Managing invasive native scrub

Successful invasive native scrub (INS) management programs are long-term and generally do not rely on one treatment method. A program that integrates a range of treatments and follow-up is most effective to control INS to rehabilitate native pastures and open woodlands.

In this section:
- Invasive native scrub treatment options at a glance
- Blade ploughing
- Chaining
- Crocodile seeding
- Cultivation and short-term cropping
- Dorper and Damara sheep
- Fire
- Goats
- Grubbing
- Herbicides
- Pasture management
- Stick raking
- Waterspreading
Invasive native scrub treatment options at a glance

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<th>Method</th>
<th>Advantage</th>
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<td>FIRE</td>
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<tr>
<td>Management burning</td>
<td>• Cost effective over large areas</td>
<td>• Infrequent opportunities because of seasonal/fuel condition requirements</td>
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<td>• All species susceptible when young i.e. &lt;50 cm</td>
<td>• Response depends on shrub species and size</td>
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<td></td>
<td>• Kills some mature shrubs and improves visibility</td>
<td>• The area may have to be destocked before the fire and will have to be</td>
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<td>• Pasture response may be rapid</td>
<td>destocked after the fire</td>
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<td>• Risk of erosion after fire</td>
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<td>Blade ploughing</td>
<td>• Shrubs are removed</td>
<td>• Very high cost</td>
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<td>• Pasture response may be rapid</td>
<td>• Soil disturbance may stimulate INS seedling germination and requires</td>
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<td>• Pasture can be sown at the same time</td>
<td>follow up treatment</td>
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<td>• Can be done at any time</td>
<td>• Inadequate blade depth will make the problem worse</td>
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<td>• Risk of erosion</td>
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<td>Chaining</td>
<td>• Large shrubs are removed</td>
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<td>• Can stimulate INS seedling germination and regrowth</td>
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<td>• Improved chance of management burn</td>
<td>• Essential follow-up is expensive</td>
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<td>• Can be done at any time</td>
<td>• Can be non-selective</td>
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<td>• Timber can be left on the ground to protect pasture regeneration</td>
<td>• Risk of erosion</td>
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<tr>
<td>Double chaining</td>
<td>• Shrubs are removed</td>
<td>• High cost</td>
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<td>• Improved pull out</td>
<td>• Material tends to ball up and reduced ability to burn</td>
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<td></td>
<td>• Less regrowth to treat</td>
<td>• Small shrubs aren't removed</td>
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<td>• Easier to introduce pasture</td>
<td>• Risk of erosion</td>
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<td>• Timber can be left on the ground to protect pasture regeneration</td>
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<tr>
<td>Crocodile seeding</td>
<td>• Low erosion</td>
<td>• Temporary knock down</td>
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<td>• Seed bed created in pits</td>
<td>• Stimulates regrowth</td>
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<td>• Pasture response may be rapid</td>
<td>• Very low kill of shrubs</td>
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<td>• Cheap knock down of mature bushes</td>
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<td>• May stimulate sufficient fuel growth for fire</td>
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<td>Stick raking</td>
<td>• Shrubs are removed</td>
<td>• High cost</td>
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<td>• Pasture response may be rapid</td>
<td>• Stimulate regrowth</td>
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<td>• Reduce rabbit harbour</td>
<td>• Will not kill sprouting species (turpentine)</td>
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<td>Manual grubbing</td>
<td>• Low cost</td>
<td>• Only plants under 50 cm can be treated</td>
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<td>• Plant specific</td>
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<td>• Can be done by any family member</td>
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<td></td>
<td>• Bushes killed</td>
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<td></td>
<td>• Useful for areas of scattered shrubs</td>
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### Mechanical grubbing or 3 point linkage cutter bar/blade plough
- Low cost
- Plant specific
- Bushes killed
- Useful for areas of scattered shrubs
- Timber can be left on the ground to protect pasture regeneration
- Plants over 1 m need to be pushed over then grubbed on both sides from the centre of the plant
- Grubbing is not raking. It is a specialised piece of equipment.

### FARM MANAGEMENT

#### Cultivation/ cropping
- Shrubs are removed
- Pasture response can be rapid
- Cash crop to recoup initial costs
- Possibility of using a sharefarmer to minimise risk
- Stubble retention aids pasture establishment
- Ploughing destroys INS roots
- High cost
- Risk of erosion/decline in soil structure
- Risk of crop failure
- Without fertilizer soil fertility drops rapidly, although high soil fertility may limit recruitment of native perennial grasses

#### Pasture and grazing management
- Minimal soil/wind erosion
- Increased animal production
- Increased opportunity for management burns
- Increased drought preparedness
- Reduced INS seedling survival
- Pasture management and perennial groundcover will help limit INS establishment but alone will not always prevent it, depending on the season.

#### Goats
- Reduced total grazing pressure with better fences if managed correctly
- Suited to dense stands of edible species, e.g. hopbush, punty bush and mulga
- Not all species are eaten by goats and heavy browsing may lead to increase in unpalatable INS
- Very likely to damage pasture, especially perennial groundcover, and soil
- Needs long rest periods afterwards
- Fencing costs are very high

#### CHEMICAL

#### Herbicide
- Minimal erosion risk
- Effective on all species
- Chemicals are very specific
- Does not require specialised equipment
- Dead standing shrubs may protect pasture regeneration
- High cost and labour intensive
- Loss of some pasture
- Loss of non-target species
- Effectiveness linked to regrowth and plants actively growing
- Response depends on shrub species and size

### References and resources

Information in this resource has been drawn from:


Blade ploughing uses a flat blade set below the soil surface pulled by a tractor or bulldozer to destroy the root structure of INS. For treating relatively small areas of INS blade ploughing has been shown to be an effective INS treatment if done correctly and appropriate follow-up performed.

When blade ploughing sprouting INS species, such as turpentine, it is essential that the blade be at least 30 cm below ground. When treating non-sprouting species (seeders) such as hopbush, a large germination of plants will occur and it is essential that the seedlings be controlled. Likewise any regrowth of sprouting species will need to be managed.

While results have been variable for sprouting INS species, the treatment results in an initial high mortality of mature shrubs for non-sprouting INS species, and has been shown to be an effective method of controlling mature INS in the western region of NSW.

Any area blade ploughed should be destocked until after the grasses have established and preferably set seed.

Best application

Blade ploughing is effective for treating INS species that re-shoot from the base (e.g. budda) and non-sprouting species (e.g. narrow-leaf hopbush).

While undertaking blade ploughing in dry soil will achieve the highest mortality, it is best undertaken when the soil is moist and clods evenly. In this way, the soil is not too hard so suitable penetration and speed of operation can be achieved, while minimising the possibility of wind erosion.

It is best performed in sandy/loamy soil. Soil in dense INS areas may be low in grass seed. While grass seed may become available from movements across the landscape, new seed may need to be introduced.

It is essential a strong healthy grass be established in the treated area to complete with any new seedling and act as a fuel for a fire if needed.
Limitations

- Extremely expensive
- Blade ploughing causes major soil disturbance to the soil and is an erosion hazard
- Return to stable pasture can take some time
- Follow-up treatment will be necessary
- Not effective in soils with a shallow hard pan or which set hard as they hinder penetration and do not allow the plough to operate at an effective depth (although in some cases these soils can be effectively ploughed when moist).

Where does blade ploughing fit in to an INS management plan?

This treatment is best suited to high value areas and isolated stands.

To achieve good results blade ploughing should be combined with grazing management and other techniques as part of an integrated management program.

Operational notes

*Depth*

Blade ploughing is effective at any depth for species which do not readily re-sprout, e.g. narrow-leaf hopbush.

To minimise regeneration of re-sprouting species, e.g. budda and turpentine, shrubs should be cut off below the first lateral roots. A minimum depth of 30 cm (12 inches) should be maintained for these species. Ploughing at the appropriate depth can achieve greater than 90% mortality. Where correct depth has not been maintained, mortality of less than 70% can be expected.
**Plough model**

With a number of blade plough models on the market, choice of model is an important consideration. For effective and cost-efficient blade ploughing the model should:

- be able to maintain correct depth
- be able to plough through target species without damage or being jolted sideways
- have good trash flow
- be matched to the tractor.

**Pasture establishment**

Limited options are currently available to landholders wishing to sow pastures in conjunction with blade ploughing, however seed boxes can be fitted to ploughs to enable a one-pass operation.

Because blade ploughing has a very high mortality rate for existing INS plants, rehabilitation of the treatment site will be faster if nucleus areas of perennial pasture species are left unploughed. Shrubs on these areas could be targeted with a different option such as herbicide.

Management of grazing pressure after ploughing is essential to enable establishment of natural or sown pastures.

It is essential a perennial pasture be established within two years of treatment.

**Landholder experience**

Blade ploughing was used to remove dense patches of larger saplings on the property. Whole paddocks were not treated – only densely invaded areas. After the blade ploughing, any invading INS seedlings were spot sprayed with herbicide on a regular basis.

Blade ploughing had an immediate significant impact on budda, turpentine and hopbush shrubs on the Cobar Peneplain, however in the absence of any further treatment INS was once again a major problem within eight and a half years.

**References and resources**

Information in this resource has been drawn a number of sources, including the following publications:

- Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Qld Department of Natural Resources and Mines.

Site blade ploughed for INS treatment (right of fence) with adjacent untreated INS

Site blade ploughed for INS treatment
Chaining

Chaining is one of the most widely used of the mechanical INS control measures. It involves dragging a thick heavy chain between two tractors or bulldozers to pull down thick INS.

Chaining can be performed using a single chain or using two chains together, one behind the other. An area can also be treated twice by dragging the chain one way and then dragging it over the same area in the opposite direction.

Chaining is a relatively cheap first treatment and does not significantly disturb soil or destroy existing pasture compared with more intensive treatments. Fallen timber provides the added advantage of a protected environment for grass and herbage seeds to establish.

The chained timber can provide an excellent source of fuel in the years following chaining. The fuel can be used in a follow-up burn to control regrowth and whipstick pine that was missed in the chaining.

Livestock management can be improved after chaining by putting in stock access tracks that are permitted under routine agricultural management activities (RAMAs).

Chaining is also a way to enable browse to be brought into reach of grazing goats.

Chaining can be a suitable way to treat:

- large shrubs
- land to be used for cultivation
- mature hopbush on grazing land.

It can also be used as an initial treatment to improve the effectiveness of other treatments such as grazing and burning.

Sites chained both ways for INS treatment with high broad leaf hopbush mortality and good groundcover response. Note post treatment hopbush germination.
Limitations

- Chaining does not kill many smaller (< 2 m) shrubs and slender saplings, particularly white cypress pine, which often bend under the chain and then remain in place with little or no setback to growth.
- Not suitable for use in dry soil and/or in areas where an erosion hazard would be created.
- Low mortality of some species (e.g. *Eremophila* spp., *Cassia* spp.)
- Difficult to be selective
- There can be a considerable impact on livestock management, with mustering made very difficult and logs on the ground restricting access
- The fallen timber can harbour rabbits and foxes
- There will be significant regrowth if the area isn't chained both ways.

Large areas of INS in the Western Division have been chained with no follow-up performed, and many of these areas are now thicker with INS than they were before chaining.

Where does chaining fit in to an INS management plan?

Chaining is generally viewed as a short-term strategy. When used alone it has a poor success rate, as much INS re-sprouts or re-establishes after treatment. Additional treatments are necessary to increase success.

Many landholders use crocodiles to introduce pasture seed into chain-treated areas. In most areas there is a fast pasture response.
Operational notes

Initial treatment

Chaining should be carried out while soil is moist to maximise effectiveness. The bole of the shrub needs to be thick enough so that it does not bend over and spring back up after the chain passes over or snap off without pulling the roots from the ground. Two-way chaining maximises mortality of shrubs from the initial treatment.

There is generally a high mortality rate among taller INS species and individual plants. However, their death reduces competition for the shrub layer that often re-sprouts or establishes as seedlings on the land disturbed by the chaining process.

Follow-up treatment

A secondary treatment needs to be applied within a relatively short time after chaining, otherwise scrub will regenerate from root suckers and/or seed to form a stand as dense, if not more so, than before the treatment.

Chaining cannot be repeated for several years after the initial chaining treatment, as the regrowth will not be high enough for chaining to be effective.

Re-sprouting species

Successful chaining of re-sprouting species, such as turpentine and budda, may require the paddock be used for cereals or sown pastures.

Landholder experience

Chaining can increase native perennial pasture production for up to five years after treatment (as a consequence of removal of competition, soil disturbance and greater rainfall infiltration). Without follow-up treatment, pasture production decreases after five years as INS re-grows, and after about 10 years there is reduced pasture production once again.

One estimate of the impact of chaining on sheep carrying capacity in the Cobar Penplain was that carrying capacity changed from one sheep to 16 hectares to one sheep to four hectares for a period of about five years after chaining, and then carrying capacity decreased.

References and resources

Information in this resource has been drawn a number of sources, including the following publications:


Crocodile seeding

Using crocodile seeding to manage INS

Crocodile seeding involves pulling an offset drum with shovel-like teeth over INS. It knocks down shrubs while introducing seed.

Traditionally a crocodile is used to increase water infiltration to encourage grass growth.

Limitations

- Temporary knock down of shrubs
- Very low mortality rates
- Can stimulate regrowth of INS
- Erosion hazard

Where does use of a crocodile seeder fit in to an INS management plan?

Even though it can have a low mortality rate of INS species, a crocodile seeder can give grasses a chance to establish in the short-term for a follow-up management burn.

Operational notes

Crocodile seeders are best used to introduce seed into areas without perennial grasses or an existing seed bank. This should be done when soil is moist to encourage native grasses establishing.

Landholder experience

Some landholders intend to knock down mature INS bushes, introduce seed, keep grazing stock off the area, burn in autumn and then treat any regrowth with chemicals.

References and resources

Information in this resource has been drawn a number of sources, including the following publications:

Bull, A (2003), Best practice native shrub management manual for south west Queensland. Queensland Department of Natural Resources and Mines.

Cultivation and short-term cropping

Using cultivation and cropping to manage INS

Cultivation with cropping can be an economical way to manage INS regrowth and restore native pastures, following treatment of the INS.

With appropriate grazing regimes, perennial groundcover establishes after INS treatment, cultivation and cropping. This provides forage for stock and fauna habitat. Cropping increases groundcover, allowing perennial native groundcover species to re-establish and can increase soil nitrogen. It also can allow gullied areas to be filled and sheet-eroded areas to become productive.

Ploughing destroys the root structure of re-sprouting INS species, meaning less regrowth.

Conservation farming practices such stubble retention help create an environment that traps grass seed and resources, and provide shelter for native pastures to establish. Research and landholder experience has shown that short-term cropping is a successful tool in restoring native perennial pastures only when appropriate post-cropping grazing management is employed. If paddocks are heavily grazed after cropping and devoid of groundcover, INS establishment is likely following wet years.

Limitations

The areas suitable to cultivation and cropping are limited to those with adequate rainfall. If rainfall is unreliable crops may not succeed. Rainfall in the Western Division is very unreliable, therefore there is a higher chance of crop failure. Also soil/land capability and slope will be a limiting factor.

If INS regrowth is still present after the first year, the area may need to be cultivated and cropped for a second time to control this regrowth.

Soils that have a tendency to set hard or contain shallow pans should generally be excluded from ploughing operations.
Where does cropping fit in to an INS management plan?

Appropriate pasture and grazing management is essential to establish and improve native perennial pastures following cropping. INS will re-establish on heavily grazed land without healthy perennial groundcover.

Landholder experience

*Initial removal of INS*

Landholder experience in western NSW shows there are a number of ways to approach cultivation and short-term cropping. Specific landholders’ approaches have included:

- Chaining/bulldozing INS on previously ringbarked country with INS between standing trees. Leave for six months to two years (up to 10 years if necessary) for fuel to develop and to obtain the benefit of grazing. Burn to reduce the amount of timber on the ground that has to be moved, then stick rake the remaining timber into windrows. Burn, stick rake, burn then level the ground surface and plough. Sow a crop of oats, triticale or barley.
- On some properties the treated area was not burned prior to pushing timber into the windrow.
- On some properties the period between initial chaining/bulldozing and burning was extended to allow a good bank of native seed to develop in the soil.
- If seedlings and suckers were not a problem, the first ploughing was deferred to obtain more value from the established pasture.
- The area being treated can be chained more than once to obtain benefit from native pastures before proceeding to ploughing and sowing.
- On one floodplain property the INS was treated by using a very heavy offset disc plough followed by stick raking, burning, ploughing and sowing.

Some landholders expressed concern about using disc ploughs to prepare the ground for the initial crop on the basis of its detrimental impact on soil structure. Others now use minimum tillage and direct drilling wherever possible – particularly drilling into stubble during the cropping phase.

*Rotations*

A Property Vegetation Plan (PVP) for INS allows for up to three crops within a 15 year period.

Many landholders aim to employ long rotations, and different combinations of INS treatment, sowing and pasture grazing have been implemented successfully. Decisions on rotation length and when to crop vary between regions and properties, but should consider:

- seasonal conditions
- market prices
- INS species present (e.g. re-sprouting or not) and degree of INS regrowth
- labour and machinery availability
- grazing and pasture management goals.

References and resources

Information in this resource has been drawn a number of sources, including the following publications:

Bull, A (2003), *Best practice native shrub management manual for south west Queensland*. Queensland Department of Natural Resources and Mines.


Dorper and Damara sheep

**Using Dorper or Damara sheep to manage INS**

Dorper and Damara sheep are hardy meat sheep from South Africa that are suited to Australia’s rangelands.

Both Dorpers and Damaras graze and browse a wide range of feed (pastures, shrubs and trees, including some INS species), so can be run on INS affected grazing country. This allows INS to be treated and used as a productive resource, and the sheep control germinating and establishing INS seedlings.

Other advantages of running these breeds include reduced cost of inputs with no shearing required (Dorpers) and earlier turnoff of meat sheep.

**Limitations**

Dorpers and Damaras only eat some INS species and can make an INS problem worse if stocked in such a manner that they just remove the palatable INS species (e.g. hopbush and mulga). If grazing is not managed correctly, budda and turpentine can establish. Turpentine establishment is especially enhanced when sheep remove other plants competing for nutrients and moisture.

The sheep only graze up to sheep grazing height.

Heavy grazing is required to treat woody scrub using these breeds of sheep and this may result in long-term damage to perennial pastures unless an adequate period of rest is allowed after treatment.
Where do Dorper and Damara sheep fit in to an INS management plan?

Dorpers and Damaras can control emerging palatable INS seedlings and regrowth, as well as browse to control palatable established INS.

They can be useful where INS is dense so other options are unsuitable, e.g. where low levels of groundcover prevent burning opportunities, or where mechanical or chemical treatments are not cost-effective.

The sheep can open dense areas at relatively low cost. They browse scattered shrubs before denser patches. In opening up denser patches, pasture growth is encouraged and other treatments may be able to be used (i.e. fire).

As Dorpers and Damaras can only browse INS up to a certain height they have little significant impact in areas with tall INS. Chaining when the sheep have eaten most of the available browse is a good follow-up treatment. This controls the INS, and allows the full value of the INS resource to be obtained.

Operational notes

Secure fencing and provision of an adequate permanent water supply are essential if using Dorper or Damara sheep to control INS.

Without appropriate management, grazing by these sheep (as with all livestock) can lead to long-term land degradation as a consequence of their impact on groundcover.

Landholder experiences with Dorper and Dorper cross sheep (Dorper/Merino, Damara) suggests that the sheep only graze and browse INS when a good groundcover pasture is also available, so they are ideally run on a mix of open pasture country and INS.

References and resources

Information in this resource has been drawn a number of sources, including the following publications:


Using fire to manage INS

Management burning is the most effective overall method of managing INS seedling outbreaks and can also be used to reduce INS density in more mature stands. Management burning has the added advantage of minimising wildfire risks by reducing fuel loads.

Fire is most effective (up to 100% mortality) if used during the first two years after an INS germination event when seedlings are less than 30 cm high. Follow-up is often needed to control further germination.

Experience has shown that of INS listed species white cypress pine, green turkey bush, mulga, narrow and broad-leaf hopbush, and punty bush are most easily killed by fire.

Limitations

Thick INS will not burn alone – there must be sufficient fuel underneath to carry a fire for a successful management burn. Waiting for adequate fuel to build up means that the opportunity to burn may be infrequent.

Building up fuel for an effective management burn and regenerating pasture post-burn may mean destocking the treatment area before and after the fire. This is not always practical, particularly on smaller properties.

Fire also enhances the germination of many INS species, so follow-up treatment is necessary.

Where does fire fit in your INS management plan?

Landholder experience has shown that while good initial mortality rates of a number of INS species are achieved by burning, in many cases INS re-established. A one-off burn alone is not an effective tool to control INS, so follow-up treatments must be used.

Some landholders have used burning to buy time in an area encroached by INS to allow the establishment of appropriate watering facilities and fencing to allow control of total grazing pressure.
Operational notes

All appropriate fire permits must be obtained and adhered to.

Fuel load

A good body of fuel is necessary for a successful management burn, although the amount varies with type of plant, e.g. more fuel is required if grass is coarse (like wire grass) than if it is fine and compact (like spear grass).

Every leaf on the bush must be scorched to give a maximum death rate. Thus the fire must be intense enough to achieve this objective without running the risk of burning outside the planned area. Scorch height, however, is not the same as flame height. Leaves will be scorched to above the flame height by the radiant heat of the fire.

A successful burn across the desired area will be enhanced if there is a continuous layer of fuel over the paddock.

Experience has shown that grass makes the best fuel. Generally 900 to 1200 kg/ha of dry grass growing up to 30 cm high will ensure an adequate scorch height of invasive native scrub up to 3 m high. However, in semi-arid woodlands most grass grows in tussocks (clumps) and these must be close enough together, or have enough litter between them to ensure that the fire will carry across the paddock.

Fuel levels need only be sufficient to give the desired scorch height and allow for prompt and effective lighting up.

While seasonal condition is a large driver of pasture growth, grazing management is crucial to ensure that there will be enough fuel for burning. Grazing pressure from domestic, feral and native species reduces the frequency of burning opportunities, so managing total grazing pressure is an important preparation activity.

A McArthur Grassland Fire Spread Meter is a useful tool in planning a management burn.

![Post-fire mortality of Mulga, Punty Bush, Budda and Turpentine relation to plant height (Source: Hodkinson and Harrington 1985)](image)
**INS response**

Mortality varies between INS species. Research has shown mortality of 20-30% for established turpentine and budda, and 70-100% for hopbush, puny bush and cypress pine.

Mortality also depends on:

- the age of the INS being treated – older shrubs are more tolerant of fire than younger plants
- the density of the INS – dense INS often does not have enough fuel under it for an effective burn.

Burns in more open country with scattered juvenile INS are more successful than burns in areas where INS is dense.

**Firebreaks**

The type of firebreaks necessary in a particular situation depend on many factors. These include the type of fuel, the expected fire intensity, the amount of dead plant material that has been deposited in the windrow of the firebreak by the grader, the amount of labour and equipment available on the day of the burn and the management burning experience of the personnel involved.

When constructing firebreaks, it is important to guard against a build-up of excessive dead plant material in the graded windrow. If there is a build-up of plant materials such as dead shrubs, the burning leaves and embers may spot across the breaks during back-burning operations. If the windrow is to be turned into the paddock it is much safer to burn the windrows at night, well before the management burn. Preference would be to grade the windrow to the fence or away from the burn side.

In most situations, constructed breaks should be strengthened by back-burning on the burn day. Fire breaks can often be made by taking advantage of natural breaks such as clay pans, water courses or densely scrubbed areas without grass or ground fuel. Tidy breaks around fences protect them from fire and give better vehicle access for checking them and observing livestock.

In the Western Division there are guidelines for the construction of fire breaks. For further details please check with your local Catchment Management Authority (CMA) office.
When conducting management burns it is essential to check that all equipment is fully serviceable. All machinery should be tested several days before the burn to allow time for repairs.

Each mobile unit should carry a water tank and pump and be equipped with a UHF radio. Each unit should be individually identified and carry a map of the burn area with clearly identifiable positions marked on it, particularly the points where water is available and safety zones. Remember, a visiting neighbour who is helping with the burn will not know the paddock as well as the owner does.

If possible, each watering point should have its own pump for filling the units’ water tanks. For a full list of equipment you may require, contact your local RFS Captain or major centre. Instruments to measure wind speed, temperature and relative humidity are necessary and may also be obtained from the RFS. These measurements, together with a Grassland Fire Danger Meter, can predict fire intensity and rate of spread. Knowledge of these factors is vital for making sound decisions on lighting and managing the burn.

A very useful piece of equipment at a management burn is a grader; this can be quickly brought in for assistance if necessary.

Consider upgrading fencing to manage total grazing pressure from kangaroos and goats.

Planning grazing management is essential. Destock the area to be burnt and make sure there is plenty of feed elsewhere to feed stock. Reducing overall stock numbers may be required.

Check INS type to be burnt against fuel loads. For example, is there going to be enough fuel to burn 1m high cypress pine?

Determine if any other treatment methods need to be used; any one method may not work on its own. Dozing/chaining may be required to flatten INS prior to burning.

Herbicide treatment may be required if fuel loads are patchy and burning doesn’t eliminate all seedlings.

Determine the season that best suits the requirements. Autumn and spring burns are desirable.

Establish photo points for monitoring of pasture and INS.

Check local Catchment Management Authority, Western Lands and other relevant authorities on permits and approvals (e.g. PVP) that are required before burning can commence.

Establish a check list so you can keep track of actions taken or other works required.
Planning your burn – months before burn

- Monitor fuel loads. Make sure you have enough grass and ground litter (900 to 1200 kg/ha) to carry a fire.
- A burn plan should be drawn up so people can understand what you intend to do and so others, like your neighbours, understand what may be required of them.
- Firebreaks should be constructed, not just around the burn area; other paddocks close by should have fire breaks as well. These breaks should also protect environmentally sensitive areas, riparian zones, and historical sites (including Aboriginal heritage).
- Identify what equipment may be required and where to obtain equipment, like a McArthur grassland fire danger meter or perhaps a quick-fill pump from the Rural Fire Service (RFS).
- Check that all fire fighting equipment and vehicles are in working order.
- Are there adequate watering points close to the burn? Tankers may be required.
- Will there be enough people to assist on the day and possibly to patrol for several days after?
- Ensure knowledge of weather patterns for time of burn. Check Bureau of Meteorology (BoM) and other internet resources.
- Obtain a permit to burn (if in the fire danger period) and notify your neighbours and RFS of the approximate date you wish to burn.
- RFS Brigade captains should encourage as many members as possible to attend. INS burns are a good opportunity to gain skills and knowledge.
- Make sure you have appropriate cover – third-party, personal and property insurance.
- Identify and map your property (large aerial, land-sat, mud map), including:
  - Assets - buildings, structures
  - Vegetation types - INS areas, grazing areas (winter, summer)
  - Environmentally sensitive areas – threatened plants and animals or communities, historical sites (including Aboriginal heritage), etc
  - Asset protection zones - fire exclusion areas, safety areas
  - Strategic fire breaks - main tracks, roads, graded fence lines, rocky outcrops
  - Future and past burn areas
  - Any important features on your neighbour’s property (water, protected area).
  - Area allowed to be burnt under the PVP.

Planning your burn – day of burn

The decision to burn or not has to be made on the day.

- Check weather conditions and BoM for the forecast of your area.
- Check fire breaks and equipment, and that water tanks are full.
- A briefing must be conducted with all personnel involved in the burn.
- Determine UHF radio channel and other forms of communications.
- Explain the lighting pattern to those involved.
- Maps must be supplied to all involved in the burn (map should have water points, control lines, radio channel, weather forecast, PVP area, etc).
- If people are to be responsible for a designated area or role, others should be notified – e.g. western sector of fire (Bob), pump operator (Steve), grader driver (Dave).

Remember, visitors to your property will need to know your property like you do – the names of paddocks, tanks, landmarks and features could be confusing if things don’t go right.

After burn

- Patrolling of the fire ground is essential, especially if there are heavy fuel loads near the fire edge. These should be extinguished if possible.
- Also, check for hollow trees on the fire edge that may have caught alight. Patrolling may have to continue for several days if weather conditions stay hot and windy.
- Check the interior of the burnt area to see if the burn was successful. You may need to light unburnt areas to kill all INS seedlings.
Year after burn

- Continue to monitor site for groundcover, plant species and density. The established photo points will be valuable for this.
- If rain has occurred shortly after the burn and grasses are returning quickly, short-term grazing could encourage plant growth, but make sure stock are removed before seed set. Leaving adequate groundcover will also help in preventing the survival of germinating INS seedlings.
- Monitoring should continue for germination of INS for several years, especially if a good wet season has followed the burn.
- Depending on INS species, grazing by goats may be beneficial (e.g. hopbush), but allow for grasses to re-establish first. Spot treatment with herbicides will also be beneficial for small outbreaks.

Post-burn management

Regenerating perennial grasses compete with emerging INS seedlings for moisture. Until the regeneration of protective groundcover occurs, burnt areas are particularly susceptible to wind and water erosion. Post-burn grazing management is important to let grasses re-establish.

The burnt areas should not be grazed by domestic stock until the predominant perennial pastures at the site have reached maturity and set seed at least once.

References and resources

Information in this resource has been drawn a number of sources, including the following publications:


**Managing invasive native scrub**

**Goats**

**Using goats to manage INS**

Goats can remove extensive amounts of foliage of palatable INS species under heavy grazing conditions. Where this kills shrubs, INS density is reduced. Where shrubs are not killed, the reduction in foliage can open the INS enough to allow pasture growth. Stocking goats to manage INS has the potential to yield income from animal products. However, optimal stocking rates for INS control may not result in a saleable product.

Management of goat grazing can also support a feral goat control program. There are a number of resources available to landholders to humanely control feral goats, and these should guide any control program.

Goats regularly eat hopbush, mulga, and cypress pine, although hopbush tends to be more heavily browsed as pasture levels decline. Mortality of hopbush is up to 90% after two or three years of heavy goat stocking. Mulga and pine are more resilient to repeated defoliation, so mortality rates are much lower (e.g., 30% for mulga).

In western NSW, goats have been recorded as eating emu bush, wattles, and bimble box seedlings with some effect. Goats will occasionally eat punty bush and silver cassia.

Goats are effective in controlling whipstick pine. Larger mature goats can break off pine whilst pulling the plant down to graze the top of the young tree.

For adequate INS control, it is essential that there is adequate fencing and water around the area to be treated.

**Limitations**

Goats do not graze INS exclusively and they remove perennial grasses. Heavy grazing is required to kill woody scrub, and this may result in long-term damage to perennial pastures unless an adequate period of rest is allowed after treatment. Total grazing pressure management and appropriate seasonal conditions are needed to recover pastures.

Goats only effectively control species that they find palatable (e.g., hopbush and mulga). Goats do not readily eat turpentine and budda. The density of unpalatable species can increase and become a huge problem as goats browse out the competing species.

The reproduction of turpentine (especially) can be enhanced by goats as they remove competition (both groundcover and woody vegetation) for nutrients and moisture.
Where do goats fit in to an INS management plan?

Goats are not appropriate in all situations, and for best results they should be integrated with other management options.

Goats may be useful where INS is dense and other options are unsuitable, e.g. where low pasture levels restrict burning opportunities, or where mechanical or chemical treatments are not cost-effective.

Goats will open dense areas at relatively low cost. They browse scattered shrubs before denser patches. In opening up denser patches pasture growth will be encouraged and other treatments may be able to be used (i.e. fire).

As goats can only browse INS up to a certain height they have little significant impact in areas with tall INS. Chaining when goats have eaten most of the available browse is a good follow-up treatment. This controls the INS, and allows the full value of the INS resource to be obtained.

Operational notes

Goat breed

Herds of goats used to control INS usually comprise trapped feral goats. The flock quality can be upgraded by introducing Boer bucks or selecting for characteristics to produce a better line.
**Stocking strategies**

Continuous pressure will result in the highest INS mortality. Strategies that give the shrubs a chance to recover will reduce mortality.

Sheep and cattle are often removed from the paddock during goat stocking. Some landholders add a small number of goats to their sheep flocks as part of their INS management strategy.

Goats have also been stocked at high levels for short periods in a ‘crash grazing’ strategy.

A ‘deferred grazing’ strategy involves resting the paddock from goat grazing at certain times of the year (e.g. after the first significant rain).

Another strategy is to stock goats in paddocks with INS and low pasture levels. In this situation goats have a more rapid impact on INS because they are immediately forced to consume large amounts of browse. Shorter stocking periods are required, so income forgone through not stocking sheep and cattle is reduced.

**Stocking rate**

Stocking rate depends on the amount of palatable browse and pasture levels in the paddock. When determining an appropriate stocking rate remember:

- There is a trade-off between a stocking rate that is most effective for INS control, and one that gives maximum goat production.
- Heavy stocking rates quickly reduce INS, but with greater risks of pasture loss, soil erosion and goat welfare.

*The left of the fenceline demonstrates goat impact on bimble box seedlings, pine seedlings and groundcover.*
Good fencing is essential to manage total grazing pressure.

Electric fencing is becoming more widely used in western NSW. Electric fences need to be set up properly. If incorrectly set up, faults will short-out the fence and it will be ineffective.

In some instances fencing that allows feral goats to enter the paddock has been used to increase flock size. However, this fencing also allows kangaroos into the paddock, increasing total grazing pressure.

Overgrazing can damage pastures and lead to bare soil, and subsequent erosion and production problems. Soil and vegetation condition need to be carefully monitored, and goat numbers adjusted as necessary. Well fenced ‘goat’ paddocks allow strategic management of goats for paddock spelling.

Two critical times for pasture management are after rain and after goat stocking. Stocking levels should allow pasture to seed, and a period of spelling should follow goat stocking to allow pastures to re-establish and seed.

References and resources

Information in this resource has been drawn a number of sources, including the following publications:


Grubbing

**Managing invasive native scrub**

**Using grubbing to manage INS**
Grubbing is a mechanical treatment where INS shrubs are uprooted using a ‘grubber’ attached to a tractor.

Grubbers have a relatively low horse-power requirement and can be a cost effective method of INS control.

Grubbing gives instant results and can be used at any time with minimal erosion risks. It does not kill non-target species, and the operator can easily see the treated area.

Grubbing is effective against all species but particularly those that re-sprout at the base (e.g. budda, turpentine, hopbush).

**Limitations**
Grubbing is very slow and difficult to use in dense stands of INS where access may be a problem.

**Where does grubbing fit in to an INS management plan?**
Grubbing is best used in light to medium density stands of INS where little time is spent driving between shrubs, and the density is not so great that there is a constant danger of staking tyres. Grubbing is also a useful treatment for areas of scattered INS shrubs.

An example of a front mounted grubbing unit
Operational notes

Equipment

A number of models of grubber are available. A front mounted grubber consists of a horizontal double-bladed steel cutting edge mounted on two steel uprights, which in turn are attached to a front end loader equipped with hydraulics. The hydraulics allow the cutting block to rotate, assisting the uprooting of shrubs.

Operation

The grubber is driven into the ground at the base of the shrub and ‘grubs’ it out using the upward motion of the front end loader and rotation action provided by the hydraulic ram. If the front-mounted grubber can cut in both directions, it also has the ability to remove shrubs from beneath trees.

Operation is easier when the soil is moist following rain. Little effort is required for shrubs less than 2 m in height.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications:


Herbicides

Using herbicides to manage INS

Controlling INS species with herbicides allows effective management without large machinery, labour or risk of damage to other property. Herbicides are less disruptive to the soil than other techniques, and application can be carefully directed to target plants. The cover provided by dead INS has benefits for soil protection and grass establishment.

It is most economical to treat early stages of INS encroachment in order to maintain open pastures. When INS shrubs and trees are small, the return on money invested in treatment is quicker and the groundcover of a large area can be maintained.

If applying to the leaf or soil, herbicides should be used when the shrub or tree is actively growing and not moisture stressed.

Limitations

Herbicides may not be economical on dense stands.

Always read the label and use according to manufacturer’s instructions.

Where do herbicides fit in to an INS management plan?

Herbicides are best used:

- to maintain open areas and contain the spread of dense clumps (by treating outliers)
- where it is impossible to use fire or mechanical methods, as using herbicide does not require destocking and pasture loss is minimal compared to fire or mechanical methods
- to initially treat coppicing or re-sprouting species, or as a follow-up after other methods
- to treat regrowth.

Operational notes

Which herbicide?

Your local herbicide agent, CMA officers and neighbours are able to advise which herbicide will work best on your property.

How herbicides work

Many popular herbicide products work by interrupting photosynthesis, causing shrubs to lose their leaves and exhaust root reserves. Control is gradual and is characterised by intermittent growth and die back. It may take the herbicide up to 18 months to kill the shrub. Herbicides work more quickly when the shrub is actively taking up moisture.
**Application methods**

**Soil application** involves a residual herbicide being placed on soil near the base of the shrub. Chemical is carried down into the soil by the first effective rainfall after application. Most of the herbicide is absorbed through the lateral roots just outside the drip line. The herbicide should be placed just outside the drip zone so that the leaf canopy does not interfere with rainfall and movement of herbicide into the ground. Over-application should be avoided as it can result in bare areas devoid of vegetation. Also, soil application should not be used on very sandy soils as the herbicide may leach off-site and kill non-target species. This is particularly important when using water soluble products.

**Stem injection or cut stump application** uses small amounts of chemical by applying it directly into the sap. This method does not depend on soil moisture to carry the chemical into the plant. It is, however, a labour intensive method and may not be feasible for species that are multi-stemmed such as turpentine.

**Basal bark application** involves mixing herbicide with diesel and applying it to the stem of the plant in a band at the base of the stem using a knapsack and drench gun. The herbicide is absorbed through the bark, effectively ringbarking the shrub.

With **leaf application** the herbicide is absorbed through the leaves and transported to the plant roots. The chemical is only absorbed under good growing conditions and is not effective when moisture stressed. A ‘wetter’ is sometimes mixed with the herbicide to help chemicals penetrate a waxy leaf. Full coverage of the plant is necessary for an adequate control. This is often hard to achieve for plant that is taller than the operator. Good results have been achieved on young regrowth.
**Application timing**

Timing of application when using stem injection is important for good control. Contrary to popular belief, autumn rather than spring is a better time for stem injection for the control of coolibah and bimble box.

Autumn applications of soil applied chemicals have been reported as most successful. This coincides with the higher chance of rain and movement of carbohydrates from the roots to the leaves prior to a stage of dormancy in winter.

Leaf application can be restricted during the hotter months of the year as chemical uptake by the plant is poor. It is much cheaper to control a few shrubs than to wait until they are very thick and a major problem. Groundcover and productivity begin to decline quickly at greater than 20-30 shrubs per hectare.

**Application rate**

Much lower rates of chemical are required for stem injection in comparison to leaf and basal bark applications.

When treating regrowth use the label rate for the original height of the shrub and not the size of the regrowth. Label rates based on the size of the regrowth will not be enough when small regrowth is grown from old, large root systems.

Landholder experience

An INS area was blade ploughed in 1990 and then left without any further treatment until mid-1998. By this time turpentine, budda and hopbush had regrown and the shrub population (excluding any trees that were present or that had established) was between 43 and 812 per hectare, with spacing of 15 m to 3-4 m between plants.

In mid-1998 the site was treated with a number of herbicide compounds in a trial. The herbicides had a variable impact with most apparent kills after four months of 90-95%, although some were only 20-50%. Hopbushes were generally poorly affected by any of the treatments.

Six months after the herbicide applications the site was showing a considerable amount of re-shooting by the previously apparently dead shrubs. No further treatment was applied and by 2007 the treated areas was again overrun by INS.

References and resources

Information in this resource has been drawn a number of sources, including the following publications:


Using pasture management to manage INS

Vigorous perennial pastures can compete with emerging INS seedlings for moisture, nutrient and light, and help control their widespread establishment. In healthy stands of perennial grass, INS seedlings are unlikely to survive normal to dry summers for the first or second season after they germinate. Effective grazing management is critical to establishing healthy pastures.

Limitations

While critical components of an INS management program, pasture and grazing management alone will not control encroaching INS.

Where does pasture and grazing management fit in to an INS management plan?

Well-managed pastures can out compete INS seedlings, reducing (but not eliminating) the need for other INS treatment options. Grazing management is an important component of pasture management as it:

- ensures adequate levels of groundcover for good soil health and to control erosion
- allows the accumulation of fuel for a management burn if burning
- minimises the time that ground remains bare after a burn if burning
- allows the regeneration of diverse and productive pastures following INS treatment.

Operational notes

INS recruitment

INS seedlings can have high survival rates in wet summers regardless of pasture competition. Under these conditions other INS management activities may need to be carried out.

Post-treatment grazing

Post-treatment grazing pressure needs to be managed to allow desirable ‘soft’ native grasses to re-establish. Achieving a diversity of native grasses and herbage needs careful management of stock and control of feral and native animal grazing pressure.
Seeding

It is important to rest paddocks when grasses are seeding so the seed bank can be replenished.

Reintroduction of native pasture seed, preferably harvested from local stands, may allow faster re-establishment of groundcover.

Stocking rates

Stocking rates should be driven by a strategic purpose and plan, allowing key perennial species to remain vigorous and ensure their frequency in the pasture does not decline. This is particularly important during favourable seasons to allow depleted populations of perennial grasses to re-establish naturally. Research has shown that conservative grazing is a key factor in preventing INS encroachment.

Managing total grazing pressure

Total grazing pressure has to be kept low enough to allow native grasses to regenerate. This can be achieved through careful placement of watering points and fencing, and by spelling paddocks.

In addition to livestock, grazing pressure from native and feral animals needs to be factored in to grazing management plans. Feral goats, kangaroos and rabbits can account for up to half of the grazing pressure on land in western NSW.

Feral goats may add substantially to the total grazing pressure. If managed as domestic livestock, goats graze in a similar manner to sheep and impact on groundcover. They will however browse a wider range of plants. Feral goats should be controlled by cooperative and coordinated programs.

Kangaroo grazing is more difficult to control. Water points in spelled paddocks should be kept free of kangaroo access. These paddocks should be kept under surveillance and kangaroo harvesters used if there is evidence of a build-up.

Controlling rabbits is an important part of overall pasture management and needs to be planned to make efficient use of available resources.

References and resources

Information in this resource has been drawn a number of sources, including the following publications:

Bull, A (2003), Best practice native shrub management manual for south west Queensland. Queensland Department of Natural Resources and Mines.


Stick raking uses a clawed blade attached to a front-end loader or bulldozer to break off young shrubs and ‘rake’ them into piles.

Timber can be left on the ground to provide shelter for establishing groundcover.

The roughened soil surface can also collect seed, debris and other resources to encourage establishment of perennial native pastures.

The position of the cutter bar on the stick rake is important for the species to be controlled. A cutter bar on the bottom of the stick rake can give good results on some species such as pine but poor results on budda. If budda is cut off at ground level it will re-shoot.

For effective control, budda needs to be broken off below ground level. This can be achieved with moderate success by positioning a bar approximately 15 cm from the bottom of the rake. The stick rake will then pull and lift the plant from the ground.

Stick raking can be selective to avoid non-target trees and species.

A example of a wide stick rake

Whipstick pine remaining after the site was stick raked
Limitations

Lower-growing saplings, seedlings and shrubs are difficult to treat.

Re-sprouting species (e.g. budga and turpentine) are difficult to control with stick raking as they rapidly re-sprout. Bimble box root suckers can occur post-stick raking.

Stick raking is only viable if regularly followed up with further treatments.

Where does pasture and grazing management fit in to an INS management plan?

Stick raking is sometimes combined with ploughing to prevent sucker regeneration.

A crocodile seeder is also sometimes used to increase infiltration and re-introduce grass seed following stick raking.

References and resources

Information in this resource has been drawn from a number of sources, including the following publications:

Bull, A (2003), Best practice native shrub management manual for south west Queensland. Queensland Department of Natural Resources and Mines.

Waterspreading

**Using waterspreading to manage INS**

Waterspreading is a land management technique used to evenly disperse water flows over relatively level land, away from drainage lines. By reducing the energy of the water flow, soil erosion is reduced and water infiltration increased. Increased water infiltration suits native grasses and herbage.

Waterspreading is not an INS control tool in itself, however it can be used to establish healthy perennial pastures after INS treatment in appropriate landscapes (i.e. less than 3% slope).

Waterspreading spreads water that would otherwise form narrow drainage lines. These drainage lines can be gully eroded and the areas that shed the water are subject to sheet erosion.

**Limitations**

Waterspreading may lead to seed of INS species being spread in flood events.

*Top and bottom: Waterspreading banks on a site previously treated for INS*
Where does waterspreading fit in to an INS management plan?

Waterspreading helps promote pasture establishment in land where other treatments have removed INS.

Established perennial pastures will help control INS establishment.

Operational notes

Waterspreading is suitable for landscapes with gentle slopes (i.e. less than 3%).

Water is channelled away from the drainage line by a series of diversion banks that change into spreader banks away from the flow line. The spreader banks have gaps that allow water to flow slowly into a shallow level channel. As the channel fills, water slowly flows out over the land surface. Excess water returns to the flow line. Depending on the system design the water may flow on or be re-spread.

Correct design and construction is essential to avoid problems such as:

- scouring in channels and gaps
- erosion at bank ends
- bank breaching during high flows
- sediment build-up
- overflows.

It is important that banks and channels aren’t too big – too much water is stored in big channels. Smaller channels allow more water to flow over the paddocks.

References and resources

Information in this resource has been drawn a number of sources, including the following publication: