NSW GOVERNMENT Department of Primary Industries

primefact

Pasture recovery after bushfires

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Important factors for regaining pasture productivity after fire include:

- Wait for significant rainfall to see which pastures recover
- Allow burnt pastures sufficient time to recover before grazing
- Improve existing pastures through grazing management, fertiliser application and weed control
- Use fodder crops for quick feed
- Plan and prepare before re-sowing perennial pastures

Many pasture species have the ability to recover from fire. However, the extent of the recovery will depend on:
- the fire heat,
- the pasture type,
- soil fertility
- previous grazing management
- and seasonal conditions prior to and following the fire.

Fire heat

The burn heat of a fire depends on amount of dry pasture plant material, wind speed, temperature and humidity. This heat factor falls into four categories:

Cool burn – Dead plant material is burnt with a small amount of unburnt dead plant material remaining. Most seed of annual clovers, annual ryegrass and weeds survive. Most perennial grasses will recover.

Moderate burn – Dead plant material is burnt. A small amount of unburnt dead plant material remains. Some seed and young perennial grasses are destroyed. Summer growing annual grasses and weeds may be severely damaged or destroyed.

Hot burn – Dead plant material is burnt and many seeds are destroyed. Young perennial pastures and those weakened by drought and other factors will likely die. Summer growing annual weeds are also destroyed. Established perennial plants with low crowns, deep roots or rhizomes may survive and recover.

Very hot burn – All plant material and seeds are destroyed. The soil surface is virtually sterilised. Surface soil organic matter is incinerated. Soil is baked, causing reduced moisture infiltration and slow or poor plant re-establishment.

Where plant material is sparse or well grazed, cool to moderate burns usually occur. Denser dead plant material, such as lightly grazed pasture or crop stubble, provide fuel for a moderate to hot burn. Very hot burns occur where hay bales or windrows catch fire, or on animal camps. Un-grazed pastures with large amounts of dry plant material can also result in hot to very hot burns. Areas underneath or near eucalypt shelter belts or bushland can also be subject to very hot burns. Actively growing pastures are less likely to burn and be severely damaged.

CSIRO research indicates that during a fire, temperature at the soil surface can vary from 50°C to 150°C in a cool to moderate burn and 150°C to 250°C in a hot burn.

Temperature below soil surface is usually not changed dramatically. This suggests that plants that bury their seed, such as subterranean clover, or that have growing points below the surface, such as many perennial grasses, will survive well.

Pasture type

The effect of fire varies with pasture species. Pasture health and seasonal conditions before the fire will also affect recovery. A weak, thin, weedy drought impacted or poorly fertilised pasture will regenerate more slowly, less evenly and be more prone to weed infestation, compared to a healthy pasture. The following sections assess the likelihood of severity of damage and survival of some pasture types.

Native perennial grasses

Most native perennial grass species are well adapted to their environment, and their fire recovery tends to be good. Summer growing native kangaroo grass (Themeda australis) recovers well and rapidly, particularly after summer rain.

Red grass (Bothriochloa spp.) usually has a reasonable recovery after a cool to moderate burn. However, buds close to the soil surface make it susceptible to damage in hot burns.

Regeneration of winter growing native grass species such as wallaby grasses (*Rhytidosperma* spp.), wheat grasses (*Agropyron* spp.) and microlaena will depend on the amount of standing dry grass at the time of fire and if the plants were green. Damage tends to be worse if these grasses were green and growing at the time of fire. If dormant, they usually withstand fire better. Microlaena, being lower-growing, tends to survive and recover better than wallaby grass.

Less useful winter growing natives, wiregrass (*Aristida* spp.) and some of the spear grasses (*Austrostipa* spp.), have buds below the soil surface and are able to withstand fire well.

Temperate perennial grasses

Phalaris

Well-established phalaris stands, particularly of the Australian type, are capable of surviving fires extremely well. Phalaris produces storage roots and has a deep rooting habit making a good recovery usually possible. In a hot burn, and where a large amount of dry plant material is still standing, fire may burn into the centre of the crown for phalaris plants. Under these conditions, regeneration occurs from the edges of the crown.

Weaker plants may be killed. Sirosa, Sirolan and the more recently developed varieties including Holdfast, Landmaster, Atlas PG and Horizon may be more prone to damage due to their erect habit and more exposed buds.

During summer phalaris is usually dormant. Fire in early summer followed by rain soon after may break dormancy. Under these conditions, these plants will need to access moisture to survive until the cooler months. The survival of a phalaris pasture may be diminished depending on the continuity of rainfall and grazing management.

Phalaris can respond quickly to post-fire rainfall, especially summer growing types. Care should be taken grazing regrowth as phalaris staggers can be a problem. Staggers is most likely to occur when phalaris is the only feed in the paddock and where stock are forced to graze young shoots after summer or autumn rains. Livestock should be carefully monitored when put back onto re-growing pastures, particularly if they have been off pasture for any period of time.

Cocksfoot

Well-established cocksfoot is more susceptible to damage from fire because it is shallower rooted and more tussock like than phalaris. Where fire travels quickly, cocksfoot recovery is often satisfactory. In hot or very hot burn situations, especially where pasture pre-fire had been lightly grazed and containing high levels of dry material, recovery can be patchy. Varieties with more erect crowns, including Grasslands Apanui will be affected more than low crowned or summer-dormant varieties, including Currie, Grasslands Wana and Kasbah. The variety Porto has a mixed population of low and erect crowned types, and will likely be affected.

Tall fescue

Established tall fescue plants survive fires better than cocksfoot plants, but not as well as phalaris plants. Continental tall fescues will respond quickly to summer–autumn rain post fire, providing useful feed. An actively growing fescue pasture will also be less likely to ignite or burn less severely, and can provide some resistance to hot fires. If green at the time of fire and if surrounded by a bulk of dry material, fescue plants will be more vulnerable to severe damage.

Perennial ryegrass

Perennial ryegrass is the most fire susceptible improved temperate grass species, particularly in a hot fire. The extent of losses will depend on the speed and intensity of the fire. Survival of plants can be poor when the crowns on the soil surface are badly burnt. The relationship between perennial ryegrass plant survival and fire intensity at Hamilton, Victoria is shown in Table 1.

If ryegrass has an opportunity to seed down prior to the fire, some regeneration may occur after a cool to moderate burn.

Tropical perennial grasses

The tropical perennial grasses sown in NSW are generally considered to have good fire tolerance. These grasses are able to recover quickly following rainfall in the summer- autumn period. Digit grass and Bambatsi panic, for example, are considered fire tolerant. They have

recovered well from major fires in the past. Rhodes grass has below ground rhizomes which can allow good regeneration after fire when rainfall follows in the growing season. Buffel grass is also considered to be quite fire tolerant.

Kikuyu

In coastal regions, kikuyu is generally one of the first species to regenerate following post-fire rainfall. While the above ground part of a kikuyu plant usually, the below ground rhizomes enable kikuyu to regenerate following rainfall in the warmer months. Where possible wait until plants reach the 4.5 leaf stage before grazing to allow plant recovery.

Applying nitrogen to kikuyu before rainfall can increase growth and provide more feed post-fire. The recommended rate for dryland kikuyu is 100 kg urea/ha. However, if there are areas of bare ground then it is probably better to apply a lower rate of N fertiliser until full ground cover is achieved.

Table 1. Survival of perennial ryegrass plants after fire (Hamilton, Victoria).

Fire intensity	Percentage survival of ryegrass plants
No fire	100
Cool burn	98
Moderate burn	79
Hot burn	42
Very hot burn	0

Winter growing annual grasses

Annual grasses that grow over winter include annual and Italian ryegrass, barley grass, brome grasses and Vulpia spp. While these grasses will most likely have set seed and senesced before the summer fire season, most of their seed reserves will be at or near the soil surface. A large proportion of this seed may be destroyed by even a moderate burn. As most of these grasses do not have high levels of dormant seed, re-establishment of these species following fire can be poor. Annual ryegrass often has the best recovery of the winter growing annual grasses following fire.

Legumes

White, red and strawberry clovers

Established white and red clover plants will be killed or severely thinned by a moderate to hot burn. White and red clovers do not bury seed with most seed on the surface destroyed by fire. If there is prolonged drought conditions prior to the fire, many white and strawberry clover plants may already be thinned. Regeneration post-fire can be poor.

If the clovers were actively growing prior to the fire then the effects of the fire may be reduced. However, a large amount of dead material prior to the fire could result in a major loss of existing clover plants.

Red clover, a short-term perennial, will most likely be affected in a cool to moderate burn. The runners of white clover plants assist with recovery after a cool to moderate burn. Recovery of white clover may be slow if runners are destroyed and regeneration is from seed.

Good soil seed reserves of persistent white clover varieties such as Haifa white clover will likely recover best, although it may be slow.

Strawberry clover, tends to survive fires and recover better than red or white clover.

Subterranean clover

Subterranean clover is often not severely affected by fire. It has usually set seed before the onset of the fire season. Most subterranean clover varieties bury seed in the soil, therefore much of the seed is able to survive fire. Regeneration following fire depends on the extent that seed has set in the preceding years.

Much of the hard seed of subterranean clover in the soil will be stimulated to germinate following fire. Where there has been good clover growth and seed set the previous two to three springs then a good recovery can be expected. Autumn rainfall will be conducive to subterranean clover recovery. However, uneven autumn rainfall may cause false breaks and impede recovery.

Other sown temperate annual winter legumes

Winter annual legume species such as serradella, biserrula, medics, rose clover, arrowleaf clover, bladder clover and gland clover are aerial seeders. However, these species can also have reasonable soil seed reserves which can survive fire. Generally these legumes have set seed and senesced before the main fire season.

Seed on the soil surface may be destroyed, but seed that is buried deeper in the soil will have some protection from the extreme heat. Regeneration can occur from hard seed buried in the soil.

The amount of legume seed in the soil before a fire is an important factor in their ability to regenerate. Grazing management, fertility and previous seasonal conditions affect soil seed reserves and therefore the ability of the legumes to recover following fire.

Heat from the fire will likely break down seed hardness and stimulate seed to germinate following autumn rainfall. Follow up rainfall is important for full recovery.

Naturalised annual clovers, sometimes known as trefoils and medics, are surface seeders and their recovery ability is similar to other annual legumes. Although much surface seed is likely to be destroyed, good quantities of seed are likely to be present in the soil, if best practice management has been followed.

Lucerne

Survival of well-established lucerne with its large tap root is often high following a cool to moderate burn. If fire is very hot, or a large mass of dry grass weeds infests then more plant damage can be expected and an increase in plant loss is likely. Older lucerne or poorly managed stands are at higher risk of plant loss following fire. Lucerne growth and recovery will dependent on soil moisture and rainfall following the fire.

Soil type and fertility

Soil type influences the extent of fire damage and pasture recovery. On heavier soils, such as basalts and alluvials, fire

effects tend to be less than on lighter, sandy soils.

Longer term recovery of pastures is generally faster on soils that are fertile and have high levels of organic matter. Lighter soils are generally lower in organic matter than heavier soils. There is also a much greater destruction of soil organic matter by a fire. On lighter soils the organic matter is more susceptible to breakdown by fire than in heavier soils.

Correcting soil nutrient deficiencies is also an important aspect for post-fire pasture recovery.

Fire has little effect on soil phosphate reserves. Superphosphate applied before a fire will not be affected, even if granules were still visible on the surface. The small amount of phosphate in the remaining ash will also assist plant growth. This will be washed into the soil following rainfall and become available for plant uptake.

The effect of fire on nitrogen levels in the topsoil can be substantial. Fire destroys topsoil organic matter reserves and the nitrogen within it is lost. Loss of topsoil nitrogen can result in poor pasture grass growth after a fire.

Often the main nutrient losses caused by a fire are through soil erosion, both wind and water. Soil pH is mostly unchanged following fire. Following fires at Junee in 2006, soil samples taken from burnt and unburnt areas were used to estimate nutrient loss. The average nutrient losses in the soils from erosion were:

- Phosphorus 10 kg/ha (in one case up to 45 kg/ha was lost where significant topsoil was lost);
- Organic carbon reduced by 0.2%. For example, if the original organic carbon was 2.0% that is a 10% loss. However, losses were highly variable with highest loss measured at 1.3% of organic carbon;
- Sulphur lost 0.3 mg/kg, with the biggest loss at 25 mg/kg;

Managing soil erosion after fire is critical. In a hot burn, soil surface may become hydrophobic and repel water. This can be difficult to manage as it may exacerbate erosion risk. It is important to retain as much of existing soil structure as possible to reduce the erosion risk. Livestock should not be allowed onto burnt areas and these areas should not be cultivated to protect existing groundcover and bare areas. Allowing burnt areas to re-establish or re-sow a pasture or grow a forage crop to increase ground cover.

Any conservation works such as contour rip lines or cultivation should be done in consultation with a qualified soil engineers.

Sowing annual forages

Annual forages can provide early feed, ground cover and assist with weed control. Winter forages may include dual purpose or forage crops such oats, wheat, triticale, brassicas, annual ryegrass, or combinations of these (e.g. ryegrass and oats). Summer forages may include sorghum, millet, Dolichos lab lab or cowpeas.

When early sowing cereals or brassicas for forage it is important to select varieties with a winter growth habit to prevent plants from becoming reproductive too soon. The NSW DPI Winter Crop Variety

Sowing Guide provides information for choosing forage and dual-purpose winter varieties.

Supplementary feeding

Often the amount of forage farm on is limited following a fire. Where possible, supplementary feed to allow pastures to recover. The NSW DPI Drought and Supplementary calculator feed app is a useful tool to work out feed rations for animals. Transition from supplementary feeding to pastures should be conducted with caution. It is important to gradually allow rumen function to adjust to differing diets. This minimises the risk of diseases such as kikuyu toxicity, phalaris staggers and nitrate or prussic acid toxicity.

Following a fire, fodder is often brought onto a property to feed livestock. Fodder is a biosecurity risk as it has the potential to bring new weeds, pests and diseases on farm. Store and feed fodder in the same location. Mark and monitor these areas for a number of seasons, especially following rainfall for a number seasons. Control new weeds early before they have the opportunity to set new seed.

Regaining pasture productivity

Seasonal conditions following a fire play a major part in speed and extent of pasture recovery. A summer storm may allow summer growing native and sown species to commence recovery. An early autumn break with good follow-up rains will help ensure the germination and establishment of remaining annual legumes, including subterranean clover and activate surviving perennial grass species, including phalaris. Variable rainfall or lack of follow-up rain can delay recovery with poor regrowth of perennial grass and annual legume establishment.

It is important to assess which pastures can be managed to full recovery through appropriate grazing management, applying fertiliser and weed control. Those paddocks that require re-sowing need to be well prepared.

See what comes back

It is difficult to know how a pasture will recover until significant rainfall is received in the growing season. It is important to see what has survived before deciding to re-sow perennial pasture.

Alternatively, water a small section to see which perennial species respond and which annuals (grasses, legumes and weeds) regenerate. Often multiple application of water is required over a 7-10 day period to keep soil moist and allow the seed to germinate and for emergence.

Allow regrowth before grazing

A critical factor is to allow pasture sufficient time (4-6 weeks or more depending on rain events) to regrow after significant rainfall where possible. The following grazing management needs to take into account the weakened state of the pastures. Where possible rotationally graze, even there is only a couple of paddocks, to allow plants to continue recovery. Pastures will recover more quickly and be more resilient if dry matter is maintained at least 1000–1500 kg of dry matter/ha.

Critical feed shortages following fire often mean that pastures cannot be managed ideally. Since stronger perennials,

including phalaris and digit grass will recover best, paddocks containing these species these paddocks should be grazed first. However, grazing needs to be well managed to ensure the pastures continue to recover and are productive.

It may be necessary to use sacrifice paddocks or areas to contain stock and minimise damage to the rest of the property, until pastures have sufficiently recovered. Sacrifice paddocks should, where possible, be arable and due to be improved in the near future to minimise loss of pasture base.

Fertilise existing pastures

Fertilising existing pastures can increase pasture production and recovery. Grasses are highly responsive to nitrogen. Clovers respond readily to correction of soil nutrient deficiencies like phosphorus and sulphur. Tropical grasses are also highly responsive to nitrogen fertiliser in summer if adequate moisture is present and this can aid in building fodder reserves during recovery. Soil testing is an important aspect of assessing most appropriate fertiliser programs.

Reduced carrying capacity

Where large areas have been burnt, stocking at normal rates may severely affect pasture recovery. Pasture productivity will be reduced for at least several months to more than 12 months, depending on seasonal conditions and management strategy. The greatest loss, depending on fire timing and following seasonal conditions, will be in autumn and winter pasture production immediately following the fire. It is important that livestock stocking rates match forage availability.

Re-sowing perennial pastures

If the fire was hot and the soil partially sterilised, re-sowing a perennial pasture may be an option. Take the time to ensure good planning and paddock preparation before sowing perennial species. The use of annual fodder crops for two or three years prior can greatly assist in weed control while providing valuable feed.

Alternatively for some temperate perennial pastures, such as phalaris, an option is to delay sowing until later in autumn or winter (especially in milder and higher rainfall environments) to allow for good weed control plus increase soil moisture prior to pasture sowing. Lucerne can also be established following the same strategy.

Target paddocks for re-sowing that have the greatest potential first such as; good soil type and depth, good fertility, access to water and low weed burden. If paddock preparation for sowing perennial pastures had begun before the fire then it may be best to sow this paddock first.

Weed control

Many pasture weeds will quickly colonise any bare areas following a fire. Although weed seed reserves may be reduced by fire, they can compensate by rapid growth smothering an already weakened pasture. Paddocks regenerating and re-sown should be inspected to identify the weeds present. A wide variety of techniques can be used for weed control, including grazing management, spray grazing or selective spraying. These techniques are

most effective on relatively small weeds, so early identification and follow-up control is essential. Selecting pasture and crop options that allow for simple and low-cost post planting weed control can be beneficial.

Many pasture weeds are annual. The effect of fire on soil weed seed reserves is similar to that on pasture plants. In addition, some weeds, including Scotch thistle and Paterson's curse may act as biennials and survive over summer. All these plants can rapidly regenerate or re-establish to dominate weakened pastures.

Some perennial weeds, including serrated tussock, poa tussock, Coolatai, African Lovegrass, Chilean Needle grass, dock and sorrel will survive even hot burns. Fire can favour some of these weeds. Stock will eat the palatable young green shoots of some of these weeds, including African lovegrass and Chilean Needle grass. Early grazing of paddocks containing high densities of grass weeds will provide feed for livestock and assist in control of these weeds.

Weeds, including thistles, Paterson's curse, fireweed, capeweed and crowsfoot (storksbill) may present major problems and out compete pasture species. Some of these weeds produce abundant hard seed and fires will stimulate these seeds to germinate.

Arable areas where the pasture has been destroyed or which are known to have weed problems should be priority areas for an annual forage crop. This will reduce the weed burden as well as providing useful winter feed following fires.

Animal Health issues

Animal health issues are most commonly arise in ruminants following a sudden change in diet. When animals are to graze a new paddock, it is best to do it in the afternoon when the animals have a full rumen. In addition, provide an alternative feed source such as a bale of hay. It is also a recommended to regularly monitor animals in the first couple of days after a change in diet.

Vaccinating with a 5-1 or 7-1 booster 2 weeks before a sudden diet change can help minimise the risk of pulpy kidney (enterotoaemia) and other clostridial diseases.

As previously mentioned, there is some danger of stock poisoning when grazing regenerating paddocks. Many plants, including variegated thistle and capeweed contain high levels of nitrate in their young foliage. Likewise, for cereal forage crops grazed earlier than normal. Forage sorghums can cause cyanide (prussic acid) poisoning. Staggers can occur on predominantly phalaris pasture, particularly the older varieties.

In general, avoid sudden re-introduction to pastures that livestock have not been exposed to. Contact a local veterinary advisor for further information.

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