are generally feed grains and dual-purpose grain and fodder. Following an early break or late summer rain, winter wheat, barley and canola can be sown as early as March or early April as their requirements for a cold period (vernalisation) ensures they flower in the optimal flowering window (Figure 2, page 15). One tactic commonly used in the HRZ is to dry sow early feed crops ahead of forecast rain, which can provide a four or five-day head start on seeding (Hunt et al. 2020).

More information on early sowing practices can be found in GRDC's *Ten tips for early sown wheat* and *Ten tips to early-sown canola* (see Useful resources).

Dry-sown wheat emerging after break-of-season rainfall at FAR Australia's Victorian research site in May 2017. Photo: Darcy Warren, FAR Australia

The benefits of dry sowing

- **Operational efficiencies** – in large cropping programs, sowing on a set date and dry sowing when necessary allow more area to be sown without the need for larger equipment and before paddocks become too wet to sow. If a paddock becomes too wet, growers often cannot get machinery back into the paddock in time to complete the sowing program. Dry sowing helps to manage this risk and also spreads labour requirements and operations over a longer time period, reducing fatigue and errors.
- **Early plant establishment** – dry sowing can result in earlier establishment of crops as the seed is already in the ground when break-of-season rain falls; germination can occur rapidly. Early germination, when soil temperatures are warmer, can improve crop establishment and vigour, allowing the plants to produce greater biomass and develop a more advanced root system before waterlogging sets in. These healthier and more advanced crops have improved tolerance to waterlogging and other stresses than crops sown after the season break.
- **Higher yield potential** – crops that are established dry are able to use a longer growing season and therefore use more water throughout the season. This provides greater opportunity for biomass production, setting higher grain yield potential and in some instances reducing the impact of waterlogging. These all combine to increase the crop's water use efficiency.
- **Reduced impact of pests on early crop growth** – slugs, earwigs, slaters and other pests can cause significant damage to young shoots in the HRZ. When conditions become wet and soil temperatures drop, pest damage to seedlings can be greater due to slow plant growth. Getting a crop established early means plants are more robust before entering the slow-growth period and are better able to withstand pest pressure.
- **Improved stubble flow through the seeder** – under moist conditions stubble can become 'ropy'. With high stubble loads, common in the HRZ, this can lead to poor stubble flow and hair-pinning, where stubble is not cut but pushed into the seeding slot. Under dry conditions stubble is more likely to be brittle, enabling stubble to flow more easily through the seeding implement.

Risks to consider when dry sowing

- **Crop establishment** – crops emerging from a dry-sown paddock may be patchy if moisture is sufficient to induce germination but inadequate for even emergence and establishment. Establishment under marginal moisture conditions is strongly influenced by soil type and constraints that reduce water infiltration, storage or extraction.

  If parts of a paddock are non-wetting, water may run off, resulting in dry patches. By contrast, heavy-textured soils with high clay content need considerable rain to wet up as they retain water tightly. The seed may not be able to extract sufficient water from the soil to germinate. Soil texture and the seeding system will also affect seed–soil contact, which in turn influences crop germination and establishment.

  These are important considerations when selecting paddocks to be dry sown.
- **Weed management** – knockdown herbicides will not be effective in dry-sown paddocks if the weeds have not germinated. This places increased reliance on pre-emergent residual herbicides for weed management. If pre-emergent residual herbicides fail (due to marginal moisture), there are limited post-emergent herbicide options in cereals for some weeds. Therefore, selecting paddocks with low weed burden is the best option for dry sowing.
- **Residual herbicide damage** – crop damage can occur when a paddock is sown dry and plant-back periods and rainfall have been insufficient to allow the breakdown of residual herbicides applied during summer or from the previous season. Careful herbicide management is important and it is crucial to adhere to the plant-back requirements specified on the herbicide label.
- **Frost** – early establishment of crops can potentially lead to an earlier flowering window, increasing the potential frost risk. Careful consideration must be given when selecting cultivars and their maturity for dry sowing to minimise frost risk and to maximise yield potential.
- **Fertiliser toxicity** – when fertiliser is applied in high amounts too close to germinating seed, the fertiliser can delay crop emergence and damage roots. This is called fertiliser toxicity. Dry sowing can exacerbate fertiliser toxicity as there is limited soil moisture to disperse the fertiliser.

  This is especially the case on light-textured soils under marginal moisture conditions and with fertilisers that have a high salt index (muriate of potash) or with fertilisers that result in the production of ammonia (for example, urea). It is also more common on wide row spacings where seed and fertiliser are more concentrated than in narrow row spacings.

  It is important to separate the seed and fertiliser, especially when dry sowing. Under typical row spacings, separation of at least 3 to 4 centimetres is recommended.
- **Legume nodulation** – unless a paddock has grown a legume recently and the soil is not hostile to the nitrogen-fixing rhizobia, inoculation of the seed is required for legumes to nodulate and fix nitrogen well. Rhizobia are sensitive to dry conditions, particularly for pulses on acidic soils. If pulses are inoculated with peat formulations and are then sown into dry soil, the viability of the rhizobia on the seed starts to decline and nodulation failure is possible if the dry period extends for more than two to three weeks.

If sowing inoculated seed into dry soil, avoid seed that has been treated with a fungicide or trace element coating as these can be hostile to rhizobial survival. Different inoculation formulations (for example, granules) and increased inoculation rates can help mitigate these risks. Alternatively, if a paddock has a strong history of legume nodulation and production with a good background level of rhizobia in the soil, inoculation may not be required.

- **Timeliness of in-season operations** – dry sowing typically results in homogenous crop emergence across many paddocks, which can lead to difficulties in timely in-season crop management. If a large proportion of the farm is sown early with varieties of similar maturity, it is likely that multiple paddocks and large areas will require fertiliser and pesticide applications at the same time. This may create some logistical challenges to complete these operations in the optimum window.

Advanced planning

To realise benefits and increase the likelihood of success from dry sowing, advanced planning is crucial to manage risks. If dry sowing for the first time, plan a small area to gain confidence (for example, one or two paddocks) with the aim of expanding the area in the following year.

It is important to note that sowing the whole cropping program into dry soil is risky and it is recommended that dry sowing should only ever make up a proportion of the program.

In addition, 'sowing by date' (using dry sowing regularly) requires an understanding of the critical factors and key considerations to improve the likelihood of success, including:

- understanding the occurrence and impact of waterlogging;
- optimal paddock selection;
- crop rotation and selection;
- crop development and flowering windows;
- seeder machinery to maximise establishment;
- disease and insect management; and
- learning through case studies how other growers are using dry sowing.

1. Understanding the occurrence and impact of waterlogging

Winter waterlogging and its impact on crop health is one of the key reasons for dry sowing in the high-rainfall zone.

In high-rainfall areas, one of the aims of dry sowing is to promote crop establishment before waterlogging occurs. Early sowing encourages healthy root growth before waterlogging events, which are most common in winter. Waterlogging can contribute to increased disease and weed pressure, but early-sown, vigorous crops are more likely to tolerate these stresses.

Waterlogging occurs when water exceeds the soil's water-holding capacity or 'field capacity' and cannot drain away. The water occupies much of the soil pore space (the space between soil particles) so there is insufficient oxygen for the roots to respire. This impairs root growth and the uptake of nitrogen and other nutrients. Gases that are detrimental to roots, such as carbon dioxide and ethylene, subsequently accumulate.

The uptake of nitrogen is halted and root tissue starts to decompose when crops are subjected to extended periods of waterlogging, resulting in plants that become chlorotic (yellow). Over prolonged waterlogged conditions, plants eventually die. More advanced crops are better able to tolerate short-term waterlogging, than are crops sown later. Early-sown crops that have developed strong root systems close to the soil surface before the onset of waterlogging tend to recover once the soil has dried.

DEFINITIONS

Field capacity is the maximum amount of water the soil can hold. When soil water exceeds field capacity, it either drains away (causing leaching on sandy soils) or accumulates in poorly drained soils, causing waterlogging.

Wilting point is the minimum amount of water in the soil that plants can access before they can no longer extract water from the soil.

Potential plant-available water is water between field capacity and wilting point that is, the maximum amount of water the soil can retain that is potentially available for plant uptake.

Dry sowing allows crops to establish before waterlogging occurs. Photo: Danielle England, AgInnovate

2. Optimal paddock selection

Selecting the right paddock for dry sowing is crucial for managing risks and determining the ultimate success of the crop. There are several factors to consider when selecting paddocks, such as knowing and managing existing weed populations, herbicide residues in the soil and soil texture and variability.

Weeds

The biggest risk to dry sowing crops is weeds germinating alongside the crop, because a knockdown herbicide used before sowing will not be effective as weeds have not yet germinated. This increases reliance on pre-emergent and in-crop selective herbicides, decreasing the weed spectrum that can be controlled and exacerbating the risk of herbicide resistance. Consequently, dry sowing is best suited to paddocks with low weed seedbanks.

Paddocks more suitable for dry sowing include those where:

- a 'take no prisoners' approach has been applied to weed management during fallow;
- pastures were spraytopped in the previous spring to minimise grass weed seed set; or
- there is a history of low weed numbers.

Paddocks where the weed seed burden is unknown, or weeds have not been effectively managed in the previous seasons, are not good candidates for dry sowing. Instead, wait for a good germination of weeds after the first rain to complete a successful knockdown herbicide application before sowing.

Dry sowing often relies on the successful use of pre-emergent herbicides for managing grasses in cereals and broadleaf weeds in legumes and oilseeds.

Photo: Evan Collis

Managing grass weeds in dry-sown crops

Where paddocks have significant grass weed seedbanks, planting legume pastures, faba bean or canola may be suitable crop options for dry sowing. These crops allow for the use of in-crop herbicides that control grass weeds, provided other risk factors can be managed (such as herbicide resistances, chemical plant-back periods and disease pressures). The WeedSmart 'Big 6' outlines a range of important strategies to implement on-farm to prevent and manage herbicide resistance in weeds (see Useful resources).

Given that dry sowing should only ever make up a portion of the program, the sowing period will typically straddle the break of the season and dry sowing will switch to traditional sowing mid-way through the program. Planning the dry sowing program to make the best use of time and equipment and to prioritise relatively weed-free paddocks and crops makes most of the standard weed management strategies available to that part of the cropping program sown after the break.

Pre-emergent herbicide strategies for dry sowing

Profitable dry sowing relies on the successful use of pre-emergent herbicides where minor weed populations need to be managed. However, herbicides differ in their chemical properties and application methods, which affect their mobility through soil. Pre-emergent herbicides require water to move through the soil to the zone where they are active on weeds.

The availability of a pre-emergent herbicide to germinating weeds is determined by the interaction between the solubility of the herbicide and how tightly it is bound onto soil colloids and organic matter. Factors such as soil structure, cation exchange capacity, pH, herbicide volatility, the environment, soil water and the rate of herbicide will also affect its availability and efficacy (Figure 1). Management practices can also affect this soil–herbicide interaction including tillage, stubble cover and incorporation by sowing (Congreve and Cameron, 2019).

Due to the nature of these soil-active herbicides, pre-emergent herbicides can cause crop damage. Seeder set-up is one of the key tools for spatially separating herbicide and seed. This is influenced by the seeding system and is more easily achieved in knife-point and press wheel systems than in disc systems (Kleeman et al. 2015).

The main features of pre-emergent herbicides that need to be considered are:

- water solubility;
- binding to soil organic matter; and
- the inherent tolerance of the crop to the herbicide.

Herbicides with higher water solubility, lower binding to organic matter and lower inherent crop tolerance are more likely to cause crop damage (Preston and Boutsalis, 2020). Understanding these interactions assists in minimising the potential for crop injury when dry sowing (Congreve and Street, 2019).

The mobility of pre-emergent herbicides in soil is a key behaviour to understand when selecting products for a dry soil scenario. With significant rain at the break of the season, water will move in a 'wetting front' down the soil profile, dissolving any water-soluble herbicide present. Binding of herbicide to soil and organic matter takes time to occur (Congreve and Street, 2019). In a dry sowing situation, where pre-emergent herbicides have been surface applied, a large rainfall event can create a rapidly moving wetting front that takes water-soluble pre-emergent herbicide with it before it has had a chance to bind to the soil (Congreve and Street, 2019). This can wash active herbicide into the crop root zone and cause damage to the emerging crop that was sown dry. This is of higher risk in light-textured soils that have less ability than heavier soils to bind herbicides.

The mobility of a range of key pre-emergent cereal herbicides can be found in Table 1.

MORE INFORMATION

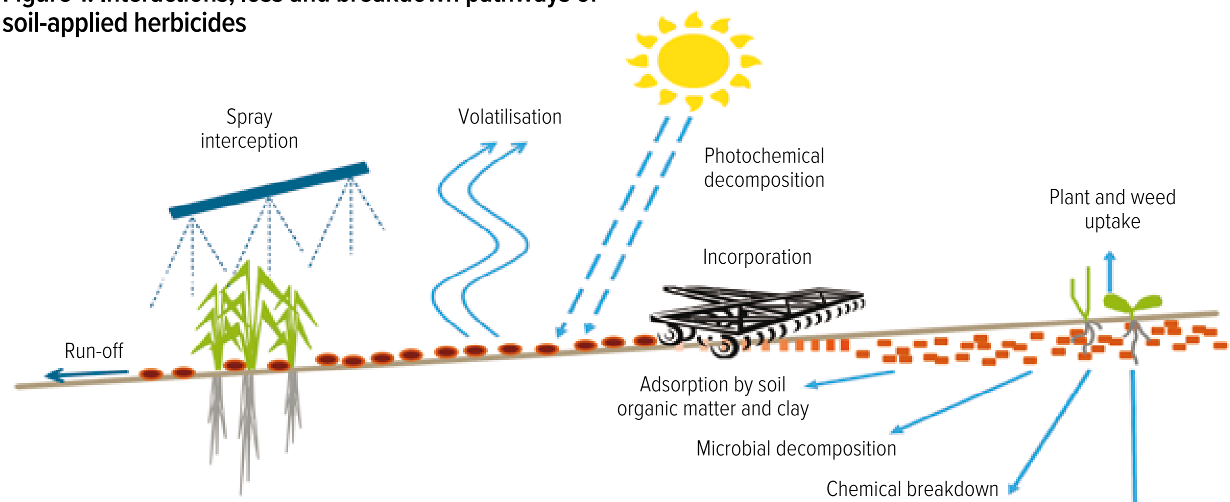
- **Detailed information on herbicide behaviour can be found on the GRDC website. Relevant publications include *Soil behaviour of pre-emergent herbicides in Australian farming systems* on the Herbicide behaviour resources page and *Understanding pre-emergent herbicides and how they interact with the environment* (2020) GRDC fact sheet (see Useful resources).**

Table 1: Water solubility and binding of some common pre-emergent herbicides.

Herbicide	Trade name	Solubility (mg L^{-1})*		Binding (K_{oc})**	
Trifluralin	TriflurX®	0.22	Very low	15,800	Very high
Pendimethalin	Stomp®	0.33	Very low	17,500	Very high
Triallate	Avadex® Xtra	4.1	Low	3000	High
S-metolachlor	Dual Gold®	480	High	200	Moderate
Prosulfocarb	Arcade®	13		1367–2340	Slightly
Pyroxasulfone	Sakura®	3.9	Low	223	Moderate
Napropamide	Devrinol®	74	Low-moderate	839	Slightly
Cinmethylin	Luximax®	63	Low	373	Moderately
Bixlozone	Overwatch®	40	Low	334–465	Moderately
Propyzamide	Rustler®	9	Low	840	Slightly
Mesotrione	Callisto®	1500	High	122	Moderately

*at 20°C and neutral pH
** in typical neutral soils
***Boxer Gold® also contains S-metolachlor
This is not an extensive list of herbicide behaviours and further information can be found in Useful resources.
Check labels for use patterns in individual cereal crops.
Source: Kleeman et al. (2015), and *Understanding pre-emergent herbicides and how they interact with the environment* (2020) GRDC fact sheet (see Useful resources)

Figure 1: Interactions, loss and breakdown pathways of soil-applied herbicides



Source: Congreve and Cameron (2019)

Degradation of pre-emergent herbicides

Degradation of pre-emergent herbicides that are applied well before the break of the season and under dry sowing conditions is difficult to predict and will be highly variable. However, under completely dry conditions, some pre-emergent herbicides can persist in soil.

Minkey (2017) found that Sakura®, Boxer Gold® and TriflurX® persisted for five to six weeks under dry conditions and due to their long residual nature were suitable for dry sowing, although efficacy reduced over time. It should be noted that the prosulfocarb component of Boxer Gold® can lead to crop damage in light-textured soil due to high solubility and low binding qualities. However, the persistence of pre-emergent herbicides in the absence of soil moisture should provide some confidence when dry sowing.

Herbicide resistance

For pre-emergent herbicides, weed resistance is highest to trifluralin and then the Group J herbicides (Avadex® Xtra and Arcade®). There is less resistance to Boxer Gold® and Sakura® (Preston and Boutsalis, 2020).

Trifluralin should be used with caution in the southern Australian HRZ due to high levels of ryegrass resistance. In a 2019 survey conducted by Adelaide University, annual ryegrass resistance to trifluralin was detected in about 70 per cent of paddocks surveyed in the south-east of South Australia. Herbicide resistance testing is important to determine which herbicides are still active on the spectrum of weeds and to identify alternative herbicide options if required.

Even if growers do not currently have trifluralin resistance in their crop, they are at high risk of developing it in the future. That is why robust pre-emergent herbicide strategies for dry sowing should be carefully planned with the assistance of an adviser. The overall weed management strategy should comprise herbicide and non-herbicide tactics such as crop competition and harvest weed seed control. The WeedSmart 'Big 6' provides a range of important strategies to implement (see Useful resources).

While pre-emergent herbicides are an important tool for dry sowing, they are most successful when the weed seedbank is low as this takes the pressure off the herbicides.

Herbicide residues

Paddock selection for dry sowing also needs to take into account herbicide use in the paddock in the previous year and the likelihood of herbicide residues. Opportunities for dry sowing generally arise after a dry summer, where sufficient summer rainfall may not have occurred to break down herbicides before seeding. This can result in residue levels that exceed toxicity thresholds for the crop (Rose et al., 2019; Congreve and Cameron, 2019).

Typically, chemical and microbial herbicide breakdown starts when soil moisture exceeds wilting point and when activity increases as soil temperatures rise. As such, the extent of herbicide breakdown is heavily dependent on the cumulative rainfall from the previous season's application and not just rainfall received in the immediate period before sowing. However, plant-back periods for herbicides depend on several factors, including:

- herbicide chemical properties (for example, solubility);
- rate of herbicide applied;
- soil pH;
- soil type (clay and organic matter content);
- soil microbial activity;
- stubble load and paddock preparation (especially for clopyralid);
- cumulative rainfall and timing of rainfall following application;
- temperature; and
- crop and cultivar to be planted.

The factors influencing herbicide persistence in soils are complex and interactive. It is important to base herbicide and crop decisions on the paddock conditions (soil properties and cumulative rainfall). Always check and follow label recommendations for plant-back periods. More information on herbicide degradation and behaviour can be found on the GRDC website Herbicide behaviour page (see Useful resources).

Different crops and cultivars may have differing tolerances to herbicide residues, so work with an agronomist to determine crop and cultivar options for susceptible paddocks.

Soil type texture and constraints

Plant-available water is determined by the soil's capacity to 'wet up' (that is, rainfall infiltration), to store the water and then make it available for plant uptake. Water availability is dramatically affected by soil texture – the proportion of sand, silt and clay particles. This is because water adheres to clay particles more strongly than to silt or sand particles.

Water repellence can have a significant effect on crop establishment under dry sowing as incorporation of the non-wetting layer by minimum tillage occurs before the soil wetting event (rainfall). In water-repellent soil, marginal moisture resulting from a weak break of season can lead to patchy establishment. Sowing on or near the previous crop rows can help to overcome these effects as water infiltrates down the pre-existing root channels, which the new crop can follow (McBeath et al. 2016).

Water repellence is not the only constraint affecting crop establishment variably across paddocks. Soils with high clay content can also affect establishment, particularly on marginal soil moisture. Given the stronger adherence of water to clay particles, it is harder for plants to extract water from soil pores in heavy-textured soils, and more rain may be required for germination and emergence than in light-textured soils. Consequently, if breaking rains after dry sowing are marginal, this can result in patchy and staggered establishment in areas of high clay content.

In addition to water-holding capacity, soil texture can also affect mechanical disturbance of the soil by seeding equipment under wet and dry conditions. Using knife points for minimum soil disturbance in heavy-textured clay soils can result in uneven-sized clods and create poor soil–seed contact, resulting in poor germination. Consequently, preference should be given to loamy or light-textured soils over clays for dry sowing.

3. Cropping rotation and selection

Planning to incorporate dry sowing into the cropping program requires considering all enterprises of the farming system and key decision points for each. In the HRZ, livestock plays an important part in many farm businesses so it is important to consider available livestock feed, such as regenerating pastures and fodders, in the schedule. Pastures and fodder crops often make up 50 to 70 per cent of the managed farm area in the HRZ, and this can affect available machinery, labour resources and the start date of dry sowing. A good sowing plan will maximise efficiencies, optimise machinery use, and use agronomic and variety tactics to minimise risks.

Key farming system factors to consider when planning the order of sowing and the proportion of the schedule that will be dry sown include:

- likely demand for livestock feed – this may include pasture legumes, fodder species, winter-grazing cereals or winter-grazing canola;
- crop mix and order – this includes the fit of dual-purpose crops, canola, faba bean and cereals; and
- paddock selection – preferencing paddocks that minimise risks under dry sowing scenarios, as outlined in chapter two.

Livestock feed

Traditionally in the HRZ, a pasture legume/grass mix is sown early for livestock feed. In these paddocks, weed management is often not a high priority at sowing and can be managed later in the season with spraytopping or hay cutting when the spring flush in other paddocks has relieved feed pressures.

Fodder crops typically involve sowing oats or barley, dual-purpose winter wheat or a canola cultivar for winter or spring grazing. These are traditionally sown in late March to early April (early sowing) before the break of the season.

Pastures and fodder crops provide a low-risk dry sowing opportunity as the aim is to increase biomass rather than grain yield, so avoiding frost and heat risks during flowering is not a consideration. In the case of dual-purpose crops, grazing management can be used to delay crop maturity to target a flowering window and take the crop through to grain harvest.

Oats

Oats are suitable for dry sowing as a grain or hay crop. Oat cultivars with a range of maturities can be sown dry, allowing for early sowing opportunities where the break of the season is delayed. Oats can also be used as a tool for ryegrass management when cut for hay.

Grazing can be an important farming system tool for managing risks associated with dry-sown crops in the HRZ. Photo: Annieka Paridaen, Premier Ag

Canola

In the HRZ, canola can be dry sown into spraytopped pasture paddocks or the previous year's cereal paddocks. Canola crops provide multiple opportunities for post-emergent herbicide applications throughout the season. It can be a good fit for dry sowing if the paddock is a good candidate where there is a large population of non-resistant grass weeds. A mix of long and short-season cultivars are available for the HRZ, enabling longer-maturity cultivar use for early dry sowing opportunities and shorter season cultivars under a late-break season scenario.

Insect pest monitoring is crucial in dry-sown canola. Insecticidal seed dressings form part of an integrated pest management approach, and residual insecticides can be applied post-sowing, pre-emergent if necessary.

Further information regarding profitable management of canola can be found in GRDC's 20 *tips for profitable canola* (2019) (see Useful resources).

Faba bean and other legumes

When dry sowing faba bean or other legumes, several factors need to be taken into consideration. General information on faba bean production can also be found in GRDC's Faba Bean Southern Region GrowNotes (see Useful Resources).

1. Rhizobia survival in dry soil. Pulse and pasture legumes provide a sustainable source of nitrogen (N) by fixing root-nodulating bacteria called rhizobia. If a paddock has not grown a legume in the past four to five years, then inoculation is required to ensure sufficient numbers of rhizobia provide good nodulation and N fixation. However, rhizobia applied as a seed-based inoculant are sensitive to desiccation under dry conditions, particularly where soils are acidic.

   When considering dry sowing legumes, selecting paddocks that do not require inoculation (that is, paddocks that grew the legume in the past four to five years and are not acidic) can be beneficial. Chickpea and lupin need to be inoculated in the HRZ because their rhizobia are highly specific and they have not been widely grown in the region (Denton et al. 2018).

   If inoculation is required, then the use of peat-based, freeze-dried or liquid inoculants is generally not recommended for dry sowing as rhizobia struggle to survive in dry soils. However, good nodulation using peat inoculant can be achieved when dry sowing faba bean and lupin, provided rain occurs within two to three weeks and particularly if the inoculation rate is doubled (Denton et al. 2018). Granular inoculants do not suffer the same rate of decline in dry soils as other inoculants and can be used where soil has been dry for four weeks or more. However, Farquharson et al. (2018) identified some variability in the degree of success with granular products under dry sowing conditions.

   It is important to remember that the survival and success of rhizobia can be reduced dramatically by seed dressings of agrochemicals and trace elements, particularly when sowing into dry and/or acidic soils (Denton et al. 2018).

2. Soil and machinery interactions. Faba bean is generally sown deeper than other crops, which can reduce the risk of a false break. However, sowing deep will increase fuel use and machinery wear, particularly when sowing into dry soils. Seed depth may be compromised and the seedbed may be cloddy and uneven. It is important to roll the paddock after sowing to manage this uneveness and to make in-crop operations such as spraying and harvesting easier. However, rolling can also affect herbicide effectiveness and weed emergence, so it is important to be aware of each herbicide's behaviour and solubility. Detailed information on this can be found on the Herbicide behaviour resources page on GRDC's website (see Useful resources).

3. Early biomass production. Following dry sowing, if germination occurs while the soil is still warm, good vigour will generally help legumes rapidly develop early biomass. This can lead to increased risk of fungal diseases, which can be managed with fungicides as part of an integrated disease management (IDM) approach.

4. Weed management. Faba bean and other legume species provide opportunities for in-crop grass weed control throughout the season, but options for the management of broadleaf weeds are generally limited. There are some pre-emergent broadleaf herbicide options available but paddocks with large broadleaf populations should be avoided when considering dry sowing legumes.

Cereals

Grass weeds management is one of the most critical factors when dry sowing cereals. Ideally, paddocks with low weed seed numbers should be selected. If choosing to dry sow cereals following a cereal in rotation, effective grass weeds management needs to have been achieved in the previous crop to ensure the seedbank is low.

Any volunteer cereals and weeds from the previous crop that are emerging in the dry-sown cereals also need to be managed. Imidazolinone (imi)-tolerant cereal varieties have the ability to manage barley grass, brome grass, silver grass and other non-imi-tolerant volunteer cereals in-crop, so are another cereal option when sowing under dry sowing conditions.

Dry sowing is suitable for most crop types. Photo: Alistair Lawson

4. Crop development and flowering windows

Phenology describes the pattern of a crop's development cycle. For cereals this includes emergence, tillering, stem elongation, flowering and grain filling through to maturity. The timing of flowering is particularly important because most crops are sensitive to stresses at this time.

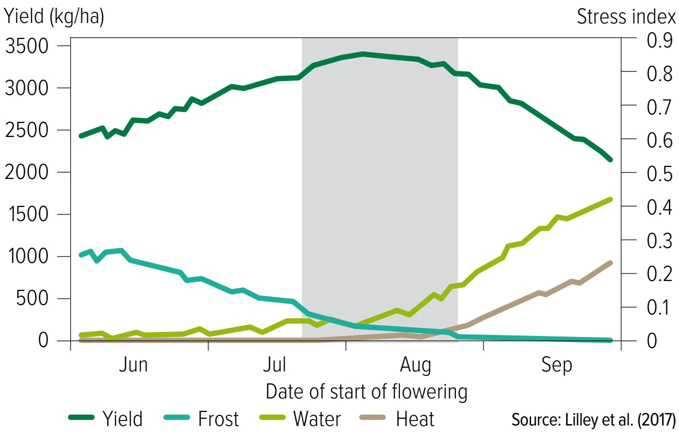
Optimum flowering window

The optimum flowering window describes the time of flowering when the combined risks of exposure to frost and heat (and drought) are minimised at any given location (see examples in Figure 2 and Table 3). It is a long-term average and is not a guarantee that frost or heat events will not occur in this window in any given year, but provides the lowest likelihood of damage occurring during flowering (Lilley et al. 2017).

If flowering occurs too early (before the optimum window), the risk of frost damage increases, but if the crop flowers after the window the risks of heat and drought stress increase. Therefore, it is important to match sowing time and variety maturity to target flowering within the optimum window.

Compared to delayed sowing, early-sown crops have longer vegetative stages (a longer period from emergence to flowering) and develop larger root and shoot systems that are better able to capture water, nutrients and light, giving them higher yield potential (Agriculture Victoria, 2020). However, even if high yield potential has been set throughout the season, it is unlikely to be realised if crops are exposed to frost, drought and/or heat events during this critical flowering period.

Figure 2: Example of optimum flowering window for canola at Wagga Wagga, NSW (in grey). This period optimises all abiotic risk factors influencing yield, including intercepted radiation, frost, heat and water stress.



Source: Lilley et al. (2017)

Research by CSIRO and Southern Farming Systems through the GRDC Water Use Efficiency Initiative (2008–13) showed that yield penalties when sowing later than the optimal sowing timeframe were generally higher than when sowing too early. Data showed that sowing after 27 April (into a moist soil profile) resulted in wheat yields declining at a rate of 40kg/ha for each day of delayed sowing (Rifkin, 2009). Dry sowing enables germination to start immediately after the first significant rainfall event, and consequently the crop will incur the least yield penalty from delayed emergence of crops sown after the rainfall event.

Fortunately, genetic diversity in crop phenology and the prevailing climate triggers (temperature, daylight for flowering) readily exist in commercial crop cultivars. This means different cultivars can be grown to target flowering in the optimal window based on the anticipated time of germination.

Optimal flowering period – a short period in spring (about 10 days) during which the combined risk of exposure to frost, heat and drought stress is statistically lowest for local conditions and the best time for flowering to maximise yield (see Useful resources, *Ten tips for early sown wheat*).

Ideal sowing time – the time of sowing (normally into moist soil) that will result in germination occurring at the right time (germination window) for that cultivar to start crop development resulting in the crop flowering in the optimal flowering window (Rifkin, 2009).

To target the optimal flowering window when sowing into dry soil, a crucial point to remember is that it is not sowing date but rather the germination date that will set the starting point for crop development and ultimately achieve the optimum flowering window.

With dry sowing, the exact timing of the first rains is uncertain so the emergence date cannot be predicted accurately. It important to identify the likelihood of receiving breaking rains by a certain date to assist with cultivar selections. Considering both short-term forecasts and patterns of rainfall in different decile years can assist with key decision points around cultivar selection.

The tactics required to target the flowering window successfully are:

1. Determine the optimal flowering window for the location.
2. Target the optimum flowering window by determining the ideal germination date for each crop cultivar to be used in the cropping program.
3. Create a 'team' of crops and cultivars that will provide a broad range of sowing date or emergence date opportunities.
4. Use forecasts and decile years to determine a range of scenarios around likelihood of germination dates to plan sowing date and match cultivars for suitability to dry sowing opportunities.

Table 3: Optimal flowering period for locations across the southern region HRZ.

Location	Wheat	Canola
Naracoorte	24/9 – 12/10	11/8 – 3/9
Hamilton	21/10 – 10/11	1/9 – 21/9
Inverleigh	6/10 – 28/10	25/8 – 15/9
Bairnsdale	7/10 – 25/10	14/8 – 8/9
Cressy	1/11 – 21/11	16/9 – 3/10
Delegate	4/11 – 22/11	18/9 – 6/10

Source: Bell et al. (2015), Lilley et al. (2015)

Matching cultivar selection to sowing opportunity

Flowering is a pivotal point for crop development. Before flowering, crop growth is directed towards building the physical structures that capture resources (sunlight, water and nutrients) and hold the plant upright. It is in this phase that the potential number of grains able to be filled after flowering is set (Rifkin, 2009). Due to the early establishment of dry-sown crops, the plants are likely to have larger root systems, which will enable them to handle dry spring conditions and increase their uptake of nutrients.

Crop development stages such as emergence, stem elongation, flowering, grain fill and maturity are all primarily triggered by a combination of temperature, day length and available water. Nutrients have relatively little impact on the rate of development. Selection of cultivars with the right maturity or development triggers and time of sowing are the two main management levers that can influence a crop reaching these growth stages.

Influences on crop development stages

Accumulation of temperature or degree days

The accumulation of mean daily temperature or degree days (°Cd) dictates crop development. A crop will develop more rapidly under warm conditions. For example, sowing to emergence usually takes 150°Cd. If the average temperature per day during this period is 10°C, then sowing to emergence will take 15 days (150/10=15). If the average temperature is 15°C, then it will only take 10 days.

Day length (photoperiod)

Day length can influence the timing of the different growth stages. Crops sown at lower latitudes (closer to the equator) do not experience the same extremes in day length as those at higher latitudes. For example, a cultivar sown in Queensland is likely to have a very different flowering date and thermal time to the same cultivar sown in Victoria because of differences in day length. For wheat crops, the shorter the day length, the longer the thermal time needed for flowering.

Vernalisation

Winter cultivars, such as *EGA Wedgetail⚖ and * LongReach Kittyhawk⚖ wheat, need a period of cold temperature (vernalisation) to trigger the onset of the reproductive phase. (*Varieties have been updated from original publication.)

This excerpt is from Rifkin P (2009), 'With an understanding of the relationship between varieties, management and yield, better decisions can be made' (see References).

Dry sowing crops gives them longer vegetative stages to capture more light and water for growth. Photo: Nicole Baxter

Timing of the sowing opportunity

There are three basic scenarios under which dry sowing is regularly used. The first is to take advantage of early sowing opportunities primarily in early April and in some instances late March, ahead of forecast early breaking rain. The second scenario occurs before the traditional season break, in mid to late April. The third is in the event of a late break of season for example, sowing dry in May. Being prepared to dry sow under all of these scenarios allows for the sowing program to start by a set date rather than waiting for a break of season.

1. Dry sowing in late March or early April

Opportunities for early dry sowing are generally focused around fodder. Long season winter-type cultivars provide a good fit for early sowing as they require vernalisation to trigger flowering compared with spring-type cultivars. Winter-type cultivars typically have stable flowering times from a broad range of sowing dates, so these will flower at about the same time regardless of the first rains and whether they emerge in March, April or May.

2. Dry sowing in mid to late April

Dry sowing in April as part of the regular program promotes yield benefits from early crop emergence and provides improvements in sowing logistics. Slow-maturing spring cultivars are a good fit for this scenario.

3. Dry sowing with a late break of season

In the event of a late break of season, spring cultivars can be matched to the predicted season length based on the probability of a germination date, with mid-to-fast cultivars being a good fit for this scenario.

As the dry sowing schedule progresses and the break has still not occurred, then switching to shorter-season varieties will help to target the optimal flowering window and reduce any potential yield penalties. Using a range of cultivars with different maturities can help to spread the risk of flowering outside the optimal flowering window in the event the break does not come until much later in the season.

More specific crop information on varieties, time of sowing and flowering windows can be found in GRDC GrowNotes (see Useful resources).

Optimal flowering in canola

Like cereals, the start of flowering in canola is triggered by a combination of temperature, cold requirement and daylength (Brill et al. 2019). As with cereals, sowing too early increases the risk of frost exposure during flowering and sowing too late is likely to have an adverse impact on yield and oil content from heat and drought stress in spring.

However, unlike cereals, canola is only semi-determinate in its growth, meaning it can continue to branch out while other parts of the plant are flowering or filling seeds and nearing maturity. Consequently, canola is good at compensating for shocks such as frost provided there is adequate soil moisture to recover. As a result, canola flowering should be targeted around an optimal start of flowering rather than a specific flowering window, which is generally earlier than cereals.

The optimal start of flowering (OSF) is the period when canola should start flowering to minimise the risks of frost, drought and heat, producing the highest yield potential at a given location on average over many years (Brill et al. 2019). Unlike cereals, which flower for about 10 days, indeterminate canola plants will flower for up to three weeks. Like cereals, the OSF is defined by the climatic conditions for a location. Cultivar selection can be used to target the optimal window and match to the appropriate dry sowing opportunity.

For canola in South Australia and Victoria, yields are reduced by about five per cent for each week flowering is delayed beyond the OSF (GRDC Canola Grownotes, see Useful resources). As canola is a smaller seed than cereals, establishment and early growth are slow. Late sowing into cold soils resulting in slow canola growth can also make seedlings more prone to disease, insects, slugs and other constraints.

According to Brill et al. (2019), the guide for the best timing for sowing different canola cultivars is:

1. March – winter cultivars;
2. Late March to early April – slow spring cultivars;
3. Mid-April to early May – mid-spring cultivars; and
4. Late April to mid-May – fast spring cultivars.

To calculate the OSF date and the most suitable cultivar for dry sowing in your area, GRDC and CSIRO have developed the canola flowering calculator (see Useful resources). Further varietal and management information can be found in the GRDC publication *20 tips for profitable canola* (2019) (see Useful resources).

Flowering window in legumes

Optimum flowering windows are not well defined for legumes in the HRZ. Like canola, legume species are indeterminate in their growth, meaning that once flowering starts they can continue to flower and set pods for many weeks, provided moisture and temperatures are favourable. Legumes provide more flexibility as a dry sowing option than determinate species (such as wheat and barley) because even if early flowers are aborted, they often have enough water to set sufficient pods.

5. Seeder machinery to maximise establishment

Different textured soils respond differently to mechanical disturbance during dry sowing. Experience shows that all seeder set-ups can be made suitable for dry sowing and adjusted to achieve good crop establishment.

When the time comes to consider seeder replacement, there is much thought given to the seeding system, including disc or tyne, tyne breakout, seed/fertiliser delivery systems and stubble handling capacity. Results of the crop establishment survey led by the University of Adelaide in 2018, which included dry and traditionally sown crops, showed many of these factors did not significantly affect crop establishment. Growers can be confident that any machinery type or seeder set-up can be adjusted to achieve good establishment and should not be considered a limitation to the ability to sow into dry soil.

As is the case with any sowing operation, seeder calibration and testing are critical – especially when dry sowing. It is important to remember dry soils can be tough, so they may require more horsepower and diesel consumption and may increase wear and tear on the seeding machine. Some of the typical adjustments to consider when dry sowing include higher tyne breakout pressures (which will vary according to soil type), good seed and fertiliser separation to prevent fertiliser toxicity, and/or slower speed to control soil throw into the inter-row and avoid pre-emergent herbicide damage in the neighbouring furrow (Kleeman et al. 2015).

When sowing into dry soils, it is better to sow a fraction deeper as this can help prevent erratic germination of seed from insufficient rainfall events and facilitate good establishment.

Dusty conditions and dry sowing with a disc seeder in SA.
PHOTO: Luke Clark, Australian Control Traffic Farming

Machinery influence on fertiliser strategies

Seeding system and set-up are also important for preventing fertiliser toxicity by ensuring separation from seed when dry sowing. Fertiliser toxicity can occur when too much fertiliser is placed too close to the seed.

Virtually all inorganic fertilisers are salts, and when they dissolve they produce high concentrations in the soil around the granule, which has an osmotic or drying effect on nearby soil and roots. The relative measure of a fertiliser's potential for damaging osmotic effects is estimated by its salt index (Norton and Desbiolles, 2011). The salt index, and therefore the fertiliser toxicity risk, of muriate of potash is greater than that of urea which is greater than that of mono ammonium phosphate (MAP), when applied at the same rate. As well as salt effects, some fertilisers, especially in alkaline soils, can also produce free ammonia (for example, urea, Di-ammonioum Phosphate (DAP), Monoammonium Phosphate (MAP), which is highly toxic to germinating seed.

Fertiliser toxicity is affected by soil moisture (marginal moisture creates more issues), soil type (light-textured soils are more prone than clays) and crop type (canola and lentil are more sensitive; wheat and barley are relatively tolerant). Dry sowing can lead to greater risk of fertiliser toxicity as there is an increased chance of marginal soil moisture during germination and crop emergence.

The easiest way to minimise the risk of toxicity effects is to ensure seed and fertilisers are separated by at least 3 to 4cm. Some seeding systems are better able to do this than others. Double-chute, split-seed systems and fertiliser banding can also reduce the risk of fertiliser toxicity (Norton and Desbiolles, 2011).

Narrow row spacings, used throughout the HRZ, lower the risk of severe toxicity effects in single-chute systems by decreasing the fertiliser density within each row compared with wide row spacings. Similarly, wide tynes will distribute fertiliser across a greater area when compared with discs or narrow points, which concentrate the fertiliser in a thin slot.

As a general rule of thumb, when dry sowing:

- avoid fertiliser contact with the seed particularly for canola and lentil;
- deep banding fertiliser at least 3 to 4cm below the seed is a good option (even in cereals)
- if using a single-chute seeder, top dress all urea or potash – these should not be drilled with the seed.

The International Plant Nutrition Institute Seed Damage Calculator (http://seed-damage-calculator.herokuapp.com/calculator) can be used to estimate how much fertiliser can be safely applied via single-chute systems, adjusting for soil type, moisture, crop, row spacing, tyne width and other factors.

6. Disease and insect management

Dry-sown crops will be prone to all the same diseases and pests as crops sown after the break of the season. As with traditional sowing, seed intended for dry sowing should be treated with seed-protection chemicals if required to manage diseases. It is important to remember seed treatments may affect rhizobial survival, so legume seed that requires inoculation should be treated with caution.

The fact that crops sown dry often emerge early means susceptible disease and pest growth stages are reached more rapidly; it is important to monitor vigilantly for pests and diseases. Monitoring soon after emergence is key to successful management. The warm, moist climatic conditions associated with a late autumn break can lead to an early outbreak of fungal leaf diseases. This may necessitate earlier and more frequent fungicide applications.

By contrast slugs, earwigs, slaters and other pests can cause significant damage to young shoots in the HRZ. When conditions become wet and soil temperatures drop, pest damage to seedlings can increase due to slow plant growth. Getting a crop established early through dry sowing means plants are more robust before entering the slow growth period and better able to withstand pressure from pests.

Manage crops carefully for pests and diseases. PHOTO: Michael Nash

7. Case studies

Grower case study

Determine end dry sowing date before start date

Now entering its fifth season of dry sowing, Circle H Farms starts sowing with the end date in mind. At Naracoorte, Circle H aims for a finish sowing date at the end of the first week in May, then works back to calculate when sowing needs to start, which is usually the middle of April.

A similar sowing pattern is followed every year: clover, faba bean, wheat and barley. Wheat comprises about 40 per cent of the cropping program and includes the cultivars LongReach Trojan⍉ and RockStar⍉. Legume crops, including faba bean and clover, account for a further 40 per cent with the remaining area (irrigated) sown to lucerne and safflower or other seed crops. The varieties sown under irrigation can change annually.

The farm's 6200 sheep graze the early-sown clover during winter. In spring they go onto the pasture paddocks before grazing on the the stubbles during summer and autumn.

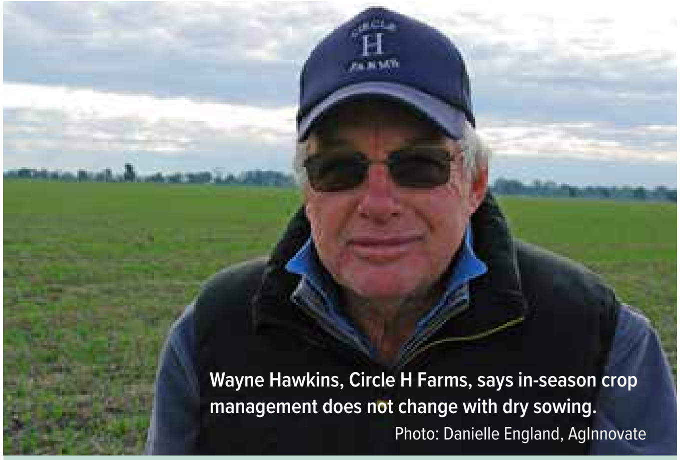
Wayne Hawkins has been dry sowing since the business invested in John Deere disc seeders five seasons ago. Circle H moved to disc seeders after problems with water sitting in the furrows for weeks at a time in wet years, which resulted in damaged emerging crops. Wayne says tyne machines did not suit their soil types. When they tried to dry sow with the tyne machines, they left clods that made the paddock too rough. The clods caused issues when harvesting clover seed crops. The single-disc seeder leaves the ground smoother, with minimal soil disturbance.

"We bought the disc seeder and kept the tyne seeder 'just in case' it got wet. The tyne seeder stayed in the shed for two years before we sold it," Wayne says. "It's a bit like buying a new GPS spray unit and putting a foam marker on the side. So just be confident and go for it."

Dry sowing means Circle H Farms sows one month earlier than district sowing time, making all the other operations earlier as well, including post-emergent spraying and nitrogen application. The biggest advantage in dry sowing, according to Wayne, is that there is no pre-seeding herbicide spray, saving the growers one pass. Instead, they sow beans deep, which delays crop emergence so the weeds emerge first. This allows them to apply a post-sowing pre-emergent (PSPE) and knockdown herbicide application in one pass. Urea also goes on earlier than normal, as soon as the crop is established.

Wayne's three tips on dry sowing

- **Finish by a certain date and get crops in earlier rather than run the seeding program overtime.**
- **Do not worry too much about weeds – there are lots of options.**
- **Do not worry too much about frosts – get it in early (with the right variety) and get it growing.**



Wayne Hawkins, Circle H Farms, says in-season crop management does not change with dry sowing.
Photo: Danielle England, AgInnovate

SNAPSHOT

Grower: Wayne Hawkins, Circle H Farms

Location: Frances, South Australia

Cropping area 2020: 2430ha total – 1100ha wheat, 400ha beans, 600ha balansa clover, 330ha barley

Enterprises: cropping and sheep

Growing season rainfall: 500mm

Soil type: black cracking clays, heavy loamy soils

"We've got less weeds with dry sowing than we've ever had," Wayne says. He attributes this to robust legume/cereal rotations and good herbicide rotations and timing.

In-season crop management has not changed with dry sowing. According to Wayne, dry sowing just means the crop is establishing earlier before it gets too wet and cold. Stubble management is also no different since they have started to dry sow, and burning has been an important stubble management strategy when sowing clover seed crops to ensure good seed and soil contact.

Some growers are concerned dry sowing will lead to frost problems during spring. Wayne's view is that if they have a frost, there is plenty of hay to cut. He says dry sowing means there is more biomass grown during the season, so there is generally more hay to cut. At Frances, frosts can occur any time between August and November – this long frost risk period makes it hard to manage.

Wayne says the best thing about dry sowing is that his team can always get onto a paddock. Having the truck out in the paddock with the seeder saves a lot of time and stress. "Seeding just hums along," Wayne says.

In May the ground is normally still hard and does not soften up until after significant rain. The ideal scenario is receiving 20mm of rain before the start of seeding, so the top soil is nice and soft. However, this is not necessary when using discs and dry sowing. "The disc seeder handles the black cracking clays and hard loamy soils easily," Wayne says.

The only problem so far with the disc seeder has been hair-pinning in thick, damp, standing wheat stubbles. If hair-pinning looks like being an issue, then the crop is sown deeper so the machine can cut through the stubble. With clover crops, the stubble is burnt so there is no hair-pinning and good seed–soil contact is established for the small seed.

In 2020 the growers added weights to the seeder to help disc penetration in the dry soils.

Agronomist case study

Use a range of varieties when dry sowing

Elders Naracoorte agronomist Adam Hancock says most of his clients are preparing their paddocks to begin dry sowing over the next few years. For those clients already dry sowing, sowing starts in early April.

"Most clients have three or four paddocks they can start with and can normally sow all of their faba bean paddocks, and up to 30 to 40 per cent of the cropping program, dry," Adam says.

"Farming is all about compromise. Dry sowing allows you to increase your yield if done correctly, and at the same time enables you to manage frost and heat exposure risks during flowering by using a range of cultivars to mitigate the influence of unknown germination dates."

It is important when dry sowing to use a range of varieties (cultivars) to spread flowering across a range of days, he says.

"By dry sowing you will have more crops establishing at the same time and more crops flowering at the same time. There will also be more crops that need spraying at the same time.

"The biggest mistake is sowing too much area dry. Then the boomspray has too much area to spray before the crop emerges. The soil remains warm for quite a few days after the break and there can be just 48 hours between being too early and too late with a spray application.

"If you've got a small boomspray, it is important to think about how much area to dry sow in one day."

Elders agronomist Adam Hancock says it is important to plan your dry sowing program. PHOTO: Danielle England, AgInnovate

SNAPSHOT

Agronomist: Adam Hancock

Location: Elders, Naracoorte

Growing season rainfall: 440mm

Adam says the most important consideration is understanding that dry sowing needs to be planned. He uses a calendar Gantt chart to plan the seeding operation, which also helps the discussions on paddocks appropriate for dry seeding and the grower's machinery capacity.

"If we know that it will take five weeks and two machines to complete seeding, then we can plan target sowing dates for each crop and paddock," Adam says.

He says dry sowing can be successful irrespective of machinery choices. His clients all have different machines, from wide-row knife-point and press wheel units to narrow-row disc machines.

Adam believes it is important to understand your machine capability in your soil type. For example, when dry sowing crops into heavy clay soils, discs may skid along the top, leaving the grain on the surface. There are mechanical adjustments to help alleviate this.

It is also important to pick the soil types suitable for dry sowing. "There are some paddocks that can be too hard when it's dry. For example, if you've got a 250mm knife-point press wheel system then the soil might be too hard to dry sow."

Adam warns that dry sowing can put a lot of pressure on pre-emergent and in-crop herbicides and recommends selecting the cleanest paddocks.

"You must know your pre-emergent herbicide options, regardless of what crop you are growing. Research suitable herbicides for use pre and post-seeding, either before or after the rain, and work with a professional agronomist to pick the best options."

Foliar disease pressure in dry-sown crops can also increase and Adam suggests being fully prepared for disease pressure. "Crops get out of the ground fast, making them more vulnerable to the initial spore release from the first couple of rainfall events," he says.

"Stubble-borne spore releases are the biggest issue, which can really only be managed with variety selection, seed treatment and making sure the fungicide is applied at the right time. Every crop (canola, wheat or beans) has a weakness to be managed if sown dry. Knowing what variety is susceptible to which disease helps with prediction and planning."

Knowing the best management strategy beforehand is also important. "Dry sowing has some risks, including shallow-sown seed due to a lack of seeding depth or getting the herbicide out on time without causing crop damage."

Dry sowing decisions and planning aside, Adam says the rest of the season and its management remains the same: in-season crop management, rotations, crop types, fertiliser strategies and/or harvest set-up. He also recommends "learning from as many people you can".

Grower case study

Spread risk by starting small

The Millring Pastoral family of Alan and Judy, Rowan and Renee and Tim and Belinda Paulet completed their first year of dry sowing in 2019 in an unusual situation.

Dry sowing is uncommon in the Gippsland region, where the family operates an integrated livestock and cereal grains agribusiness across six farms located at Toongabbie and Flynn. They use the calendar to set sowing date, rather than soil moisture conditions.

"We focus on long-season varieties, with sowing beginning in early April," Rowan Paulet says. "We sow 30 per cent wheat, barley and canola and 10 per cent beans, into 1000 hectares across the farms. We also sow annual ryegrass and summer crops of rape and millet for livestock feed."

In 2019, the family stuck to the calendar system for time of sowing, but conditions were unusual with no subsoil moisture coming into sowing at the start of April.

"It was very dry conditions for sowing, not something we're used to, so we decided to stick to sowing by the calendar rather than wait for an autumn break," Rowan says.

With below-average yields in 2018, the Paulets baled straw and decided against burning stubbles, instead retaining ground cover. Integrated into the grazing strategy, the retained stubbles protected the soil from summer heat and strong winds, resulting in good soil structure ahead of dry sowing in 2019.

The Paulets' soil type is typical for central Gippsland – loam over clay. Soil testing indicated the generally acidic soil was low in potassium and calcium, but sufficient for phosphorus and high in iron.

"Heading into the 2019 season, we thought there would be residual nitrogen from 2018, but deep N soil tests indicated we didn't have carryover nitrogen," Rowan says.

Due to the low nitrogen carryover, canola, faba bean and barley were all sown with 100kg/ha MAP mixed with 25kg/ha muriate of potash (MOP) using a double-chute system and banding to achieve seed separation. The canola also received 50kg/ha urea at sowing. Mid-year, all crops received a further 50 to 80kg/ha urea and 50kg/ha MOP, with up to two further applications of urea to a maximum of 200kg/ha. In addition to fertiliser requirements, the Paulets applied gypsum and lime when required.

"We regularly apply 0.5t/ha [tonnes per hectare] of gypsum in the canola pre-sowing phase and liming as determined by soil tests," Rowan says.

In planning the dry sowing program, the Paulets decided to start with canola and beans on advice from others with experience as they were considered safer and more reliable for dry sowing.

"We decided to sow canola and beans first. Wheat followed, sown in late April. Barley was sown in May. Canola and beans were chosen to plant first because we were trying to spread our risk in unfamiliar conditions," Rowan says.

Ignite, Victory and Phoenix canola went in at a rate of 3kg/ha, Zahra$^{\phi}$ faba bean at 150kg/ha, Manning$^{\phi}$, RGT Accroc and SF Adajio wheat varieties at 80kg/ha, and RGT Planet$^{\phi}$ and Rosalind$^{\phi}$ barley were sown at 80kg/ha. To assist faba bean nodulation, peat inoculant was applied at double rate with the appropriate rhizobia to overcome the effects of dry soils on rhizobia survival.

All seed was direct drilled, at normal planting depth, using a Horwood Bagshaw PSS airseeder 4000L, 8m machine, hauled by a 270 horsepower John Deere. Rowan says the seeder and tractor are rarely uncoupled. Some minor adaptations were made to the method with dry sowing such as slowing the sowing speed and not waiting for a weed germination before planting their crops.

"We drove a bit slower to try and reduce clodding of the soil," Rowan says. "We put a lot of faith in our pre-emergent herbicides and they worked well. We used Sakura® plus Avadex® for wheat, Boxer Gold® for barley, propyzamide for canola, Terbyne® Xtreme® and diuron mixed with trifluralin for beans. Post-emergent herbicides, most crops received a broadleaf spray and the canola was sprayed using grass-selective herbicide."

Patchy emergence is the biggest risk to dry sowing, in Rowan's view. "Start with a crop you're confident about – for us it was canola – and make sure you've got good seed-to-soil contact."

Following seeding, regular crop monitoring is important for keeping on top of weeds and pests. "Crops are monitored regularly, especially at the early growth stages for weeds and pests," he says. The canola paddocks were monitored at night for slugs, pre-sowing and post-sowing.

Enough rain fell in August to build the soil moisture profile, which dried out in September and October. Follow-up rain in November yielded 50 to 70mm across the farms to help crops finish. Canola yielded an average of 2 to 3t/ha and cereals 4 to 6t/ha in that season.

"They were slightly above average yields in a below-average season; the beans did what we thought they would, at 2t/ha," Rowan says.

SNAPSHOT

Growers: Alan and Judy, Rowan and Renee, Tim and Belinda Paulet, Millring Pastoral

Location: Toongabbie and Flynn, Victoria

Cropping area: 1000ha

Enterprises: mixed cropping and livestock

Growing season rainfall: 350 to 400mm

Soil type: loam over clay

2019 crop program: 30% wheat, 30% barley, 30% canola, 10% beans

Alan and Judy Paulet, Millring Pastoral, used dry sowing in 2019.
PHOTO: Jeanette Severs

Grower case study

Plan ahead for dry sowing

Simon and Alistair Gabb use dry sowing to optimise their in-crop rainfall and maximise yield potential. The Gabbs use dry and early sowing as an important strategy for reducing the impact of waterlogging and maximising water use efficiency and yields in the high-rainfall zone.

When do you start dry sowing?

The Gabbs base their sowing on a calendar date rather than a rainfall event. They have found in the HRZ that if you get too much rain at the break the paddocks become untrafficable and waterlogged, preventing germination and reducing crop growth.

The Gabbs begin their dry sowing plan by looking at the optimum germination time for each of their crops. For example, the optimum germination time for barley is the first week of May.

Varieties, flowering windows and frost

According to Simon, the biggest challenge of dry sowing is speculating on the germination and emergence dates. He says depending on the likelihood of emergence dates, higher rates may need to be used when dry sowing to account for potential lower germination

October and early November are their biggest frost risk periods. In the 2017 and 2018 seasons the Gabbs had severe frosts on consecutive days that coincided with flowering times. Since suffering near 100 per cent losses in those years, the Gabbs have adopted the practice of growing two wheat varieties with different growing season lengths to offset flowering dates and mitigate risk of wipe-out from a single frost event.

The brothers grow feed wheat, long-season winter wheat RGT Accroc and shorter-season non-winter wheat LongReach Beaufort(|) varieties to spread the sowing, flowering and maturity dates. They simplify their break crops, sowing ATR Wahoo(|), triazine-tolerant (TT) canola and PBA Samira(|) faba bean. They use this mix of crops to mitigate seasonal risk in the enterprise as well as provide weed and disease breaks.

Al Gabb and Simon Gabb recommend working closely with an adviser when starting to dry sow. PHOTO: Annieka Paridaen, Premier Ag

SNAPSHOT

Growers: Simon and Alistair Gabb

Location: Skipton, Victoria

Cropping area: 700ha

Enterprises: cropping and sheep

Growing season rainfall: 400mm

Soil type: mixed loam with buckshot sand layers

2019 crop program: 420ha cereals (wheat and barley); 280ha break crops (pasture, faba beans and canola)

The importance of weed control

Careful weed control is vitally important for the success of dry sowing, according to Simon. Their rotation consists of up to three years of sown perennial pastures, beans, canola, and then up to three years of cereals (either wheat or barley).

In the final pasture year, the pasture is spraytopped early (late August/September) and planted with a spring fodder crop to manage the weeds. The fodder crop is grazed heavily pre March/April, sprayed out and brought into the cropping rotation. This gives them up to six years between cereal crops to control ryegrass numbers.

The Gabbs use grazing pressure during the pasture phase to keep annual ryegrass under control before spraytopping it in the final year. A spring knockdown is a very important tool in managing weed seed numbers, Simon says. “If ryegrass is allowed to set seed again, you rely on chemical control in-crop. This is critical to setting up the following five-year cropping program.”

The Gabbs are aware that the cereal-on-cereal phase in their rotation creates a high-pressure grass weed system, so they try to keep weed seed numbers as low as they can throughout the rotation, which includes spraytopping in canola and beans. They are not afraid to cut a cereal crop for hay if the weed burden is too bad; for example, they will not just cut the section of the paddock with the bad weed burden but the whole paddock to ensure good control.

Spraying high-weed-pressure cereal crops with Roundup® a minimum of 24 hours before putting the mower conditioner into it is a must. This is generally followed up with a Gramoxone® application once the paddock has been baled and carted to ensure there are zero surviving weeds and that two modes of action have been used to prevent further resistance forming.

The importance of knockdowns and pre-emergent chemicals as an upfront defence against ryegrass is well understood, with the Gabbs not compromising on double-knock opportunities and pre-emergent efficacy, instead using IBS (incorporated by sowing) and PSPE (post-sowing pre-emergent) sprays where necessary in stubble paddocks.

The pasture phase

The pasture phase is used to take pressure off the chemicals in their pursuit of weed control. The pasture phase is sown with balansa clover as an introduction to setting up a pasture, or a perennial ryegrass and subclover mix. This allows them to control weed seed numbers and to ensure good soil health for the cropping phase of the rotation.

The Gabbs usually crash-graze pasture paddocks that have hard-to-control weeds with intensively high stocking rates. In 2019 they started to implement strip grazing to ensure the sheep ate everything, including the radish and annual ryegrass. Simon says the hard grazing regime does not allow the perennial ryegrass pastures to grow past the early reproductive stage, so the plants usually do not last beyond three years. At this stage it is time for the paddock to go back into the cropping rotation.

Machinery

All crops are sown with a 10m Simplicity airseedeer with 250mm wide spacings, single chute and knife points with trailing press wheel. It allows them to inter-row sow and as it is a parallel unit there are no trash flow issues like you get with a parallelogram seeder. The pastures are sown by a contractor with a specific pasture-sowing machine on narrow spacings, which also discourages weeds in the pasture phase.

Simon says it was a trade-off between a parallel unit and a parallelogram, where a parallel seeder is not as good for seed placement or below-seed cultivation but is better for trash flow, allowing the seeding unit to get through stubbles both wet and dry.

Stubble management

The Gabbs have moved from burning stubble to baling straw. The wheat is harvested high and spread, with the straw windrowed to approximately 100 to 150mm above ground then baled. The barley is harvested low using a Claas Lexion combine to retain straw quality. The straw is then picked up and baled straight out of the header rows using a Claas Lexion combine to retain stubble quality. This minimises chaff, which can upset pre-emergent efficacy and trash flow at seeding.

The stubbles are only lightly grazed to leave as much standing as possible. The Gabbs avoid overgrazing, instead choosing to use containment feeding to take the livestock pressure off cropping paddocks. The sheep go into the confinement areas post joining in early March and do not come out of confinement until the food on offer (FOO) targets are met before lambing in winter.

"We leave the straw standing as much as possible," Simon says. "It is not the standing stubble that creates the issue (at seeding); it's smaller chaff-like material that is already on the ground."

Crop management

The Gabbs have a single-chute system on their seeder, so they select their fertiliser carefully. The brothers use a variety of fertilisers depending on soil tests. In 2019 they applied N-Rich 22 fertiliser at sowing to provide starter nitrogen and phosphorus. Further into the growing season crop, nitrogen was added two to three times during the vegetative and stem elongation stages. This was guided by deep N soil test results and allowed variable rate N application.

Liming is regularly used to manage an acidic topsoil (10 to 15cm). Lime is an integral part of the whole farm plan. The Gabbs use grid soil mapping as part of their liming program. A third of the farm is tested every year, allowing lime to be spread using variable-rate technology on paddocks every three years. The minimum rate spread is 1000kg/ha regardless of soil pH to account for the acidifying effects of fertiliser, despite soil below 20cm being less acidic (pH >6).

The Gabbs pre-emergent chemical strategy is considered carefully with their agronomist when dry sowing. Often they use an IBS application with a knockdown and PSPE applications before rainfall or where tie-up of chemical on stubble may be an issue.

Using more than one mode of action in herbicide applications allows them to keep on top of herbicide resistance as well as reduce the risk of herbicide failure in trashy or dry situations.

The fungicide program depends on the season, with proactive disease monitoring directing management in faba bean. Fungicide applications are generally applied at the flag leaf and ear emergence stages in cereals.

The downside to dry sowing

- Seed placement with small seeds can be an issue, especially dry sowing canola as it is less forgiving in the heavier soil types. However, the larger seeds (beans and cereals) are more forgiving.
- The Gabbs have noticed more wear and tear on machinery due to dry conditions. They have found bearings and points wear more, requiring more maintenance.

The upside to dry sowing

- Dry sowing reduces the risk of being backed into a corner with impassable, waterlogged paddocks after the rain.
- Dry sowing gives a greater potential for using in-crop rainfall and lets you set up the paddock for its maximum crop yield potential.
- Early-sown cereals can also be used for grazing, which takes pressure off pastures before they are stocked for lambing.

Simon's top tips for dry sowing

- **Talk with your adviser about dry sowing. Chat about the pros and cons of dry sowing for your cropping program. Then together work out the fertiliser, chemical and varietal selections you will need to make the program work. Ensure you do this well in advance, 12 months or so, before incorporating dry sowing into the program.**
- **Start with a small area; do not go and sow everything in the first year. Try a canola or wheat paddock, or one of each.**
- **Make sure you have a sound rotation that you are confident in. Choose a paddock with a very low (almost nil) weed seed burden, so that if you do not get good crop germination (and therefore crop competition) after the opening rain you will not get high weed numbers developing throughout the year. Use a multi-enterprise approach with pastures, pulses, oilseeds, hay and cereal and a well-managed herbicide program with varied modes of action to keep weed pressure low.**
- **If weeds blow out in a paddock, do not be afraid to cut it for hay. Mechanical control of weeds is the number one method to drop weed seed numbers quickly in preparation for next year. If you let weeds go, it can be a downward trajectory to dirty paddocks very quickly.**

Agronomist case study

Sow the right variety at the right time

The key to a successful cropping program is getting the crop in on time, says Premier Ag agronomist Annieka Paridaen. In the Victorian high-rainfall zone, sowing on time requires some crops to be dry sown most years using good rotations and the "right cultivar" to manage ryegrass numbers and frost.

Annieka says the risks of dry sowing can be reduced by establishing a good rotation (to reduce the risk of ryegrass) and by knowing what cultivars you can sow dry to reduce the frost risk.

"Dry sowing greatly reduces the risk of not getting crop in the ground at all (with a wet autumn break of the season), which is something we have seen in the Victorian high-rainfall zone in three out of the past four years," Annieka says. "Growers cannot afford not to dry sow around here!"

Frost events can cause damage to maturing cereal crops over a six-week period between the start of October and mid-November, and we do not know when it will occur, Annieka says. However, sowing dates are easily determined with weather and cultivar data so growers can set up crops for success by sowing on time, growing biomass and making a call on cutting hay if a frost occurs.

She notes that a late-sown crop can be frosted too, but will have had limited time to build biomass. Hay can also be used as a tool to manage pre-emergent herbicide failures.

Annieka first got involved in dry sowing as a member of the Southern Farming Systems team when she joined a GRDC water use project researching early-sown wheat with the CSIRO in 2011. This project gave Annieka a good understanding of the interaction of wheat genotype (vernalisation, photo period triggers) and sowing date.

"In 2011 early sowing was associated with frost risk, with not much consideration given to the risk of delayed sowing and the effect of heat and drought stress on crops in spring," Annieka says. Historically, heat and drought stress were more likely to affect crop yields in the Victorian HRZ than a severe frost event, but growers were happy to sow later if it took them out of the frost risk window.

She says the optimum flowering window for wheat in Victoria's HRZ was determined through weather data looking at the chance of temperatures <0°C and the chance of temperatures >34°C. Mid-October was the time when the risk of frost versus the risk of heat stress was lowest.

The GRDC-invested CSIRO/Southern Farming Systems project, led by CSIRO's Dr James Hunt, looked at commonly grown cultivars in the region at the time. It determined optimum sowing dates through genetic traits and field testing. It explored the opportunity to sow winter wheats very early (before April) without the risk of flowering too early (because of their vernalisation requirements). It also trialled slow-maturing spring wheats such as LongReach Beaufortⓓ (a dominant wheat cultivar in the Victorian HRZ) with an optimum sowing date of mid-April to early May. The research found that if sowing LongReach Beaufortⓓ any later you could expect a yield penalty, especially if it was an average spring, Annieka says.

She says this research gave agronomists and growers confidence to begin sowing earlier so the sowing program could be finalised by early May, reducing the risk of not being able to get on paddocks after a decent autumn break.

Annieka draws everyone's attention to a GRDC *Early-sowing*

Annieka Paridaen, Premier Ag, says choosing the right cultivar is paramount when considering dry sowing. PHOTO: Annieka Paridaen, Premier Ag

SNAPSHOT

Agronomist: Annieka Paridaen, Premier Ag

Location: south-west Victoria (Streatham)

Growing season rainfall: 500 to 650mm

Table 4: Examples of varieties and sowing windows in Victoria

	Winter wheat examples	Slow-maturing spring wheat examples	Mid-maturing spring wheat examples	Fast-maturing spring wheat examples
Sowing window	Late February – Late April	Mid-April – Early May	Late-April – Mid-May	Mid-May onwards
Mallee & Wimmera	Rosella, EGA Wedgetailⓓ, Wylah, Whistler	LongReach Lancerⓓ, Kioraⓓ	LongReach Phantomⓓ, Harperⓓ, Yitpiⓓ, Magentaⓓ, LongReach Trojanⓓ	Corackⓓ, Maceⓓ, LongReach Scoutⓓ, Shieldⓓ
North East & North Central	EGA Wedgetailⓓ, Wylah, Whistler	Bolacⓓ, LongReach Lancerⓓ, Chara, Kioraⓓ	LongReach Phantomⓓ, EGA Gregoryⓓ, LongReach Trojanⓓ	Suntopⓓ, LongReach Scoutⓓ, Corackⓓ, Youngⓓ
South West	SQP Revenueⓓ, Manningⓓ	LongReach Beaufortⓓ, Bolacⓓ, Forrestⓓ, Kioraⓓ	Derrimutⓓ, LongReach Trojanⓓ	LongReach Scoutⓓ, Elmore CL Plusⓓ

Source: James Hunt, CSIRO, GRDC 2014 Southern Region Update Paper, GRDC 2015 Early-Sowing Wheat in Victoria fact sheet *wheat in Victoria* fact sheet (Hunt and Paridaen, 2015), which summarises this research on the interaction of sowing dates, cultivars and yields across different Victorian cropping zones.

If you were new to dry sowing, what crops and paddocks would you start with?

The CSIRO/Southern Farming Systems research with investment from GRDC showed that canola and beans could be sown before mid-April without any yield or agronomic trade-offs, so in practice these crops are usually prioritised in the first half of April before wheat sowing begins around 20 April. Annieka's clients tended to finish with barley or short-season wheat.

If dry sowing for the first time, Annieka recommends break crops such as canola and beans because there are good options for post-emergent ryegrass control. Longer-season wheats (winter wheats or long spring wheats) that can safely emerge before Anzac Day without having any major implications on flowering window are also a great starting point.

Paddocks with a poor seedbed, or those that are cloddy or compacted or have poor soil–seed contact (where seed placement may be compromised), will be slower to germinate and will require more rainfall. These paddocks are not ideal for dry sowing. Annieka recommends either leaving them until later in the program or improving the seedbed where possible by rolling.

Annieka's top three tips for agronomists

1. Understand the program.

How many days of sowing are there? Start with the date when sowing needs to be finished by and work back to figure out the sowing start time (allowing for breakdowns and weather events). Start on time to finish on time.

2. Know your cultivars and match with sowing windows.

Do not set cultivars up for failure by sowing short-season cultivars dry early in the program and risking an early germination date. Likewise, avoid sowing longer-season cultivars late as this will reduce yield potential. There is lots of research and data on sowing dates in wheat and canola – there is no need to guess.

3. Eliminate weed control as a determinant for sowing windows

Establish a good rotation with two years of ryegrass control so that a knockdown on grass weeds is not paramount to the crop's success. Cereals, with good early vigour and tillering, can provide good competition for ryegrass compared to waiting for a knockdown and having a slow-growing crop that cannot compete with later-germinating grass.

Annieka's three biggest dry sowing risks

1. Pre-emergent herbicides in the dry.

Some products require rainfall to activate/wash in, which can require some management. Use a pre-emergent that persists in dry conditions.

2. Not knowing when the break will be.

If a very late break occurs, growers can have longer-season crops planted that emerge outside their optimum sowing window. This increases the risk of flowering in the hot/dry period. So reduce this risk by diversifying the crop maturity length and sow more than one cultivar in a crop type (particularly wheat).

3. Staggered germination of crops.

Often there is enough rain to germinate seeds that have had optimum placement or are in lighter soils, but in the heavier parts of paddocks or in areas with poor seed placement plants can emerge later. The temptation is to sow into deeper moisture, but this usually results in poor plant numbers and delayed emergence once it does rain. Sowing too deep can cause issues early with canola grass spray timing; however, crops seem to even up throughout the season and there are not many issues with maturity later in the season. You cannot quite eliminate this happening, but it is not that big an issue because crops can compensate well when given space.

Agronomist case study

Understand machinery for dry sowing

Gippsland growers sow according to the calendar, even in severe drought, as the soil often retains some moisture over autumn, according to Sale agronomist Gary Condron from Rodwells.

Despite dry conditions in 2019, Gippsland grain growers stuck by their usual timings and sowed according to the calendar. They also stuck to their planned rotational program. Gary estimates close to 50 per cent of the dry-sown cereal and canola seed germinated early on stored soil moisture, with the rest of the seed germinating after the break of the season rain.

"In this area, we don't usually get the hot and dry conditions of the northern croppers. But last year was the hottest and driest year I've seen in Gippsland in the past 15 years and the drier-than-normal soils in 2019 did throw up some issues," Gary says.

"In really dry soil, our equipment can struggle because of high breakout requirements on knife-point press wheel seeders and excessively hard soils. Many Gippsland grain growers use a knife-point press wheel seeder.

"Their machines are used to sow into moisture. The friction on the points was much hotter and produced more excessive wear in the 2019 season than growers were used to, so regular and additional maintenance may be necessary.

"They also needed more horsepower to pull. That all led to more machinery maintenance and increased fuel costs.

"Every year you've got to look at the soil type and how the machine is operating. The softer, sandier soils tend to sow deeper and throw more soil around than the clay loams.

"The heavier soils took more getting through, which meant the machinery was working harder and increased maintenance and repairs, so selecting the right paddocks for dry sowing is key."

Sowing according to the calendar without waiting for rain can make for challenging weed control. While the 2019 season meant there were considerably fewer volunteers, the lack of rain meant pre-emergent herbicides were not activated at the appropriate time in some cases.

"Often we get into trouble because we've disturbed the soil so weeds strike up before we get enough rain to activate the pre-emergent," Gary says.

"The pre-emergent herbicide and robust weed control strategies focusing on the WeedSmart 'Big 6' are critical for dry-sown crops. Otherwise we have weed competition in the crop all the way through to harvest.

"In the wetter years, when we have more cover, excessive trash or vegetation can prevent soil contact with the pre-emergent and can neutralise the active ingredient. Last year, all options were on the table.

"In 2019 in-season crop management was very conservative, mostly because we were adjusting inputs to match the available moisture for the crops to use.

"The dry weather kept weed burdens very low so we didn't have to spend as much on herbicides, fungicides and fertilisers."

Canola and winter wheat were the first crops to be sown by most growers.

While dry sowing and adjusted in-crop management are critical tools for future dry periods, Gary suggests experimenting with dry sowing in small on-farm trials to find out what works. He recommends dry sowing a strip through a paddock to give growers a chance to assess their machinery's capabilities and if it can handle the harder work, especially on heavier country.

"Make sure you have spare points, because they are going to wear out pretty quick," he says.

"Try and keep your two pre-emergent herbicides in the program. They work exceptionally well if they're used appropriately and they will do a good job on controlling weed burden.".

SNAPSHOT

Agronomist: Gary Condron, Rodwells

Location: Sale (Gippsland), Victoria

Sale agronomist Gary Condron says dry sowing is an important tool in seasons similar to 2019. PHOTO: Jeanette Severs

8. Useful resources and references

Useful resources

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