Managing stubble

During the last 25 years, conservation farming has continued to evolve. There is now less burning, less soil cultivation and increased retention of crop stubble. This trend has been driven by the need to maximise water use and protect soils from erosion, in an era of increasing climate variability.

Background

Crop stubble is the straw and crown of plants left on the soil surface after harvest. Stubble also includes straw and chaff discharged from the harvester (header). It is also known as 'residue' or 'trash'.

Stubble management is one of many complex issues that farmers must contend with. Traditionally, grain growers have burnt stubble to manage weeds, diseases and reduce biomass to make sowing easier. This is no longer the preferred option; numerous other methods can be used to manage stubble.

Retaining stubble, rather than burning or cultivating, protects the soil from erosion. It also conserves soil moisture and organic matter to sustain crop production. This is particularly beneficial in dry areas or in dry seasons.

Stubble influences many things including the passage of machinery, light penetration, soil temperature, herbicide interactions, frost severity, pests, weeds and diseases.

Burning is often used as a last resort to manage heavy stubble loads, invasive weeds or pests. Stubble burning may be a reasonable option in particular circumstances.

Alternatives to burning heavy stubble

- Effective management of heavy stubble can begin with cutting the stubble at harvest as short as possible - ideally to no more than the row width, with the chaff evenly spread
- As a 'rule-of-thumb', if you can run your foot through the heaviest stubble, early on a dewy morning, you should be able to sow with a tyned seeder
- Some growers chop and spread stubble behind the header while retaining standing stubble
- Particularly heavy stubble can be cut higher and mulched after harvest. This helps to shorten stubble, retain soil moisture and accelerate decomposition
- If sowing the next crop with a disc seeder - rather than tynes - stubble can be cut higher. The straw and chaff need to be spread uniformly
- Straw can be baled after harvest. In some years, this is profitable - especially when feed is in short supply
- Inter-row sowing allows stubble to be retained when crop rows are more than 22 centimetres wide
- Growers may need to review stubble management decisions each year.

Stubble retention trends in Victoria

From the mid-1990s to 2009 in Victoria, the adoption of conservation cropping practices tripled. Farmers increasingly recognised its benefits to productivity and sustainability.

Areas where stubble is burnt represent a minority of the total Victorian crop. Most farmers will only burn stubble when absolutely necessary, having considered all available options and the potential implications of burning.

Stubble retention rates vary between years and districts. It is more challenging to retain stubble following wet years and for farmers in high rainfall areas or following irrigated crops.

Surveys in western Victoria provide insight into stubble burning trends.

While stubble retention rates increased consistently during the 'Millennium Drought', they have fluctuated since then. Levels of burning or cultivation were highest with heavy stubble loads following wet seasons (Figure 1).

In the northern Wimmera, more than 80 per cent of paddocks had retained stubble in 2021 – double that of 1996 (Figure 1).

In the southern Wimmera, almost 75 per cent of cropped paddocks had retained stubble in 2021. Almost 20 per cent

had been burnt or prepared for burning. This was mostly windrow burning.

Four per cent of paddocks surveyed in the high rainfall Glenelg-Hopkins catchment were burnt in 2021. This figure was 30 per cent for cropped paddocks in the eastern part of the catchment, where there is significant grain production. This was almost entirely whole paddock burning, rather than windrow burning.

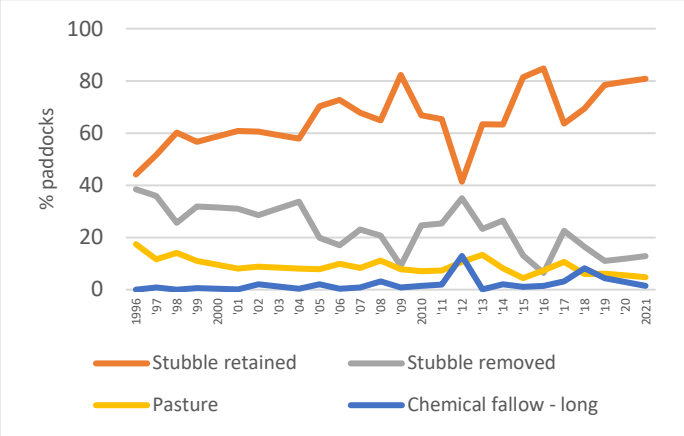

Figure 1: Trends in land management in the northern Wimmera since 1996. *Data for 2000, 2003 and 2020 are patched.

Benefits from retaining stubble

Soil properties in Victoria's crop growing regions have improved due to increased stubble retention. The main impacts are less erosion and moisture conservation.

Lower erosion risk

Stubble provides ground cover, which protects soil from wind and water erosion by slowing wind speed at the soil surface and reducing runoff. To protect soil:

- Stubble needs to be at least partially anchored
- At least 70 per cent ground cover minimises water erosion risk and at least 50 per cent ground cover minimises wind erosion risk
- Stubble height should be at least one-third of the width of crop rows. As a 'rule-of-thumb', the shelter provided by a barrier is approximately three times its height; 10 cm tall stubble will protect the adjacent 30 cm of topsoil
- Maintain sufficient stubble for six to eight weeks after sowing.

Improved water use efficiency and soil health

Retaining crop stubble can improve soil moisture content by reducing evaporation and increasing rainfall infiltration rates.

Saving more surface soil moisture after autumn rains helps farmers to sow crops on time. This maximises grain yield potential and water use efficiency.

Other benefits of retaining stubble

- Promotes nutrient recycling. It can contribute to a very gradual improvement in soil organic carbon and the soils' microbial biomass
- Significantly lower fuel costs and less labour
- Lentil crops sown between cereal stubble rows are more easily harvested; plants grow taller and pods are higher.

Disadvantages of burning

- Drier surface soils
- More risk of topsoil loss from erosion
- Loss of nutrients
- A faster decline of soil organic carbon and soil microbes and fauna, with repeated burning
- Poorer soil structure, e.g. reduced soil aggregate stability and hydraulic conductivity and higher bulk density
- Risk of escaped fire
- The potential, or perceived, impact of smoke as an air pollutant and its impacts on rural communities and industries.

Strategic removal of stubble

Many Victorian farmers take a 'flexible' approach and are willing to reduce stubble loads - if they are likely to cause problems with sowing, establishment or weed management.

Legume and oilseed crops produce lower stubble loads. Their inclusion in the rotation may be help with managing stubble.

Grazing

Livestock can help remove old stubble. Dry ewes or wethers can be useful in removing two-year-old stubble to enable inter-row sowing. Small mobs of sheep in large paddocks often only reduce stubble loads in parts of the paddock.

Baling

In some years, stubble can profitably be removed after harvest by baling straw. Baled straw has uses in animal bedding, mushroom compost and in some years, livestock feed. It has other potential uses, such as for bioenergy.

Strategic burning

Strategic stubble burning in autumn can sometimes be a valid option when based on sound agronomic principles. Cool, late burns may successfully remove high stubble loads while leaving sufficient cover for soil protection.

Challenges with retaining stubble

Stubble retention has many benefits but requires an integrated 'systems' approach to manage challenges including weed, pest and disease pressures. All aspects of

the farming system need to be considered, including agronomy, grazing management and set-up of machinery and guidance systems.

With very heavy stubble loads, the challenges become greater, including:

- Difficulty sowing due to stubble physically impeding the operation or causing seeder blockages
- Mouse populations
- Snails, slugs and insect pests such as mandalotus weevil and European earwigs
- The inability to control weed seed set in the previous year due to wet conditions and herbicide resistant weeds
- Stubble-borne diseases.

Soil acidity can increase with stubble retention, compared with soils where stubble is burnt. In general, farming increases soil acidification while burning has a liming effect.

Reasons growers may choose to burn

While the long-term benefits of retaining stubble generally outweigh those of removing stubble, some growers choose to burn strategically for reasons such as:

- Ease of sowing and better establishment of small seeds, such as canola
- A less suitable habitat for many crop seedling pests
- Managing certain weeds, particularly herbicide-resistant weed populations
- Low cost way to remove stubble and control weeds, speed and convenience
- Reduced reliance on agricultural chemicals
- Better weed control due to a more even distribution of herbicides and effective incorporation of pre-emergent herbicides
- Less nitrogen tie-up (immobilisation)
- In some instances, less frost damage to crops
- Less inoculum for certain crop diseases (if stubble is completely removed).

Effect of stubble burning on crop diseases

Retaining stubble can increase the risk of stubble-borne diseases. Diseases should be managed proactively, in an integrated way. This can involve selecting disease-resistant crop varieties, inter-row sowing, crop rotation and strategic fungicides.

Even though burning can reduce disease levels, it usually only gives partial control - which means diseases still need to be managed.

Any stubble remaining after burning can still support carry-over of disease. These include:

- crown rot, take-all, yellow leaf spot, eyespot and *Septoria tritici* blotch in wheat
- the net and spot forms of net blotch in barley and
- blackleg in canola.

For canola, burning will reduce the amount of stubble available to produce spores - but a large proportion will remain after the paddock has been burnt. Even burnt paddocks will produce blackleg spores (171kb download). Normal blackleg management practices should still be used.

For crown rot and take-all, burning stubble does not remove inoculum below ground. Burning can also exacerbate crown rot's impact later in the season, due to drier soil.

Retaining stubble can also assist in disease management. A recent Agriculture Victoria study found that standing cereal stubble can reduce ascochyta blight infection in chickpea crops. Similar results have been found with diseases of lupin sown into mulched cereal stubble.

Further information on individual diseases and management options is available through Field Crops Diseases Victoria.

Timing and temperature of burning

Farmers opting to burn stubble should do so as close to sowing time as possible, to maximise soil moisture and reduce the erosion risk during summer.

Farmers must ensure they comply with all relevant regulations or laws.

Standing stubble can quickly reach 300°C while burning, but this is very short-lived. Very large stubble loads can reach 600°C, removing more soil organic carbon than lower temperatures.

With narrow windrow burning, temperatures can reach between 400–600°C and for a longer period. Windrows should be as tight and dense as possible for a hot burn. Canola windrows tend to burn hotter and for longer than cereal stubble.

Annual ryegrass and wild radish seed can be completely killed at 400°C. Brome grass requires at least 40 seconds at 450°C to kill all seeds.

It is recommended that landholders intending to undertake burning collaborate and communicate as early as possible with their surrounding community before the start of the private land burning period.

Strategic windrow burning

Whole paddock burning is declining in favour of windrow burning (Figure 2). Strategic windrow burning is a useful compromise, lessening the wind erosion risk - particularly if undertaken just before the break of season, e.g. mid to late April.

Aim to maintain reasonable levels of stubble when windrow burning - particularly in the medium to low rainfall zones, or after dry seasons. Up to 90 per cent of the stubble can be retained if the fire is restricted to the windrows.

Raking and burning narrow windrows (50-60 cm wide) kills more weed seeds than whole paddock burning.

Long term trials showed that windrow burning reduced stubble loads by 40 to 60 per cent compared with stubble that was spread. This was beneficial for subsequent crops on heavy stubble in good seasons but detrimental in dry years, at the low rainfall site in Western Australia.

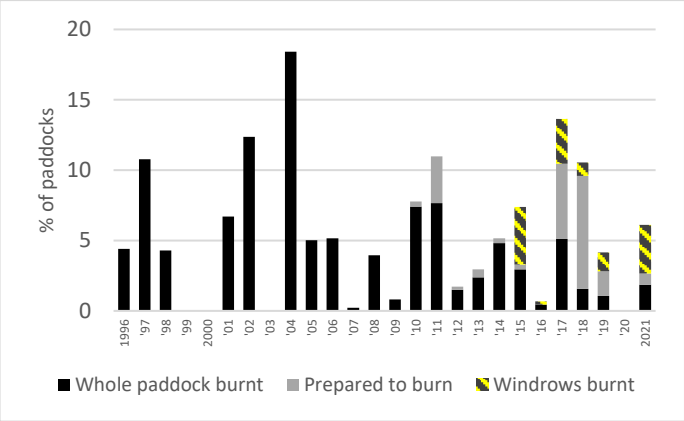

Figure 2: Trends in stubble burning in the northern Wimmera. (No data shown for 2000, 2003. No burning recorded in 1999; survey not undertaken in 2020). SOURCE: Agriculture Victoria and Wimmera Catchment Management Authority.

Minimising escaped fire risk

Canola is well suited to narrow windrow burning. Canola stubble has a lower risk of escaped fire than cereal stubble.

Narrow windrow burning is not well suited to wheat crops yielding more than two tonnes per hectare. Barley is also generally not well suited to narrow windrow burning due to the heightened risk of escaped fire.

Stubble should not be grazed before windrow burning as this also increases the risk of escaped fire.

Effect on weed seeds and pests

Windrow burning can be more effective in removing snails and weed seeds than whole paddock burning. Burning chaff in windrows can destroy nearly all annual ryegrass and most wild radish seed.

Chaff lining can be used in conjunction with windrow burning if weed seed numbers are high. Chaff lining is another form of harvest weed seed control and an alternative to windrow burning, where weed seeds are placed on controlled traffic machinery tracks and composted.

After a wet summer, there can be excess moisture underneath narrow chaff windrows, making it hard to kill annual ryegrass seeds. As narrow windrows are larger, they are more likely to hold moisture.

Mice can become a problem with narrow windrows.

Weed management while retaining stubble

As part of an integrated approach, weed seed control can reduce the need to burn stubble. This includes harvester-fitted mechanical mills that destroy weed seeds.

Herbicide efficacy with high stubble loads

Certain pre-emergent herbicides can be inactivated by organic matter. Others are more suited to farming systems with heavy stubble loads, i.e. pre-emergent herbicides with high solubility and low stubble binding capacity.

Spraying too close to stubble can give a poor spray pattern, and low efficacy. Correct water rates, speed and boom height and nozzle spacing give better penetration of pre-emergent herbicides.

Effect on nutrients and carbon

Approximately 80 per cent of the carbon in standing stubble will return to the atmosphere as carbon dioxide in the short to medium term. Carbon losses through burning are often only slightly more than through natural decomposition - but its effect is immediate.

Burning contributes to nutrient losses from the stubble.

Approximately 80 per cent of nitrogen, 50 to 80 per cent of sulphur and 40 per cent of phosphorus can be lost to the atmosphere from burnt cereal stubble. Additional phosphorus and potassium can be lost in the ash.

Stubble retained farming systems may need more nitrogen than traditional systems. Only about six per cent of a crop's nitrogen requirements come from stubble in no-till systems. Stubble effectively 'ties up' (immobilises) nitrogen during early crop growth. This can reduce crop biomass and potential yield. Stubble is a source of carbon for microbes, which 'tie up' more nitrogen. While traditional 'rules of thumb' fertiliser budgets assume 40 kg nitrogen is required to produce each tonne of grain, this may need to increase where high levels of tie-up are anticipated.

Nutrients may also be lost from the fertiliser during burning if it has been broadcast without follow-up rain (or irrigation).

Protection of native vegetation

Native vegetation and standing dead trees are protected by law. All flammable material requires a minimum firebreak of three metres.

Do not cultivate firebreaks within the root zone or drip line of trees or other native vegetation. The firebreak should be at least three metres from the canopy drip line around all trees.

ACCESSIBILITY

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