

ABOUT THIS PUBLICATION

Serrated Tussock Managers' Fact Pack provides information on biology, impact and control of this difficult weed.

Written and compiled by Michael Michelmore, NSW Agriculture.

This publication will be reviewed regularly. The latest information on national management of serrated tussock will be available at <http://www.agric.nsw.gov.au/reader/weeds> and will include a copy of this document ready to be printed in PDF format.

To contact NSW Agriculture, the author, or to provide feedback regarding this Fact Pack, please email tussock.management@agric.nsw.gov.au.

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INTRODUCTION

Serrated tussock is a highly invasive weed of temperate regions. The plant is unpalatable, provides no nutrition, and can be difficult to control.

This guide will help you to manage serrated tussock. You should implement a management plan for serrated tussock NOW to protect agricultural production and environmental values on:

- your own land;
- your neighbour's land; and
- throughout your district.

Serrated tussock control can be complex. A whole-farm approach is necessary, together with integrated control and management. The more your serrated tussock program is planned and linked with your neighbours', the more successful the program will be.

Although there may be high initial costs, perhaps including some changes in land use, you will achieve significant long-term benefits. Successful programs require follow up and ongoing integrated treatments to minimise re-establishment of serrated tussock.

Doing nothing will allow serrated tussock to spread and will reduce farm and environmental values in your district.

Serrated tussock is described in *Part 1: The weed and its impact*. The key weak point of this weed is highlighted—that the seedlings are small, slow growing and vulnerable to competition.

Strategies and treatments for control of serrated tussock are described in *Part 2: Management options*. The Section: *Considering your options* outlines the many factors to be considered in developing a control strategy for serrated tussock. The *Treatment choices guide* helps landowners develop appropriate control techniques.

Some of the treatments are complex and are described in more detail in *Part 3: Special notes*. Developing community and regional programs are discussed later in this Part. There are some specialised treatments and information that are not included in the first two Parts. Before providing advice on control, consultants should read the Section: *Special note for serrated tussock advisers*.



PART 1: THE WEED AND ITS IMPACT

Botanical name

The botanical name of serrated tussock is *Nassella trichotoma*.

Other common names include nassella tussock and Yass River tussock.

Some texts refer to *Stipa trichotoma*, and taxonomists may refer to *Nassella trichotoma* (Nees) Hackel ex Arechav.



Photograph: Michael Michelmore



Distinguishing features

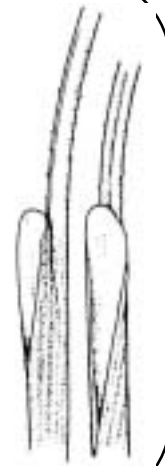
The distinctive characteristics of serrated tussock include:

- tussocky grass to 50 cm tall
- thin, tightly rolled, pale yellow/green leaves with very fine serrations, hairless
- white hairless ligule
- white swollen leaf bases
- purple tinge to young flower heads, later turning golden as the seeds ripen
- weeping flower head that breaks off at maturity
- very difficult to pull from the ground, even when small.

What is a ligule?

It's a feature on a leaf at the point where the leaf separates from the stem. Trace down a leaf to its junction with the stem. Slowly separate and bend the leaf back. A small, white, hairless flap, about 1 mm long, will protrude. Most of the grasses that are confused with serrated tussock have a hairy ligule or no ligule. The hairless ligule is the most useful guide to distinguish serrated tussock.

Drawing: D.J. Dennis, Source: Lamp, C.A., Forbes, S.J., Cade, J.W. (1990), *Grasses of Temperate Australia*, Melbourne: Inkata Press, p. 205.



People who are used to identifying grasses will note:

- **Dense tufted perennial grass** to 50 cm tall forming tussocks to 70 cm in diameter. The weed may be smaller on infertile soil.
- **Leaf-blades rolled in bud**, 20–50 cm long, bristle-like, scabrous; sheaths very short, white at the base; ligule membranous, to 1.5 mm. Plants are bleached golden by frosts in winter.
- **Inflorescence** an open panicle, branches slender, very brittle, often drooping when mature, the whole inflorescence becoming detached with fruiting.
- **Spikelets** 6–8 mm long on slender pedicels, with one bisexual floret, remaining attached to the detached inflorescence but eventually disarticulating above the glumes.
- **Glumes** sub equal, ovate to broadly lanceolate, rounded, 3-nerved, purplish below and translucent above when young, apex acuminate.
- **Lemma** shortly obovoid, scabrous, 1–2 mm long with a short bearded callus, apex truncate or obtuse, eccentrically awned at the apex with a slender, bent, slightly twisted awn to 3 cm long.



A serrated tussock leaf will easily roll between your fingers like a needle—many native grasses will feel like they have flat edges.



Drawing: D.J. Dennis. Source: Lamp, C.A., Forbes, S.J., Cade, J.W. (1990), *Grasses of Temperate Australia*, Melbourne: Inkata Press, p.204-5.



Drawing: Enid Mayfield. Source: Keith Turnbull Research Institute (2003), *Serrated tussock - Identification*, Landcare Note LC0175, Department of Primary Industries, Victoria.



Photograph: Malcolm Campbell



Photograph: Michael Michelmore

Source: Wheeler, D.J.B., Jacobs, S.W.L., Whalley, R.D.B. (2002), *Grasses of New South Wales*, Armidale: University of New England, 3rd ed.

Further information: Contact your weeds officer for advice on identifying serrated tussock.



Differentiating from other grasses

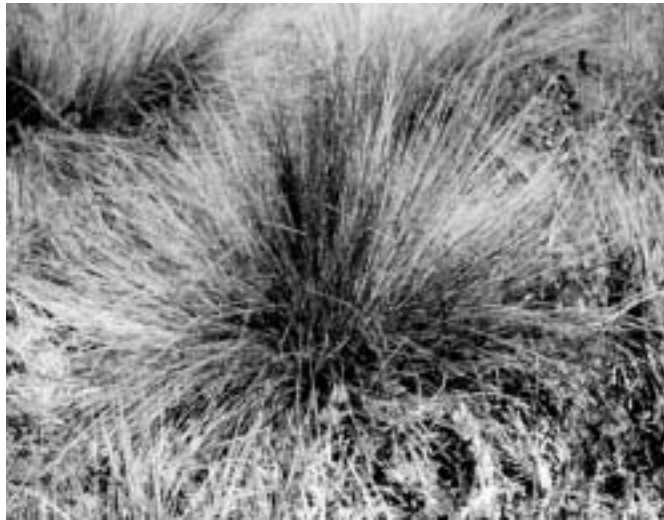
Serrated tussock can be difficult to distinguish when it is not seeding. With careful examination of serrated tussock and other grasses, you will be able to tell the difference.

Note the similarities between serrated tussock and poa tussock as illustrated in the photographs below. Accurate identification is essential in the treatment and control of weeds.



Serrated tussock

Photograph: Malcolm Campbell



Poa tussock

Photograph: Malcolm Campbell

Further reading: Taylor, U. (2003), *Tasmanian serrated tussock information kit*, Tasmania: Department of Primary Industries, Water and Environment.



Key to identification of serrated tussock from *Poa*, *Stipa* and *Danthonia*

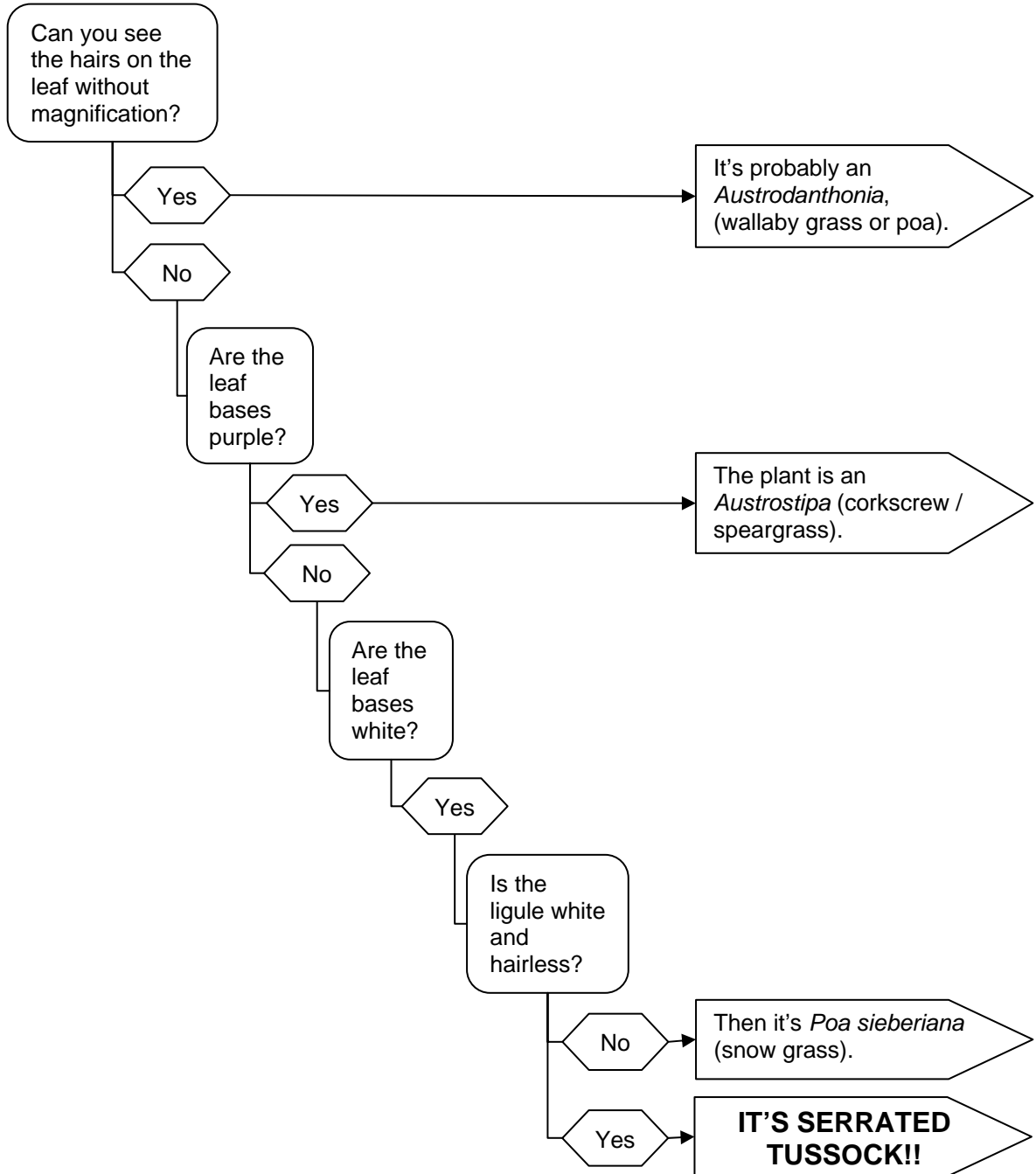


Diagram: Andrena Jones

Information source: Linda Ayres, Agronomist, NSW Agriculture



Key biology

The key biology of serrated tussock includes the following points:

- It is a long-lived perennial.
- Seed life in the soil may be more than ten years, but the majority die more rapidly.
- Germination is mainly in autumn, but may occur any time of the year.
- Seedlings are weak and slow growing and may be several years old before flowering.
- Seed is set in summer.
- Seed is dispersed mostly by wind.

Serrated tussock seedlings are weak and slow growing—strong competitive vegetation will crowd them out.

Life history

Serrated tussock is a long-lived perennial. Seedlings, which commonly emerge in autumn, are slow growing and weak. If plants are growing in low fertility or other less favourable areas, or occur under dominant vegetation, they may be several years old before they flower. There is little plant growth in winter when the leaves are affected by frost.

Seed life

Vast majority of the seed has germinated, been eaten by ants, or otherwise lost within a few years. Some seed may be still viable after a decade.

Germination

The varying permeability of the seed coat controls germination so that germination occurs over an extended period rather than with the first rainfall or in the first year.

Seed set

Serrated tussock plants older than 1 or 2 years may set seed. Large plants can produce up to 100 000 seeds per year. Flower heads are obvious and drooping in late spring. Seed is set and dispersal occurs 10 weeks later in early to midsummer. Seeds are adapted for wind dispersal; the whole seed head detaches and is readily blown away. Most seed is likely to lodge relatively close to the parent, within 0.5 km, but some seed may disperse considerably further. Other dispersal mechanisms are important, such as water, humans, and animals; seed that passes through stock may be viable.

Source: Campbell, M.H., Vere, D.T. (1995), *Nassella trichotoma* (Nees) Arech. In *The Biology of Australian Weeds*, Volume 1, Melbourne: R.G. and F.J. Richardson, pp. 189-202.



Where serrated tussock grows

Serrated tussock is native to South America. Large areas of Australia, New Zealand, and South Africa have been infested. Other areas of the world have smaller infestations. In Australia, serrated tussock is mostly confined to the cooler temperate areas, but it does have a wide tolerance. This highly invasive unpalatable perennial grass has become a major problem of perennial grasslands, native woodlands, and other vegetation communities, in the tablelands and other areas of New South Wales and Australian Capital Territory, and in several locations in Victoria and Tasmania. Only dense perennial pasture and bush areas are not invaded.

Serrated tussock is described as the worst weed in NSW, mostly associated with the Central and Southern Tablelands, covering more than 870,000 ha. Significant intractable areas have been noted as a major problem for more than 30 years without any real solutions. Other areas, such as the coast and slopes of NSW, are also affected.

In New South Wales, the plant is widespread in the Southern and Central Tablelands and is sparse in the Northern Tablelands. Serrated tussock is found in several areas of Victoria, mostly between Geelong, Melbourne and Ballarat, and is also found near Hobart, Tasmania.

Climate

Serrated tussock prefers cool temperate climates. Distribution appears to be limited by hot summers. In NSW the distribution is associated with the 21°C isotherm of mean January temperature. Occasional patches may be found outside this range.

Soil

All soil types are vulnerable. Serrated tussock grows on soils derived from diverse geological origins, including slate, shale, limestone, ironstone, granite, basalt, sandstone, and mudstone. Serrated tussock will grow in very infertile soil, but will also respond to nitrogen or phosphorus fertiliser. It grows in acid soils but is rarely found in swampy land.

Plant associations

This plant is highly invasive. Most pastures and open scrub will be vulnerable if considerable areas of bare ground are allowed to develop. Dense Australian phalaris or kangaroo grass pasture seems to be generally tolerant, as is very dense scrubland. Denser scrub or pastures either resist invasion or are invaded more slowly. The sparser the pasture or scrub, the more successful serrated tussock's invasion will be. Competition from desirable species alone will not eliminate serrated tussock once it has established, but will decrease seedling survival and re-invasion after initial control.



Landuse

Intact native vegetation is reasonably resilient to serrated tussock invasion. Where native vegetation is disturbed by erosion, fire, trampling or grazing, its resilience is reduced. Sparse pastures are very susceptible—every effort should be made to maintain pasture cover and density, so that the pasture's resilience can keep out weeds. The higher grazing height of cattle, as opposed to sheep, helps make pastures more resilient. Serrated tussock is destroyed by tillage and does not become a problem in areas that are regularly cropped.

Serrated tussock does not usually grow in wet or heavily shaded areas. Grasses that are often confused with serrated tussock grow in these areas: poa/silver tussock (*Poa labillardieri*) will grow in swampy areas, and snow grass (*Poa sieberiana*) and red anther wallaby grass (*Joycea pallida*) will grow under a dense canopy of trees.

Approximate areas infested: New South Wales 820 000 hectares; Victoria 130 000 hectares; Tasmania 1 500 hectares, as at May 2003.

Source: Campbell, M.H., Vere, D.T. (1995), *Nassella trichotoma* (Nees) Arech, in *The Biology of Australian Weeds*, Volume 1, Melbourne: R.G. and F.J. Richardson, pp. 189-202.

Source: Agriculture & Resource Management Council of Australia & New Zealand, Australian & New Zealand Environment & Conservation Council and Forestry Ministers (2000), *Weeds of National Significance Serrated Tussock (Nassella trichotoma) Strategic Plan*, Launceston: National Weeds Strategy Executive Committee.



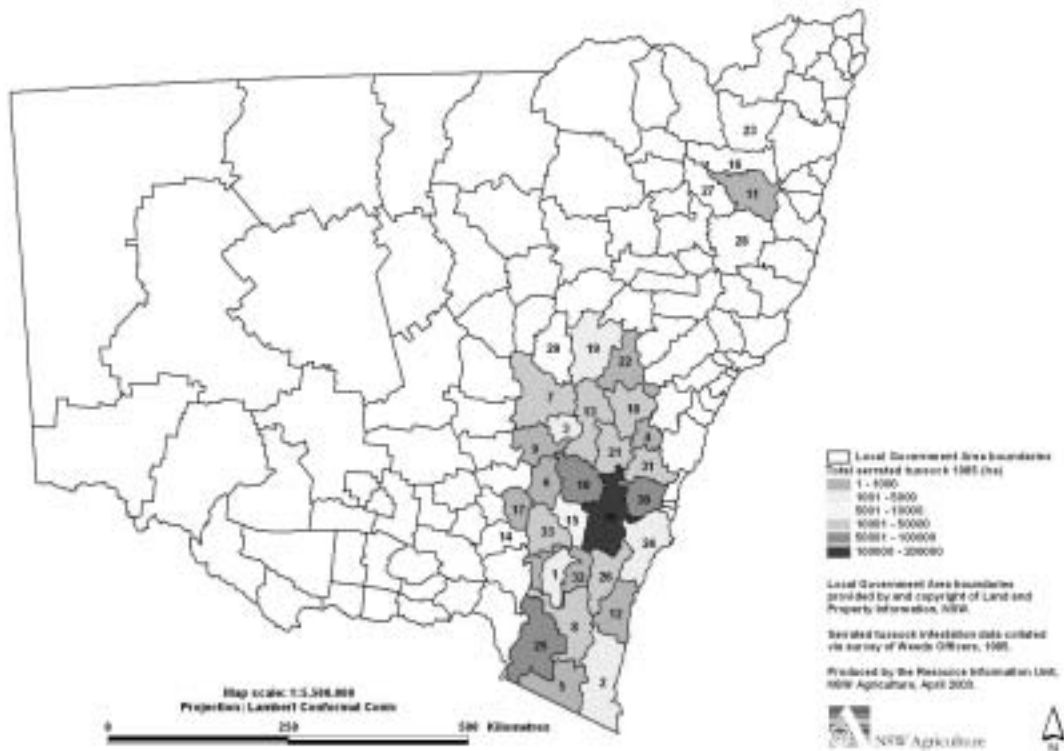
Spread history

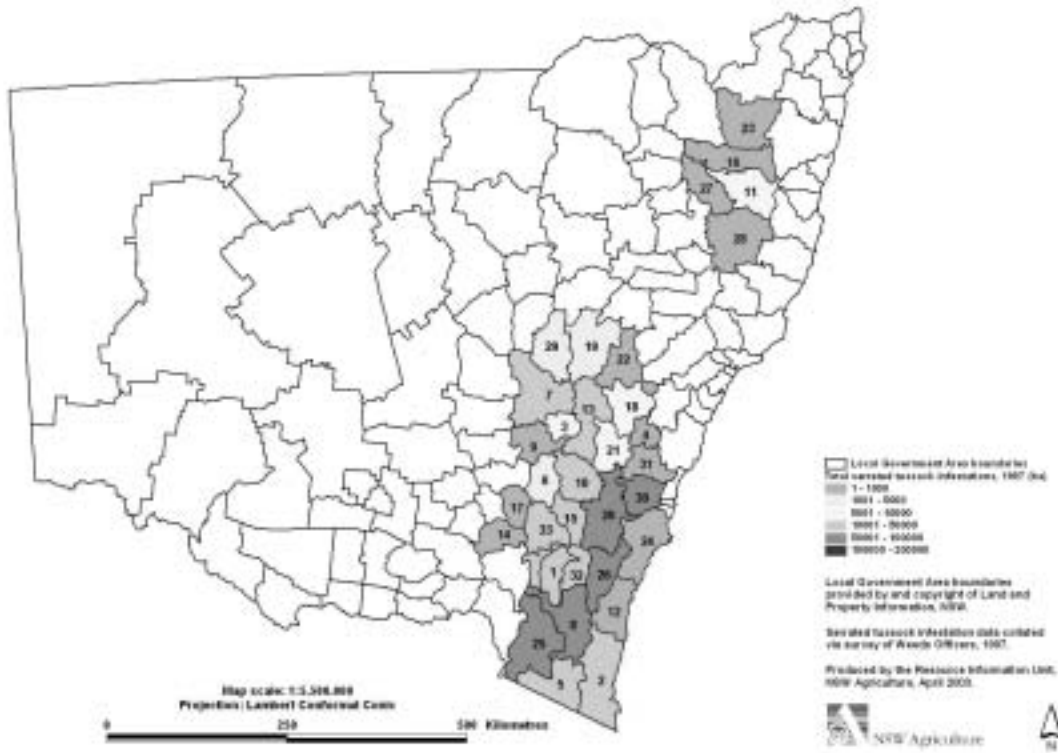
It is thought that serrated tussock was accidentally introduced to Australia in around 1900. It was first noted as a problem at Yass, New South Wales in 1935. In 1954 it was found in Victoria, then in 1956 it was found in Tasmania.

Dispersal is mostly by the wind. However, accidental dispersal through ingestion by stock, attachment to stock or in hay has been recorded. Areas downwind from seed sources will be particularly vulnerable. Typically, the greatest invasion of pastures and grasslands occurs when the vegetation is weak, with large areas of bare ground. Under continual selective grazing, serrated tussock can become dominant unless controlled.

Serrated tussock spread has generally been insidious: isolated plants are not recognised by non-specialists, particularly in the seedling stage. Often, it is only when the infestation has become widespread and dense and is already causing productivity losses that people have become concerned. Unfortunately it is at this stage that the infestation is most difficult to control. Early intervention to stop this process is essential.

Below are serrated tussock distribution maps made from NSW Agriculture surveys in 1985 and 1997.





Maps: NSW Agriculture

Further reading: Campbell, M.H., Vere, D.T. (1995), *Nassella trichotoma* (Nees) Arch., in *The Biology of Australian Weeds*, Volume 1, Melbourne: R.G. and F.J. Richardson, pp. 189-202.



Impact of serrated tussock

Serrated tussock has the potential to spread extensively throughout South-east Australia. If continued spread occurs it will cause markedly reduced productivity of land, which will then need to have a costly and difficult continuous serrated tussock management strategy applied. Grazing industries will be affected by reduced production, and the environment will be affected by reduced biodiversity.

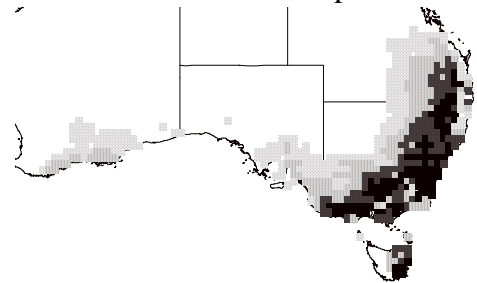
If uncontrolled, serrated tussock has the potential to invade and dominate a large proportion of pasture systems and open woodlands within its range. It could cause greater reductions in carrying capacity than any other pasture weed in Australia. An area's carrying capacity can be reduced from 7–15 dse* / ha on improved pasture down to 0.5 dse / ha on heavily infested areas. As the potential impacts of serrated tussock are so major, considerable effort is needed to prevent future losses.

Because serrated tussock has 86% fibre, it has very low nutritive content. Crude protein is around 4% and crude fat about 3.3%. If stock browse occasional serrated tussock plants as a small part of their diet there is normally no problem. However, if stock are forced to consume large amounts of the weed, then:

- Energy used to digest the fibrous leaves will be higher than energy acquired from digestion causing malnutrition and weight loss.
- The fibrous leaves can form balls in the rumen, and eventually cause death.
- Teeth become markedly worn.

As serrated tussock invades, managers must be careful to avoid overgrazing the remaining pastures. Initial infestations often develop into dense infestations as stock selectively graze more palatable associated species and leave the serrated tussock, thereby increasing the rate of invasion. Serrated tussock greatly affects land values. This is due to the increased costs of managing the weed, and the reduced carrying capacities of infested areas.

Paddocks that are grazed only by cattle may have a reduced rate of invasion, as the taller pastures left by cattle compete with the serrated tussock more than the shorter pastures in areas grazed by sheep. Goats do not digest serrated tussock significantly better than sheep or cattle. Neither do supplements help sheep digest serrated tussock significantly better. Serrated tussock frequently invades open woodlands. While serrated tussock invasion has not yet been assessed as a process that threatens ecosystems, there are major concerns in New South Wales and Victoria. This illustration (right) shows the estimated future potential spread of serrated tussock.



Further information: Victorian Serrated Tussock Working Party (2002), *Serrated Tussock*, Mini CD movie, Victoria: Department of Natural Resources and Environment.

Source: Campbell, M.H., Vere, D.T. (1995), *Nassella trichotoma* (Nees) Arech., in *The Biology of Australian Weeds*, Volume 1, Melbourne: R.G. and F.J. Richardson, pp. 189-202.



PART 2: MANAGEMENT OPTIONS

Strategies for control

Serrated tussock managers must address three key points:

- Prevention
- Every effort must be made to prevent the introduction and establishment of this truly noxious weed. Treat individual plants and small infestations before they spread.
- Out-compete the seedlings
- Serrated tussock seedlings are weak and slow growing. Use agronomic techniques to promote dense vegetation to smother the young plants.
- Destroy adults
- While the choice of herbicides has changed over the years, the on-going philosophy of serrated tussock management has been continuous vigorous control of adults and subsequent maintenance of dense perennial vegetation.

Early control of serrated tussock is the best way to avoid the high costs of controlling heavy infestations at a later date.

Control of serrated tussock can be particularly challenging because:

- It is a perennial grass weed that commonly grows in perennial grasslands.
- Seeds are readily dispersed.
- It has long-lived seed reserves.
- It is very invasive.
- The adult plants are very resistant to control methods.



Photograph: Malcolm Campbell



Landholders with serrated tussock must remove the weed and promote vigorous grass pasture or other vegetation to smother the slow growing serrated tussock seedlings.

Further reading:

Keith Turnbull Research Institute (1998), *Serrated tussock*, Victoria: Department of Primary Industries, Landcare Note PP0005.

Mudford, D. (2000), *Serrated tussock: annual control calendar*, Victoria: Department of Primary Industries, Landcare Note PP0102.

Campbell, M. (2003) *Serrated tussock – identification and control*, Agfact P7.6.54, 1st edition, NSW Agriculture, Orange.



Prevention

Learn to identify serrated tussock seedlings and adults. If serrated tussock is absent on all or part of your property, every effort should be made to prevent introduction of seed.

As serrated tussock spread is mostly by a wind-borne seed, prevention in some districts can be very difficult. Maintenance of dense vegetation or pasture will make an area more resilient to establishment of serrated tussock seedlings.

CLEAN AREAS MUST BE KEPT CLEAN

Every good land manager learns to recognise any weeds that are in their district. This is very important for plants that are hard to recognise, or for plants that are difficult to manage. Serrated tussock managers must consider prevention of introduction and methods to reduce serrated tussock seed rain.

Prevent introduction

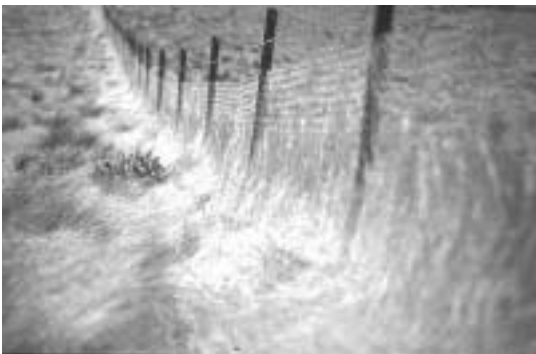
To prevent invasion, ensure that machinery, stock and produce entering a land area are not contaminated or are cleaned on a manageable area.

Stock from infested areas should be held for at least 14 days in a monitored area with dense competitive pasture to allow the seed to flush from their digestive tracts. This is especially important during the summer seeding period. Ensure that fodder and seed are not moved from serrated tussock infested areas to clean ones.

Seed rain reduction

If an area is to be re-sown in the next year, then spray topping this year to prevent seeding will help not only the paddock, but neighbours as well.

The use of windbreaks—upwind to minimise seed entry, and downwind to minimise seed escape—should be considered as part of an overall strategy. Windbreaks may not always



Photograph: Michael Michelmore

meet their purpose—their efficiency is dependent on the density of the serrated tussock both upwind and downwind, the topography, and density and height of the trees. Windbreaks provide a wide range of benefits to agriculture, the environment and amenity—consider these benefits before planting a windbreak solely for serrated tussock control. The use of rabbit fencing to catch tumbling serrated tussock seed-heads is also useful (pictured left).



Regional case study 1 – Armidale NSW

Justin Billing, Serrated Tussock Project Officer,
New England Tablelands Noxious Plants Country Council,
Armidale NSW

Here, Justin describes how early intervention successfully stopped the spread of serrated tussock.

Prevention (light: 10-20 plants per hectare)—Waterfall Way

Serrated tussock was first recorded on the property as scattered individual plants and an isolated patch of 50–100 plants in January 2001. The patch was treated with flupropanate, while the scattered individuals were chipped. In subsequent inspections throughout 2001, scattered plants were found and chipped. The landholder is now confident in identifying serrated tussock, and follow up inspection in 2002 found only the odd isolated seedling. The most recent inspection found little sign of the tussock and the property to be in good order, but annual inspections continue. The primary management technique now employed is to search the property in August/September each year, when tussock plants are obvious against the surrounding vegetation, which is typically dormant and grazed low to the ground. Individual plants found are usually chipped and the general location noted for future inspection. The advantages of using this technique are the ongoing effective removal of plants found before seed-set and the early identification of serrated tussock and other weeds amongst the pasture before they become established. Consequently, the cost of serrated tussock management in this situation remains low. The main cost incurred is the time required to undertake the preventive action.

Landholder comments

“There are so few of them about. Is it really that bad? You wouldn’t know just looking at it. Thank God James (District Weeds Officer, James Browning) found it when he did, because I never would have. As a result I’m confident I can keep it at bay just by being vigilant and acting on the odd one I find.”



Left: District Weeds Officer James Browning, checks seed-head emergence in one of the denser Serrated Tussock patches on the Northern Tablelands, NSW.

Photograph: Justin Billing



Regional case study 2—Tasmania

Andrew Crane, Regional Weed Management Officer
Department of Primary Industries, Water and Environment,
Tasmania

Here, Andrew describes some of the complex issues in the management of public programs for prevention of serrated tussock.

The prevention of new serrated tussock infestations is a key component of Tasmania's Serrated Tussock Strategy. Fortunately, Tasmania has relatively small areas of infestation. Most infestations have been confined to either agricultural areas where they are largely being managed, or to isolated areas with little stock or human movement. Despite the neglect of these areas they have not posed a significant threat to other parts of the State. However, new risks are emerging.

The move away from Local Government workforces to private contractors has had two significant effects. First, local knowledge of roadside infestations has been lost, and now contractors may visit areas only once a year. Secondly, machinery used to maintain roadsides in infested areas is now being transported long distances into uninfested areas as contractors take on new jobs. It has become critical that those involved in roadside maintenance, as well as those involved in earthmoving, road building and other engineering activities, are well-informed of best-practice hygiene and their legal obligations. To this end, workshops will be given for those involved in high risk activities, and information packages tailored to their specific needs are also being developed.

A matter closely related to that of hygiene is the increasing subdivision of infested and adjacent agricultural land for rural residential development. This has the practical disadvantage of increasing the potential number of landholders who need to be informed of the problems associated with serrated tussock, and who need to be encouraged to take those problems seriously. This can be challenging when new residents have no experience of weed management; many feel they have been "cheated" because they were not informed of the problem before purchasing the land.

A further problem is the increase in traffic and the greater potential of soil movement as foundations are excavated and roads constructed. Providing information to new land owners, builders and utility and infrastructure providers is another focus of the Tasmanian Serrated Tussock Strategy's preventive approach.



Out-compete the seedlings

Manage pastures and other vegetation to provide dense perennial cover to suppress serrated tussock seedlings.

Hoeing, spot spraying or broadacre treatments must be used to destroy plants that have become established.

Serrated tussock managers must consider seedling survival, current pasture management, and pasture manipulation and improvement.

Seedling survival

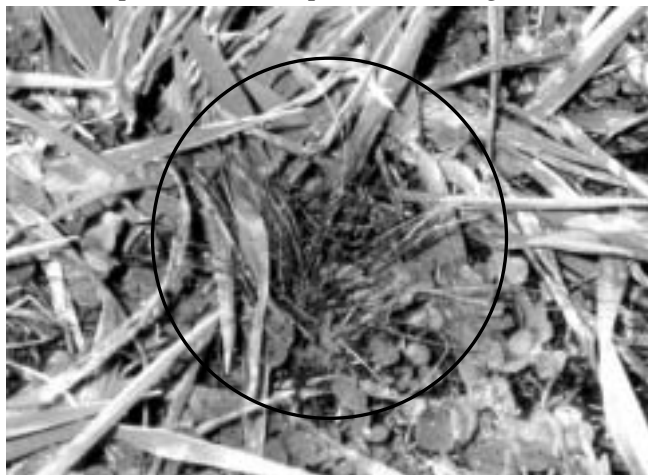
Maintaining perennial ground cover is essential to suppress seedlings. A low rate, or residues, of flupropanate may destroy serrated tussock seedlings. See section *Special note on flupropanate*.

Current pasture production

Fertilising, grazing management, and manipulating pasture species composition are essential tools to maintain ground cover and production of desirable species and thus to maximise profits.

Pasture manipulation and improvement

Your agronomist can advise on how to manipulate and improve pasture composition and cover. In arable areas, landholders may need to periodically destroy their extensively invaded pastures and sow a crop or pasture. In non-arable areas strategic stocking and fertilising will be necessary to promote the vigour and density of desirable species. The section *Special note on pasture management* contains more information on making



pastures more weed resilient. In areas that have naturally low productivity or are difficult to manage, then revegetation using trees or shrubs may need to be considered. This is described in the section *Special note on establishing trees*.

Left: The dark tuft in the centre of the circle is a serrated tussock seedling. It is being crowded out by the surrounding dense phalaris pasture.

Photograph: Michael Michelmore



Destroy adults

To destroy serrated tussock, land managers use mechanical control or chemical control, particularly flupropanate or glyphosate. Refer to later notes on these techniques.

The following section, *Consider your options*, will help you determine which treatments to use and includes a *Treatment choices guide*.

Serrated tussock managers must consider destruction of adults, sustainability of long-term land production, seed bank reduction, protection of native ecosystems, and compliance with legal requirements.

Destroy adults

Early vigorous ongoing control is essential to keep clean country clean.

Spot treat individual plants, either with a hoe or herbicide, at least twice a year to keep the weed suppressed.

A planned follow up program is needed for larger areas. For extensive areas, use a partly selective herbicide to minimise damage to vegetation.

If an area is to be cropped or resown to pasture, use a non-selective treatment, such as cultivation or boom spraying with glyphosate.

Strategic timing or particular application methods can be used to reduce damage to desirable species.

Long-term land production

After initial knockdown, continuously destroy new serrated tussock by spot or broadacre treatments.

Graziers must ensure that they have dense grass-based perennial pastures, especially of Australian phalaris or kangaroo grass. They may need to trade-off carrying capacity and pasture cover and density so that serrated tussock seedlings are suppressed.

In areas that do not support dense pastures, landholders should seriously consider revegetation with native trees, shrubs, or pines. On low rain fall or low fertility country a control option for serrated tussock may be to retire land from agriculture and revegetate it with trees.

Seed bank reduction

If there is no seeding, or no seed blows in, then the 'soil seed-bank' of serrated tussock will decrease over several years. Control serrated tussock before it sets seed.



Ploughing will increase the rate of decline of seeds in the soil but may adversely affect soil structure and increase erosion in some situations.

For areas with a long history of serrated tussock, farmers will need to continuously manage for germinating seedlings.

Protection of native ecosystems

In infested areas with considerable native vegetation, special programs should be developed to protect native ecosystems. Contact a Native Vegetation Management Officer or conservation adviser.

Comply with weed authority control policies

Serrated tussock is a Noxious Weed in most areas. Develop a program for managing serrated tussock on your property and discuss it with your Weeds Officer. Refer to section *Community and landscape management programs*.



Considering your options

Serrated tussock management will vary with your situation, as described in the *Treatment choices guide*. **Early vigorous ongoing control is essential.**

Control sparse primary infestations by hoeing or spot spraying herbicides. Maintain good pastures or dense vegetation. Control light and scattered secondary infestations by spot treatments and broadacre treatments, coupled with fertilisation, conservative grazing and, where necessary, re-establishment of pastures. Control dense extensive infestations by progressively destroying the weed in manageable blocks and replacing it with dense vegetation appropriate to land capability.

Follow up treatments will be essential to continually suppress serrated tussock. After any treatment, the greatest reinvasion of serrated tussock will occur if:

- the paddock is densely infested or has a long history of infestation
- there is a large seed bank in the soil
- there is a large up-wind seeding population
- the cover of desirable vegetation is low or damaged by previous treatments
- the land is naturally unproductive—low rainfall or poor soil
- there are few opportunities to rapidly increase desirable vegetation
- a non-residual treatment is used
- many plants are missed or treatments are ineffectively applied
- no follow up treatment is applied.

Treatment choices to destroy serrated tussock plants will vary according to the density of serrated tussock, life cycle stage of the weed, whether the land is non-arable or difficult, the condition of the associated pasture or vegetation, and the soil productivity of the area. Initial treatment choices must be integrated with follow up control of serrated tussock and ongoing management of the vegetation. This is outlined in the *Treatment choices guide*. For agricultural areas consider a combination series of mechanical, cultural or chemical treatments.

Control of serrated tussock is often challenging. Extensive use of flupropanate or knockdown herbicides damages or destroys many native grasses that are commonly present in non-arable areas. Treated areas may become bare and eroded, or ecosystem functioning may be significantly altered and become unstable. An integrated approach is necessary. Improve pastures where possible by ground or air broadcasting. Fence out low productivity areas where necessary. Use low impact stocking strategies, and fertilise to maintain a vigorous pasture cover of desirable species. On lower productivity sites consider re-forestation, especially with a dense perimeter planting to reduce seed spread.



Prepare a serrated tussock management plan for your property that sets priority areas and integrates with your property plan.

Possibilities for biological control continue to be investigated. However, if the program is successful, it would be many years before widespread effects are seen in the field.



Treatment choices guide

Use the following key to help determine appropriate treatments to control adult serrated tussock.

When considering the following treatments, carefully read the text to ensure that the situation and case are applicable. Consider the range of suggested initial treatments and the suggested ongoing management with reference to any chemical labels, Material Safety Data Sheets, permits and the special notes that follow.

By following the techniques in the *Serrated Tussock Managers' Fact Pack*, you should be able to progress from a dense extensive area of serrated tussock, to a sparse infestation, and ultimately to strategies to prevent the weed. Serrated tussock control can be successful.

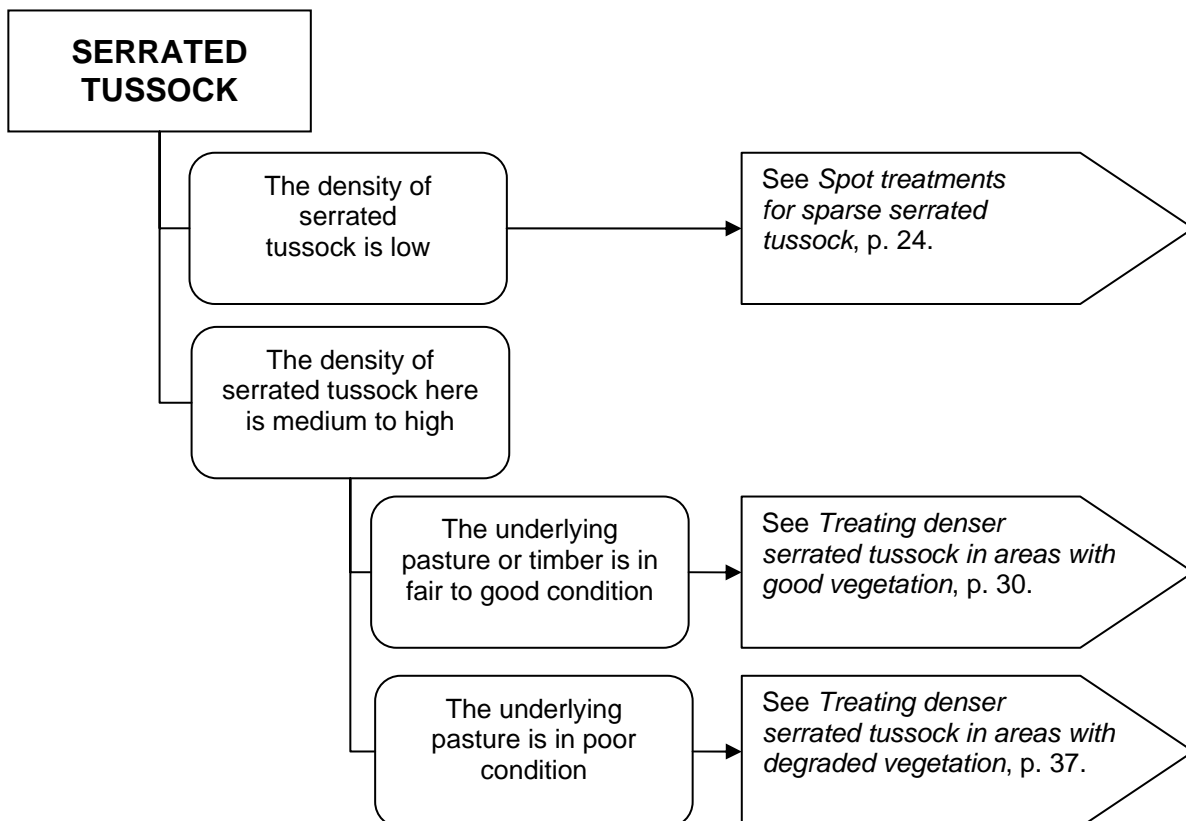


Diagram: Michael Michelmore



Spot treatments for sparse serrated tussock

Situation:

The density of serrated tussock here is low. You can reasonably walk to all serrated tussock plants to control them. The job may be difficult because the infested area may be extensive or the terrain is difficult, but broadacre treatments are not warranted.

Search for serrated tussock at least once a year and stop it before it seeds.

Suggested initial treatments address two cases

1. If not close to flowering: Spot treat to destroy serrated tussock, using a hoe or apply flupropanate or glyphosate herbicides.
2. If close to flowering: Spot treat to destroy serrated tussock, using a hoe, glyphosate herbicide, or flupropanate mixed with glyphosate herbicide.

Some of the treatments can be applied in both cases. Scatter seeds of desirable species on treated areas to improve revegetation.

Destroy serrated tussock plants with the treatment that causes the least damage to your desirable vegetation.

Suggested ongoing management

Graze strategically and fertilise to maintain ground cover. Revegetate ridges with trees or shrubs. As smaller plants are often missed, the area may need retreatment in subsequent years.

Herbicides and spot spraying

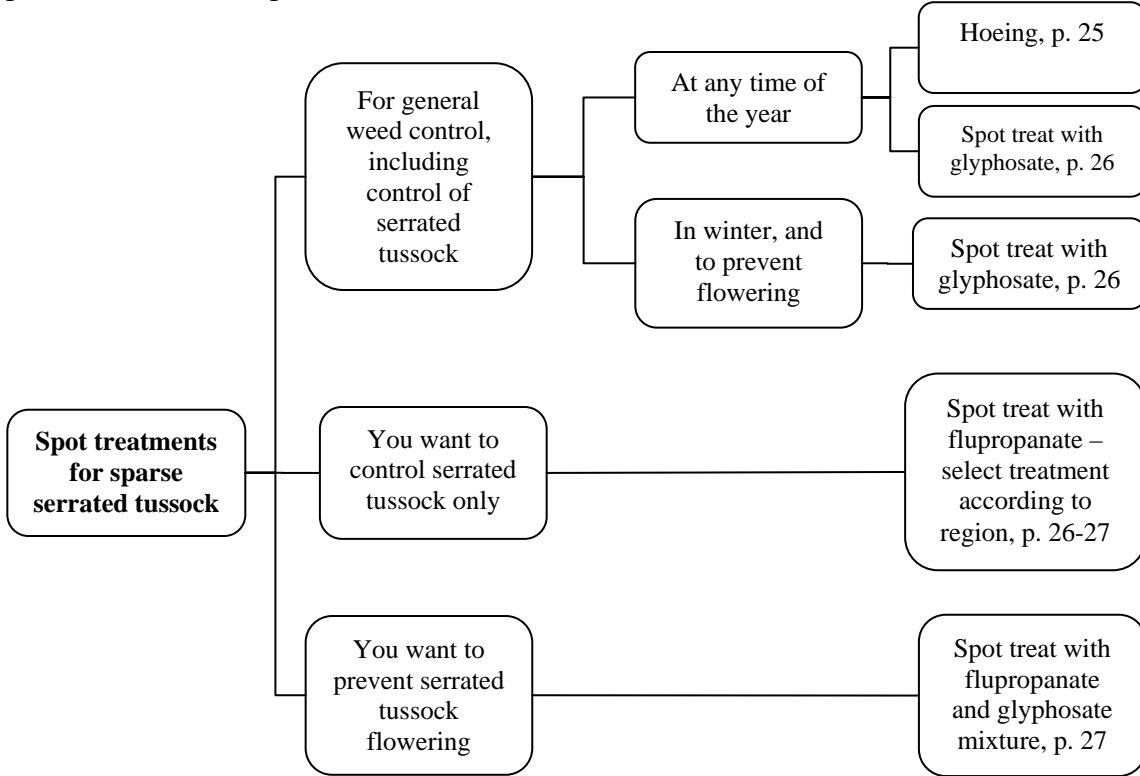
Carefully follow the directions on labels and any permits. Calibrate your spray equipment and technique so that you know the application volume for a given area. Generally, apply 1000 L water per hectare for spot spraying. To do this, time how long it takes to spray 10 m², then measure how much spray comes out in that time. Multiply by 1000 to determine the water volume per hectare. Adjust the proportion of herbicide to apply the correct rate, or adjust pressure, or nozzles, as described by the manufacturers.

Use of a wetting agent does not improve the effectiveness of flupropanate but may improve the efficacy of glyphosate. Flupropanate may take several months to affect plants and over a year to kill them. Use a carefully targeted spray to avoid off-target damage. Use dye marker; never use knockdown chemicals as a marker with flupropanate.



Cases and treatments

When considering the following treatments, carefully read the text to ensure that the situation and case are applicable. Consider the range of suggested initial treatments and the suggested on-going management with reference to any labels, Material Safety Data Sheets, permits, and to the Special Notes that follow.



Case: Spot treatment at any time
Treatment: Hoeing
Region: All areas
Timing: All year

Ensure that most soil is removed from roots. Will help prevent seeding if close to flowering. In dense weedy areas, consider application of pasture seed and fertiliser in the exposed areas after hoeing. Any type of hoe may be suitable—people might use a hoe, mattock or grubber, depending upon soil, size of weeds and personal preference.

Be prepared.
Carry a hoe when driving through your property.



Case: Spot treatment at any time
Treatment: Glyphosate
Region: NSW, ACT
Timing: All year

Apply according to label. Will reduce seeding if applied 2 to 6 weeks before seed heads begin to emerge. Use a carefully targeted spray to avoid off-target damage.

Under the National AgVet Chemicals Code, label directions may be varied to apply lower than label rates unless specifically prohibited. Research by NSW Agriculture has found that good control can be achieved in NSW with the application of 500 mL of 360 g/L glyphosate per 100 L water, or with 400 mL of 490 g/L glyphosate per 100 L water in any month. Calibrate spray equipment to apply 1000 L water / ha. This off-label use may be applied in the ACT according to APVMA permit PER4910.

Please see <http://www.apvma.gov.au> to get copies of the relevant permit PER 4910.

PER4910 ACT Expires 30/09/2005.

Case: Spot treatment winter and when close to flowering
Treatment: Glyphosate
Region: VIC, TAS
Timing: May–Oct inclusive

Apply according to label for control/suppression. Will reduce seeding if applied 2 to 6 weeks before seed heads begin to emerge. Use a carefully targeted spray to avoid off-target damage and to kill the whole plant.

Case: Spot treatment when not close to flowering
Treatment: Flupropanate
Region: NSW, ACT
Timing: All year

Apply according to label. Will not prevent seeding if close to flowering. Application should be avoided in very dry winters.

Under the National AgVet Chemicals Code, label directions may be varied to apply lower than label rates unless specifically prohibited. Research by NSW Agriculture has found that reasonable control is achieved in NSW with the application of 150–200 mL of 745 g/L flupropanate per 100 L water in any month. Calibrate spray equipment to 1000 L water / ha. This off-label use may be applied according to APVMA permits PER4625, PER4638, or PER4910.

Use the lower rate of flupropanate on light infertile slate, shale and granite soils; use the higher label rate on heavier basalt or clay soils.



Please see <http://www.apvma.gov.au> to get copies of relevant permits PER 4625, PER4638, and PER 4910.

PER4625 NSW Expires 30/09/2005; PER4638 NSW Expires 30/09/2005; PER4910 ACT Expires 30/09/2005.

Case: Spot treatment when not close to flowering
Treatment: Flupropanate
Region: VIC, TAS
Timing: Nov–Feb inclusive

Apply according to label. Will not prevent seeding if close to flowering.

Case: Spot treatment when close to flowering
Treatment: Flupropanate and glyphosate mixture
Region: NSW, ACT
Timing: Sept, Oct, and Nov inclusive

For more rapid knockdown, glyphosate may be added to flupropanate in accordance with labels. Under the National AgVet Chemicals Code label directions may be varied to apply lower than label rates unless specifically prohibited. Research by NSW Agriculture has found that good control can be achieved in NSW with the application of 150 – 200 mL of 745 g/L flupropanate per 100 L water, plus either 120 mL of 360 g/L glyphosate or 90 mL of 490 g/L glyphosate per 100 L water. This off-label use may be applied in the ACT according to APVMA permit PER4910.

Use the lower rate of flupropanate on light infertile slate, shale and granite soils; use the higher rate on heavier basalt soils. To prevent seed set, spray 2 to 6 weeks before seed heads begin to emerge.

Please see <http://www.apvma.gov.au> to get copies of the relevant permit PER 4910.

PER4910 ACT Expires 30/09/2005.



Regional case study 3—Armidale NSW

Justin Billing, Serrated Tussock Project Officer,
New England Tablelands Noxious Plants Country Council,
Armidale NSW

In this case study, relatively dense serrated tussock was destroyed with broadacre treatments. Dense pasture was aerially seeded. The landholder has developed an effective spot treatment program.

Spot treatment (moderate: 10–100 plants per hectare) – Rockvale/Aberfoyle

Serrated tussock was first identified in two paddocks on the property in June 1998. The larger paddock (~250 ha) contained only three dense patches (~100 m² each) and numerous scattered individual plants. The second paddock (~120 ha) contained at least six dense patches (1–2 ha each) and numerous scattered individuals across the whole paddock. The infestations were initially treated in October 1998 using a helicopter boom spray with glyphosate at 2.2 L / ha. Results appeared good, although due to pilot inaccuracy and spray drift, some patches recovered. Subsequent serrated tussock regrowth and seedling emergence was dealt with in April 1999 by another round of spraying with glyphosate. After spraying, paddocks were aerially seeded and fertilised to provide competition for emerging serrated tussock plants. The ongoing management program is centred on chipping and spot spraying in October/November each year, when the manager considers the tussock easiest to find. A 'Quik-Spray'® unit was purchased to assist with ongoing control. Three staff spend 2 or 3 days each year chipping and bagging or spraying plants. The outbreak is currently considered suppressed.

The main advantages of using chipping and bagging of plants for ongoing control are the relatively low cost, lack of herbicide withholding period, the removal of seeds, and the increased identification skills of staff. Spot spraying with the 'Quik-spray®' unit has the advantage of speed and ease of control compared with chipping.

Landholder Comments

"It was here for a few years before I knew what it was, and was well established by then. I hit it with everything in the first year or two, including the helicopter boom spray. Now my whole serrated tussock management program revolves around an annual chipping and spot spraying regime, to keep the seedlings from reaching maturity and setting seed."



Photograph: Justin Billing

Left: An example of a typical serrated tussock infestation at the spot treatment level on the Northern Tablelands, NSW.



Regional case study 4—Richmond TAS

Ursula Taylor, Coordinator
Tasmanian Serrated Tussock Project
Clarence City Council
Tasmania

There are several options for spot treatments, but they all cause some off-target damage. By understanding the composition of the underlying pasture and considering neighbouring land use, Lou Hanslow has minimised this damage.

Spot treatment of serrated tussock at "Summerhill", Tasmania

A small infestation of serrated tussock has been treated successfully by landowner Lou Hanslow of "Summerhill" near Richmond, Tasmania. Lou's serrated tussock occurs in a paddock that he rotates between seed crops and pasture for sheep. The serrated tussock is not a problem in the cultivated area but is scattered along the edge of the paddock close to fence lines and amongst some native bush. In 2002 South East Weed Strategy Coordinator Stuart Smith recommended that Lou use flupropanate to spot-spray the serrated tussock. Lou followed this advice and in the following spring he sprayed the infestation using a backpack.

"Initially I thought the Kenock® (flupropanate) hadn't worked but 6 months later the serrated tussock had keeled over," Lou said. "It was an excellent result. Now it's a matter of checking the site every year and mopping up what's left."

Lou was also pleased that the selective nature of flupropanate not only allowed him to continue his own paddock use, but also was no danger to the neighbouring vineyard. The herbicide destroyed the serrated tussock but left the surrounding pasture and the neighbour's vines intact. Lou now has a healthy and vigorous pasture that is preventing further tussock seed germination.

Lou Hanslow of "Summerhill" successfully spot-sprayed his serrated tussock infestation.



Photograph: Ursula Taylor



Treating denser serrated tussock in areas with good vegetation

Situation:

The density of serrated tussock here is medium to high—it would be unreasonable to spot treat every plant.

You are not willing to plough or kill desirable vegetation because either:

- The area is steep, rocky or timbered
- The underlying pasture or vegetation is in good condition.

A selective broadacre treatment is needed. Selectivity comes from:

- Partly selective herbicide, flupropanate (see later section *Special note on flupropanate*)
- Use of a wick-wiper to physically apply chemical only to serrated tussock
- Applying glyphosate herbicide when desirable vegetation is completely dormant (see later section *Special Note on Glyphosate*).

Suggested initial treatment:

Where possible, spot treat (see *Spot treatments for sparse serrated tussock*). All broadacre treatments cause some damage to desirable plants - you should carefully read the notes on each treatment and labels on any products. Choose the initial treatment on the basis of area to be treated, composition of desirable species, timing, stage of growth of serrated tussock, terrain, and density of weeds.

Destroy serrated tussock plants with the treatment that causes the least damage to your desirable vegetation.

Suggested ongoing management

Pastures should be strategically grazed and fertilised to maintain ground cover over spring and summer. Use non-destructive pasture improvement techniques—airial sow, ground broadcast or direct drill sub-clover, grass seeds and other desirable vegetation where necessary using local best practices. Allow desirable vegetation to set seed regularly. See later section *Special note on pasture management*.

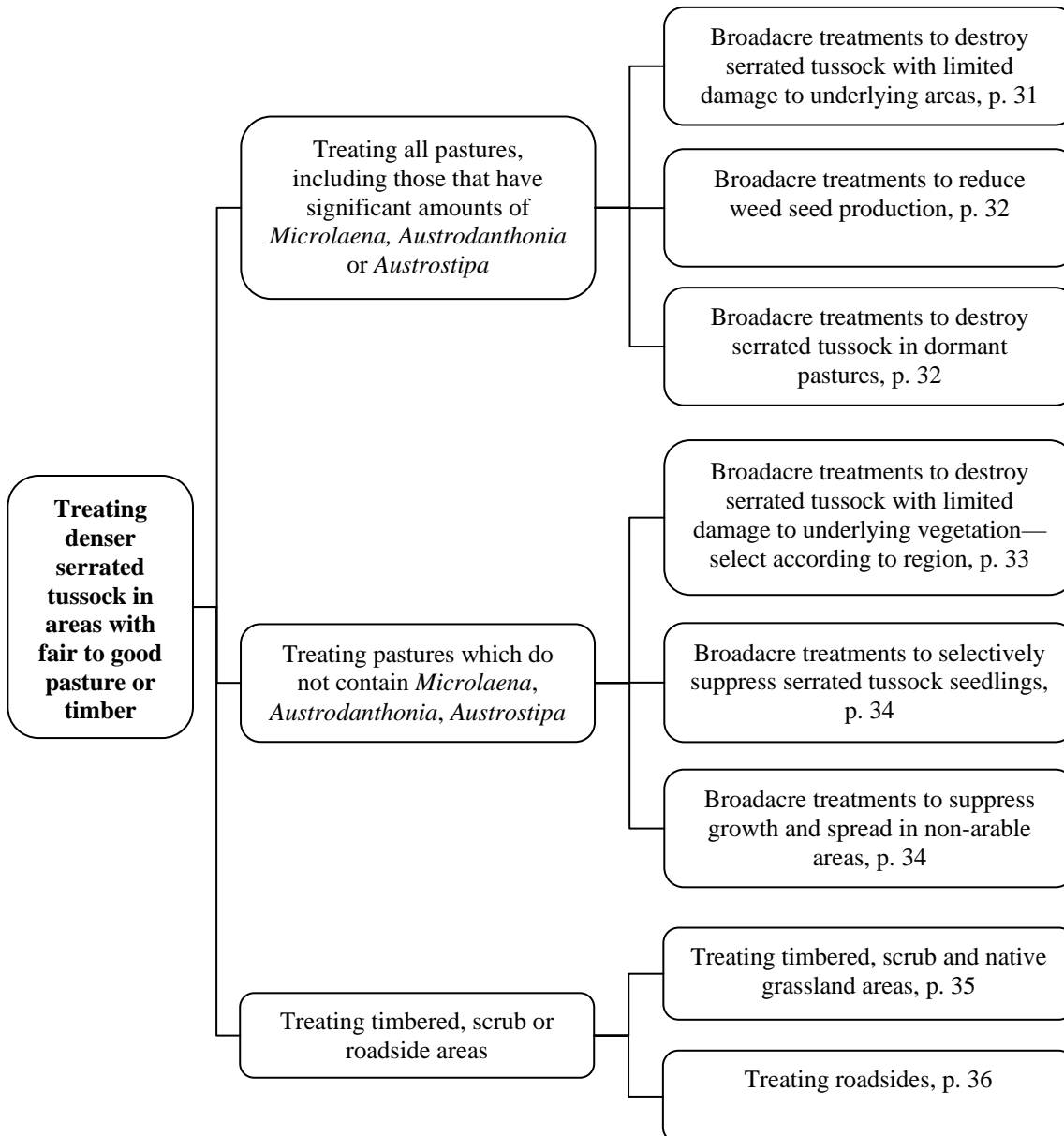
If an area has naturally low productivity (rainfall below 700 mm, steep slopes or acid top soil < pH 4.5) then seriously consider revegetation with trees or bush. Exclude stock. Manage to maximise perennial grasses and ground cover. Revegetate ridges and other areas.

Every effort must be made to encourage dense desirable vegetation, as outlined in the Section *Out-compete the seedlings*. Regularly monitor re-establishment of serrated tussock. If found, destroy plants as soon as is possible.



Cases and treatments

Carefully read all cases presented below to ensure that you choose the ones that are most applicable. Consider the range of suggested initial treatments and the suggested on-going management with reference to any labels, Material Safety Data Sheets and permits, and to the special notes that follow. Seek local advice from a pasture agronomist, forestry adviser or bush regeneration adviser.



Case: Broadacre treatments to destroy serrated tussock without follow up vegetation re-establishment
Treatment: Flupropanate rotating wiper
Region: NSW, ACT
Timing: Sept–March inclusive

Under the National AgVet Chemicals Code, label directions may be varied to apply lower than label rates unless specifically prohibited. Research by NSW Agriculture has found that reasonable control is



achieved in NSW with the application of a rotating wiper, double pass, with flupropanate in a ratio of 1:20 with water. This off-label use may be applied in NSW and ACT according to APVMA permits PER4638 and PER4910.

Graze pasture heavily prior to treatment to ensure a height differential between pasture and serrated tussock. In dense serrated tussock, stock may not graze heavily and some pasture damage may result. Add wetting agent according to label.

Please see <http://www.apvma.gov.au> to get copies of the relevant permits PER4638, PER 4910. PER4638 NSW Expires 30/09/2005; PER4910 ACT Expires 30/09/2005.

Case: Broadacre treatments to reduce weed seed production
Treatment: Topping serrated tussock using rotating wiper with glyphosate
Region: NSW, ACT
Timing: Sept–Nov inclusive

Under the National AgVet Chemicals Code label directions may be varied to apply lower than label rates unless specifically prohibited. Research by NSW Agriculture has found that reasonable control is achieved in NSW with the application of 490 g/L glyphosate via a rotating wiper at a ratio of 1:40 with water. This off-label use may be applied in the Australian Capital Territory according to APVMA permit PER4910.

Use a rotating wiper, double pass, 2 – 8 weeks before seed heads begin to emerge. Add a wetting agent. This will NOT kill serrated tussock but will reduce seeding. Graze heavily prior to treatment to ensure a height differential between pasture and serrated tussock. In dense patches of serrated tussock, stock may not graze pasture heavily and some pasture damage will occur.

Please see <http://www.apvma.gov.au> to get copies of the relevant permit PER 4910. PER4910 ACT Expires 30/09/2005.

Case: Broadacre treatments to destroy serrated tussock
Treatment: Removing actively growing serrated tussock from dormant pasture using glyphosate
Region: NSW
Timing: Any time of year

Under the National AgVet Chemicals Code label directions may be varied to apply lower than label rates unless specifically prohibited. Research by NSW Agriculture in the Southern Tablelands and on the Monaro between 1999–2003 has shown that mature serrated tussock plants can be killed with rates as low as 2 L of 490 g/L glyphosate per hectare (equivalent to 980 g / ai / ha) plus wetting agent according to



label. To get good results at these low rates, serrated tussock plants must be actively growing. To minimise damage to desirable species, carefully consider the remarks in the section *Special note on glyphosate*. Particularly, ensure that all desirable species are completely dormant. Use equipment that will give good spray coverage of the entire serrated tussock plant. A medium spray droplet applied at rates of 100 L water / ha has given excellent results. Ensure that serrated tussock plants are not covered in trash such as old seed heads and excessive dead leaf material. Follow up with non-destructive pasture improvement techniques.

Case: **Broadacre treatments to destroy serrated tussock without follow up vegetation re-establishment**
Treatment: **Flupropanate ground boom spray or aerial application**
Region: **NSW, ACT**
Timing: **June–Feb inclusive**

Apply according to label.

Under the National AgVet Chemicals Code, label directions may be varied to apply lower than label rates unless specifically prohibited. Research by NSW Agriculture has found that reasonable control is achieved in NSW with the application of 1.5 – 2.0 L of 745 g/L flupropanate per hectare, including in June, July and August. This off-label use may be applied in NSW and ACT according to APVMA permits PER 4625, PER4638 and PER4910.

Use the lower rate of flupropanate on light infertile slate, shale and granite soils; use the higher rate on heavier basalt soils. Research by NSW Agriculture has found that reasonable control is achieved in the Monaro with the application of 1.0 – 2.0 L per hectare.

Depending on country, apply in 80 – 150 L water / ha for ground application, apply in 35 – 80 L water / ha for aerial application. Calibration is very important.

Carefully read critical comments and notes on labels about damage to desirable species. Broadacre application of flupropanate to pasture is not recommended in March, April or May, as considerable damage will be done to sub-clover. Flupropanate kills several native grasses—be aware!

Please see <http://www.apvma.gov.au> to get copies of the relevant permits PER 4625, PER4638, and PER 4910.

PER4625 NSW Expires 30/09/2005; PER4638 NSW Expires 30/09/2005; PER4910 ACT Expires 30/09/2005.

Case: **Broadacre treatments to destroy serrated tussock without follow up vegetation improvement**
Treatment: **Flupropanate ground boom spray or aerial application**
Region: **VIC, TAS**
Timing: **Nov–Feb inclusive**



Apply according to label.

**The permit notes “single or double pass”,
but a double pass is usually more successful.**

Case: Broadacre treatments to selectively suppress serrated tussock seedlings in pastures
Treatment: Flupropanate at very low rates
Region: NSW ACT
Timing: Sept–Feb inclusive

Seedlings of serrated tussock are susceptible to shading and to low rates of flupropanate. Useful control of seedlings has been achieved with low rates of flupropanate. In all situations, use strategic stocking and fertilise to maintain a vigorous pasture after spraying. Pastures should be at least 12 months old before they are sprayed with flupropanate.

Apply according to label.

Under the National AgVet Chemicals Code, label directions may be varied to apply lower than label rates unless specifically prohibited. Research by NSW Agriculture has found that reasonable control is achieved in NSW with the application of 0.5 – 1.0 L of 745 g/L flupropanate / ha. This off-label use may be applied in the ACT according to APVMA permit PER4910.

Ground boom spray application can be made using water rates of 80–150 L / ha depending upon topography; calibration is very important. Use a lower rate of flupropanate for slate and granite soils. Serrated tussock plants must be less than 10 cm high and must have fewer than 80 leaves. Apply in September–November before pastures ‘bolt’ in the spring flush, or in December–February when improved species are dormant. For further information on this treatment see *Special note on flupropanate*.

Please see <http://www.apvma.gov.au> to get copies of the relevant permit PER4910.

PER4910 ACT Expires 30/09/2005.

Case: Broadacre treatment to suppress growth and spread in non-arable areas where many properties are heavily infested
Treatment: Flupropanate applied at extended intervals
Region: Steep areas of South East NSW
Timing: June–March



Initially, apply flupropanate according to the recommendations for the Cases: **broadacre treatment to destroy serrated tussock without follow up vegetation improvement**. Then, either:

- apply flupropanate according to the recommendations for the Cases: **broadacre treatment to selectively suppress serrated tussock seedlings in pastures** after 2–3 years; or
- apply flupropanate according to the recommendations for the Cases: **broadacre treatment to destroy serrated tussock without follow up vegetation improvement** up to every 10 years. This treatment should only be considered for suppressing serrated tussock where extensive districts are densely infested.

Extensive use of flupropanate or knockdown herbicides destroys many native grasses that are commonly present in these areas. Repeated use of a single herbicide greatly increases incidence of herbicide resistance—other treatments must be implemented. Treated areas may become bare and eroded, and ecosystem functioning may be significantly altered and become unstable. The area will need to be carefully monitored to re-establish desirable perennial cover. Improve pastures where possible by ground or air broadcasting. Fence out low production areas where necessary. Use low stocking rates, and fertilise to maintain a vigorous pasture cover. Consider re-forestation, especially the hard-to-manage ridge tops, with a dense perimeter planting to reduce seed spread.

After two to three years there may be a considerable number of serrated tussock plants that have become re-established. If downwind neighbouring areas are tussock free, seedlings should be killed before they are allowed to set seed. If erosion is not likely, then consider the **Case: Broadacre treatments to selectively suppress serrated tussock seedlings in pastures: Flupropanate very low rates**.

If neighbouring areas are heavily infested and it is impossible to avoid seeds blowing in, it may be more efficient and economical to delay flupropanate treatment until the tussock infestation is beginning to restrict production or begins to spread to tussock free areas. This may take up to ten years and should be incorporated into property weed control plans **THAT ARE AGREED BY WEED CONTROL AUTHORITIES**. Seek advice from an agronomist.

Consider strip spraying in alternate years so that the whole of the area is not susceptible to erosion every year.

Case:	Difficult areas—timbered, scrub and native grassland areas
Treatment:	Flupropanate by spot or aerial application
Region:	As indicated on the label
Timing:	As indicated on the label



Seek advice from herbicide manufacturers if spot treatment is not practicable. Various flupropanate products have varying warning statements.

Do not spray near desirable susceptible trees. Many native grasses, including wallaby grass and meadow rice grass, will be killed by flupropanate. Timbered, scrub and native grassland areas typically contain a mixture of adult trees, seedling trees and native grasses. As damage to seedling trees and native grasses is possible, you should discuss proposed programs with a native vegetation adviser.

Consider using the lowest feasible permitted herbicide rate.

If the area is to be revegetated, see *Special note on establishing trees*.

Please see <http://www.apvma.gov.au> to get copies of the relevant permits PER 4625, PER4638, PER 4910.

PER4625 NSW Expires 30/09/2005; PER4638 NSW Expires 30/09/2005; PER4910 ACT Expires 30/09/2005.

Some NSW farmers have applied 1.5 L / ha to trees that were 4 months old. Low rates of flupropanate have lesser effects on tree seedlings. But this needs to be tested on a case by case basis.

Case:	Difficult areas—Roadsides
Treatment:	Glyphosate by rope wick
Region:	ACT, NSW, QLD, SA, TAS, NT, WA
Timing:	Actively growing serrated tussock

Apply according to label.

Research by NSW Agriculture has found that reasonable control is achieved in NSW with the application of 360 g/L glyphosate products mixed at a rate of 1 L product in 2 L water and applied to roadsides with a rope wick wiper. This off-label use may be applied in NSW according to APVMA permit PER6675. Slash the area to be treated 4 weeks prior to the maximum growth period. Use a rope wick when unwanted species are taller than desirable species, usually 4–6 weeks after slashing. Repeat rope wicking in 8 weeks to control misses. Keep rope wick above desirable species. Two passes in opposite directions are preferred where conditions permit. Pressurised rope wicks will give better coverage of weeds. Ground speed should be no greater than 8 kph.

Please see <http://www.apvma.gov.au> to get copies of the relevant permit PER6675. PER6675 expires on 7/8/2008.



Treating denser serrated tussock in areas with degraded vegetation

Situation:

The density of serrated tussock here is medium to high – it would be unreasonable to spot treat every plant. The underlying pasture or vegetation is in poor condition. The area is arable and there are no constraints to destroying all vegetation and re-establishing desirable vegetation.

A non-selective broadacre treatment is needed.

These treatments may destroy all current vegetation. If current vegetation has any environmental or production value or is not arable, consider treatments outlined in the section *Treating denser serrated tussock in areas with good vegetation*. Spot treat fence lines and other areas that are not reached by broadacre treatments.

Suggested initial treatments

Suggested treatments address two cases:

- Planting pastures, or
- Planting trees and bushland.

For each case, you must consider four stages:

- Destroy serrated tussock, other weeds and unwanted vegetation.
- Decrease the weed seed bank in the soil.
- Establish desirable vegetation.
- Perform ongoing management of desirable vegetation and control of serrated tussock.

If an area has naturally low productivity (rainfall below 700 mm, steep OR acid top soil < pH 4.5) then seriously consider revegetation with trees or bushland. Exclude stock. Manage to keep perennial grasses and ground cover. Revegetate ridges and other areas.

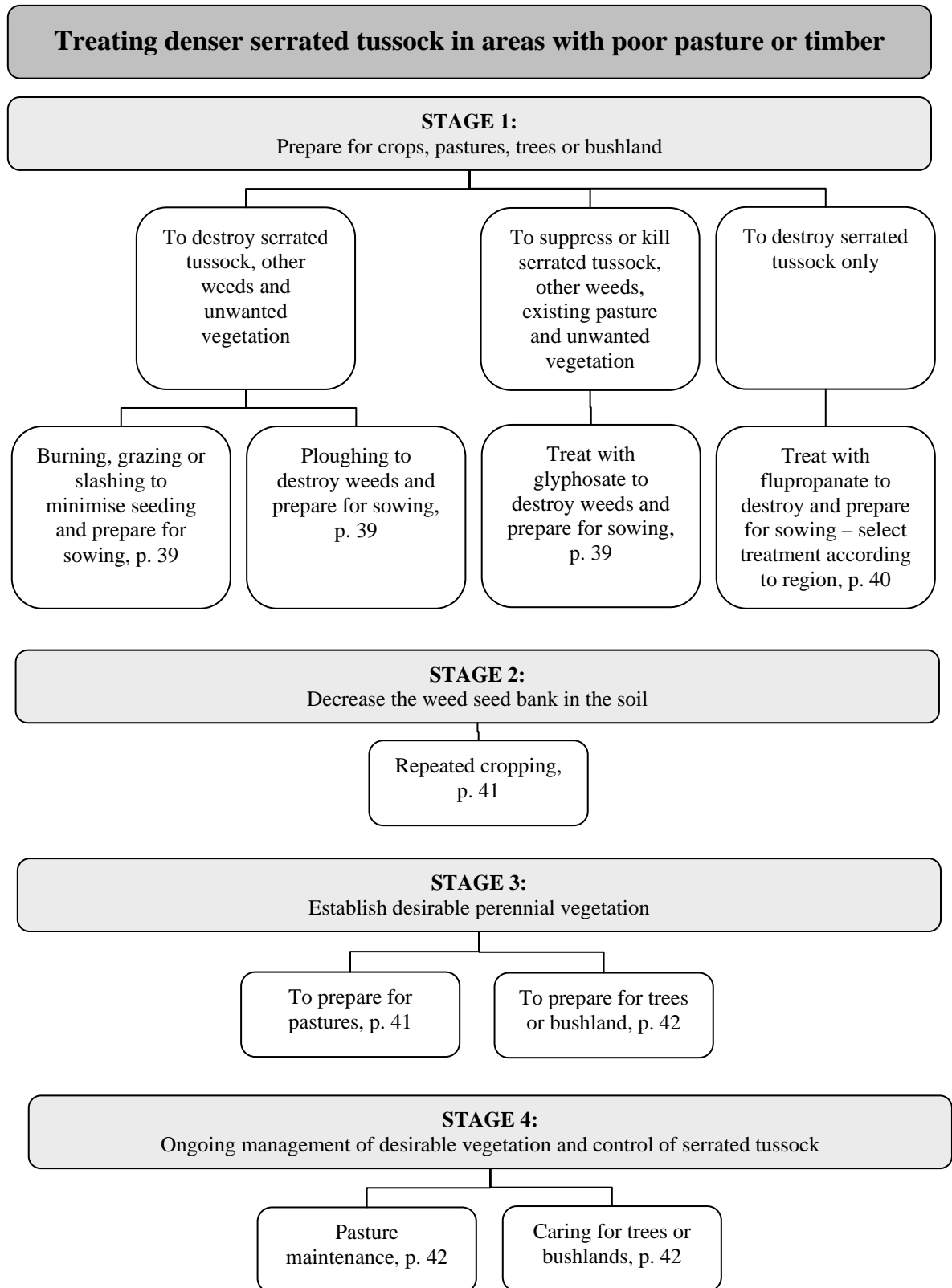
Every effort must be made to encourage dense desirable vegetation, as outlined in the Section *Out-compete the seedlings*. Regularly monitor re-establishment of serrated tussock. If found, destroy plants as soon as possible.

Cases and treatments

Carefully read all cases presented below to ensure that you choose the ones that are most applicable to your stage of serrated tussock control. Consider the range of suggested initial treatments and the suggested ongoing management with reference to any labels, Material



Safety Data Sheets and permits, and to the special notes that follow. Seek local advice from a pasture agronomist, forestry adviser, or bush regeneration adviser.



Case: Preparing for crops, pastures, trees or bushland
Stage: Destroy serrated tussock, other weeds and unwanted vegetation
Treatment: Burning, grazing or slashing to minimise seeding and prepare for sowing
Region: All regions
Timing: Aug–Sept inclusive

Burn, graze heavily, or slash to remove excess tussock, weeds and grass in winter and early spring. Seeding will be minimised. Serrated tussock will not die and will need further treatments before planting crops, pastures or trees: plough soon afterwards, or apply a knockdown herbicide once the serrated tussock has re-sprouted.

Heavily graze in autumn to remove excess grass and trash before cultivation or sowing.

**Always check with fire authorities before burning.
If stock are forced to eat too much serrated tussock
their health will suffer.**

Case: Preparing for crops, pastures, trees or bushland
Stage: Destroy serrated tussock, other weeds and unwanted vegetation
Treatment: Ploughing to destroy weeds and prepare for sowing
Region: All regions
Timing: Aug–Nov inclusive

Use a disc plough to turn serrated tussock and other weeds in winter. Fallow and cultivate in summer to remove the soil from the roots.

Case: Preparing for crops, pastures, trees or bushland
Stage: Suppress or kill serrated tussock, other weeds, existing pasture and unwanted vegetation
Treatment: Glyphosate to destroy weeds and prepare for sowing
Region: All regions
Timing: All year

Apply glyphosate according to label for control/suppression. For a chemical fallow, graze heavily in the early spring before planting, then apply glyphosate in spring according to the label. Follow critical comments and rates from the 'Weeds Controlled' tables on product labels. Will reduce seeding or serrated tussock if applied 2–6 weeks before seed heads begin to emerge.



Apply a second application according to product labels to remove other weeds that have germinated in autumn, about one to two weeks before sowing.

Research by NSW Agriculture has found that good control of serrated tussock is achieved in NSW at any time of the year by applying glyphosate according to label directions to actively growing and stress free plants. The addition of a wetter may prove beneficial. This use may be applied from August to April inclusive in the ACT according to APVMA permit PER4910.

Please see <http://www.apvma.gov.au> to get copies of the relevant permit PER 4910.

PER4910 ACT Expires 30/09/2005.

Case: Preparing for crops, pastures, trees or bushland
Stage: Destroy only serrated tussock
Treatment: Flupropanate to destroy and prepare for sowing
Region: Vic, Tas
Timing: Nov–Feb inclusive

Apply according to label. Other treatments may provide broader control of weeds and may allow far better establishment of pastures.

If flupropanate alone is applied after early August, serrated tussock is still likely to set viable seed. To prevent seeding, the use of a knockdown spray may be better where it is acceptable to damage associated pasture species when preparing for sowing. Residual flupropanate may hinder establishment of subsequent crop or pasture.

Case: Preparing for crops, pastures, trees or bushland
Stage: Destroy only serrated tussock
Treatment: Flupropanate to destroy and prepare for sowing
Region: NSW, ACT
Timing: June–February inclusive

Apply according to label. Other treatments may provide broader control of weeds and may allow far better establishment of pastures.

Under the National AgVet Chemicals Code label directions may be varied to apply lower than label rates unless specifically prohibited. Research by NSW Agriculture has found that reasonable control is achieved in NSW with the application of 1.5–2.0 L of 745 g/L flupropanate / ha, including in June, July and August. This off-label use



may be applied according to APVMA permits PER4625, PER4638, and PER4910. Research by NSW Agriculture has found that reasonable control is achieved in the Monaro with the application of 1.0 – 2.0 L / ha. Use the lower rate of flupropanate on light infertile slate, shale and granite soils; use the higher rate on heavier basalt soils. Depending on topography, apply in 80–150 L water / ha for ground application, apply in 35–80 L water / ha for aerial application; calibration is very important. Carefully read critical comments and notes on labels about damage to desirable species. Broadacre application of flupropanate to pasture is not recommended in March, April or May as considerable damage will be done to sub-clover.

Research by NSW Agriculture has found that reasonable control and reduction in seeding is achieved in NSW with the application of 1.5–2 L of 745 g/L flupropanate plus either 0.6–1.25 L of 360 g/L glyphosate or 0.45–0.9 L of 490 g/L glyphosate product during September, October and early November. Use the higher rate of glyphosate on basalt soils. Will kill serrated tussock plants and reduce seeding if applied 2–6 weeks before seed heads begin to emerge. Seek advice from an agronomist. Use a wetting agent. This off-label use may be applied in the ACT according to APVMA permit PER4910.

Please see <http://www.apvma.gov.au> to get copies of the relevant permits PER 4625, PER4638, and PER 4910.

PER4625 NSW Expires 30/09/2005; PER4638 NSW Expires 30/09/2005; PER4910 ACT Expires 30/09/2005.

Case: Preparing for pastures, trees, or bushland
Stage: Decrease the weed seed bank in the soil
Treatment: Cropping
Region: All regions
Timing: All year round, depending on crop

If a paddock has a history of dense serrated tussock, then there will be high numbers of seedlings that emerge, particularly in the first few years. A crop will be useful if high numbers of seeds do not continuously blow in and the area is quite arable. Plant a crop of winter wheat, oats, or forage brassica for one or two years to decrease the soil seed bank. Follow local techniques, and seek advice from an agronomist. Graze and / or harvest for grain.

Case: Preparing for pastures
Stage: Establish desirable vegetation
Treatment: Pasture establishment
Region: All regions
Timing: Autumn or spring

Sow pasture using local techniques, and seek advice from an agronomist or pasture guide about:

- conducting a soil test to determine best pasture varieties, seed treatments and fertilisers



- choice of knockdown herbicide, tillage, and red legged earth mite and ant control
 - time of sowing
 - pasture care and grazing in the first year.
-

Resilient introduced pastures typically contain phalaris, sub clover, and other grasses and clovers.

Case: Preparing for trees or bushland
Stage: Establish desirable vegetation
Treatment: Tree establishment
Region: All regions
Timing: Autumn or spring

Tree planting is described in the Section *Special note on tree establishment*.

Case: Pasture maintenance
Stage: Ongoing management of desirable vegetation and control of serrated tussock
Treatment: Pasture care
Region: All regions
Timing: All year

Pasture care is described in the Section *Special note on pasture management*. Use the *Treatment choices guide* to help determine specific treatment of serrated tussock.

Use strategic stocking and apply fertiliser annually to ensure effective competition for serrated tussock seedlings. Search for and destroy weeds regularly.

Case: Caring for trees or bushland
Stage: Ongoing management of desirable vegetation and control of serrated tussock
Treatment: Tree care
Region: All regions
Timing: All year

Tree care is described in the Section *Special note on tree establishment*. Use the *Treatment choices guide* to help determine specific treatment of serrated tussock.



Regional case study 5—Armidale NSW

Justin Billing, Serrated Tussock Project Officer,
New England Tablelands Noxious Plants Country Council,
Armidale NSW

Serrated tussock on arable land is comparably easy to control. In this case study the landholder used 2 or 3 years of cropping to destroy adults and the soil seedbank, followed by establishment of competitive pastures.

Non-selective broadacre treatment (heavy: > 100 plants per hectare) – Kelly's Plains

When first recorded at the site in the early 1990s, serrated tussock occurred as densely infested patches throughout a 200 ha area. A five year management plan was designed on the basis of using flupropanate for 2–3 years, in conjunction with the establishment of competitive pastures. This involved sowing oats for 2–3 years, then following up with an improved clover and phalaris pasture and regular fertiliser. All serrated tussock on the property is currently suppressed, except for one patch of about 5 ha, which was not sprayed or cultivated in 2002 owing to the prevailing drought conditions. Following rain in November–December 2002, this paddock has been sprayed and cultivated in preparation for pasture establishment.

The design of an integrated five year management plan to deal with this relatively large infestation enabled effective long-term control to be implemented on the site. Using flupropanate has the advantage of providing a 2 to 3 year residual effect, thus inhibiting serrated tussock seedling emergence. Establishing a competitive pasture at this stage further inhibits the growth of serrated tussock seedlings.

Landholder comments:

“By crikey it's a bugger of a weed this one. It's cost me a fortune just trying to contain it, let alone the lost production as it spread. If I'd known how bad it was going to be, I'd have got started on it earlier. Thankfully, the five year plan I worked out with James to deal with serrated tussock on my place means I'm now on top of most of it, and with the improved grazing and pasture management, the property's productivity is bouncing back.”

Right: An example of the typical serrated tussock infestation at the broad-acre treatment level.



Photograph: Justin Billing



Regional case study 6—Gunning NSW

Michael and Alison Nicholls, Landholders
“Yellangalo”
Gunning

Faced with a daunting population of serrated tussock, Michael and Alison have successfully integrated serrated tussock control into their long-term whole farm business plan.

The techniques for treating dense serrated tussock are well documented, especially for infestations on arable land. The initial techniques are: cultivation and sowing of dense improved pasture, or spraying out the tussock and again implementing a program of improving pastures so that they are capable of out-competing the tussock seedlings.

However, the lessons we have learnt relate less to these and other now well documented techniques and more to the management and financial aspects of a control program.



Photograph: Michael Michelmore

The greatest key to success from our experience has been a logical, methodical approach concentrating on the areas of land that will give the best improvements in carrying capacity and that will have the greatest impact on reducing seed reinfestation in the treated areas.

The treatment of such areas and the implementation of whatever particular control program one has decided upon needs to be rigorously followed up in an ongoing year-by-year spraying program to reduce the establishment of new seedlings and to pick up the plants missed in the original preparation work. Methodical and painstaking attention to fence lines, around trees and along drainage lines will all be necessary to ensure maturing plants are found and treated before the consequences of seed release are found.

Serrated tussock management needs to be as much a routine operation as any other activity in the business. It needs to be seen as a capital cost relating to the value of the land, as the economics of almost any control program are usually well beyond the income generation relating to the improvements in the carrying capacity in anything other than a very long-time horizon.

Controlling and reducing mother-lode tussock infestations requires a commitment of time and money along with a very determined and disciplined management strategy.

We have found there are many willing and very helpful resources in terms of advice and support for experimentation with new ideas, but as already mentioned it is the long-term attention to detail that will make the difference.



PART 3: SPECIAL NOTES

Special note on pasture management

Although this is not meant to be a manual on pasture management (you should refer to an agronomist or pasture management guides if you need this help), information on destroying serrated tussock and making pastures more resilient to reinvasion is provided here.

Contact an adviser on native vegetation management or other conservation expert for advice on native ecosystems.

If serrated tussock is common in your area, manage dense perennial grass pastures so that they maintain 100% ground cover for as long as possible. Established pastures should not be grazed to below 1200 kg / ha of available feed—the minimum for dry cattle before they lose weight. Periodically all pasture species should be allowed to run up to seed. Pastures with less than 80% ground cover are particularly vulnerable to serrated tussock invasion. Crash graze close to the autumn break—only enough to open the pasture and allow sub clover to establish, then lightly graze until spring. If it is impossible to maintain these standards, then seriously consider revegetation with trees as detailed in the section *Special note on establishing trees*.

Total grazing pressure refers to the impact of all grazing animals: you should monitor and manage the impacts of livestock, rabbits, insects, and where possible, wildlife.

To maintain productivity and competitiveness, sown pastures need regular fertilising.

In some districts the economics of pasture re-establishment are not so clear. This may be because the density of serrated tussock in the area is high, the area is otherwise degraded, or the land has naturally low productivity. Alternative land uses, such as revegetation with native plants or other trees such as pines, should be considered seriously. Ridges are typically invaded by serrated tussock. Landholders in these areas should consider revegetation of ridges.

The principles of these management programs may be adapted to protect native ecosystems. Overgrazing of summer growing native grasses is a major factor in preventing them from being competitive with serrated tussock. Many native species such as kangaroo grass are sensitive to heavy grazing.

Similarly, grazing pressure should be reduced to increase the competitive ability of winter-growing grasses. It has been found that in a naturalised pasture that contained summer-



growing and winter growing native species as well as serrated tussock, the proportion of serrated tussock increased substantially under continuous grazing at an average district stocking rate or higher. Limiting grazing when winter-growing grasses were actively growing provided them a greater opportunity to compete with serrated tussock. It is unlikely that such techniques will have a large effect on established adult tussocks within a time period that would be acceptable to most managers. Rather, the benefit of this technique would be to reduce seedling establishment, thereby halting the continued invasion of serrated tussock. It is unlikely that any grazing technique will completely remove all the opportunities for serrated tussock to establish, and therefore spraying or chipping will still be required.

Walk through pastures to assess the composition. If serrated tussock seedlings are widespread and there is a good density of desirable species, then the pasture will need to be managed strategically so that it out-competes the serrated tussock. If the pasture is in poor condition, then pasture renovation (see Section *Treating denser serrated tussock in areas with degraded vegetation*) or low rates of flupropanate might be considered (see *Special note on flupropanate*).

In its first six months, the growth of serrated tussock is very slow: ryegrass and phalaris produce nine and five times as much foliage, respectively.

If introduced pasture species need to be resown, then consider minimising the serrated tussock seed in the soil by using a crop, such as winter cereals for 1 to 2 years. This is especially important if there is a long history of serrated tussock on the site. The subsequent pasture should contain legumes to raise soil fertility and a strong competitive perennial grass, such as phalaris, and it should be adequately fertilised. Avoid grazing the pasture for one year after sowing. In arable and semi-arable productive areas, current pasture improvement technology should be economic over a 7–10 year period. In areas that can only be resown by surface-sown or aerial techniques, also avoid grazing for the first three spring–summer periods.

Seek specialist advice on grazing management.

Seek specialist advice on establishment of introduced pasture in weedy environments.

Reference: Badgery, W., Kemp, D., Michalk, D. and King, W. McG. (2003), *Rethinking the management of serrated tussock, our worst perennial grass weed*, Victoria: 11th Australian Agronomy Conference.



Regional case study 7 – Goulburn NSW

Peter Simpson,
Big Hill
Goulburn NSW

Peter Simpson was the agronomist with NSW Agriculture in the Goulburn district for 18 years. Here he describes how a landholder at a property near Big Hill in Goulburn managed to keep serrated tussock minimised, despite very difficult circumstances. The property was divided into two blocks. The Big Hill native pasture block in particular was covered by medium to heavy serrated tussock on the western and northern sides.

Soil and pasture types—On the house block pastures were based on introduced species and regularly fertilised. The Big Hill block was primarily granite soil and a native grass based pasture (in particular microlaena and wallaby grass) that had been fertilised and over-sown with sub clover.

The Big Hill native block was land class 4/5 and was predominately semi-arable to non-arable. The sown pastures were regularly fertilised with superphosphate at 125 kg / ha / year. The native pastures were generally top dressed with the same rate every 2–3 years.



Photograph: Joanne Ottoway

Pasture targets—The Big Hill native pasture block was under serious threat of serrated tussock reinfestation. The aim on this block was to have groundcover between 90 and 100 per cent throughout the year and minimal residual pasture of 1000 kg of DM / ha.

Livestock targets—Stocking rate was generally conservative in the vicinity of 6 to 10 DSE / ha and the aim was to have all sheep in fat score 3 or more (drought years an exception). Pastures were generally grazed on a long rotation basis and the non-arable areas were always grazed strategically to minimise serrated tussock reinfestation by pasture competition.

Machinery—Farm machinery was kept to a minimum, but the availability of 4WD bikes with small spray units attached was according to the owner “the best thing since sliced bread”.

The owner never stopped spot spraying and always had a tank mixed to enable effective control of serrated tussock and scotch thistles “on the run”.

Weed philosophy—The owner recognised that his location adjacent to uncontrolled dense serrated tussock would always put him at risk for wind-blown seed; nevertheless the serrated tussock density never increased over the 50 years that the owner spent on the property.



The owner said, “You have to be bloody-minded about weed control and never stop attacking them. I know you are running fast to stand still but my aim was to never let any weed problem increase beyond spot spraying or chipping strategy.”

Comment—“I believe where there are small but non-trafficable areas that supplementing the 4WD spray unit with the use of half to one litre trigger spray units at a cost of around \$2 each adds to the flexibility of weed control on the run.”



Special note on establishing trees

Reafforestation can provide serrated tussock control through shading and the reduction of seed dispersal on sites not suitable for pasture establishment.

Direct drilling or the use of tubestock generally provides sufficiently reliable results for the establishment of trees for serrated tussock control. More research is needed before aerial sowing is sufficiently reliable.

Plantations of radiata pine typically provide useful suppression of serrated tussock after about four years and canopy closure around ten years. You will need to consider weed control for the period from before planting up until canopy closure. Ensure noxious weeds are controlled in any forest openings.

Pine establishment costs in hilly country are typically between \$1500 and \$2200 / ha for planted seedlings. Areas will need to be fenced. Planted seedlings are reasonably reliable in areas with higher rainfall. Variable results occur in areas with low and unreliable rainfall.

Aerial sowing of pine seed is estimated to cost over \$1450 / ha after three years. Further research is needed before this treatment can be reliably used.

The cost of direct drilling pine would be slightly higher. The technique will be useful where it is possible to use sowing machinery. Both aerial and direct drilling are relatively cheap and rapid.

Useful results have also been achieved with native trees such as *Eucalyptus viminalis*, *E. melliodora*, *E. camaldulensis*, *E. polyanthemos* and *E. cladocalyx*. Bush regenerators might also consider native shrubs that readily self-regenerate, such as *Acacia*, *Cassinia*, or *Leptospermum* species.

Contact a farm forestry adviser or guide for information on:

- control of weeds before sowing or planting
- ripping, burning or ploughing requirements
- time of sowing or planting
- choice of species or mixtures
- sowing or planting rates
- fertiliser needs
- control of pests
- root additions
- weed control close to trees and between rows
- costs of establishment and care
- expected yields and income.

Contact a local adviser on native vegetation management, or other conservation expert for advice on native ecosystems.



Special note on mechanical control

Hoeing and ploughing can destroy serrated tussock plants.

Hoeing can be done at any time of the year. Hoe before summer to prevent seed production and the spread of seed. Plants with seed heads that have been hoed can be bagged and buried. Moist soil should be removed from the roots. If you are hoeing larger patches, consider scattering seeds of desirable vegetation and fertiliser in the exposed soil to compete with and suppress any serrated tussock seedlings that germinate.

Burning does not destroy all serrated tussock. Burning causes considerable damage to underlying pasture. However, burning is still considered by some landholders where it is necessary to rapidly stop tussock, damage to underlying vegetation is predictable and will be acceptable, AND vegetation replacement and weed control programs can be put in place. Serrated tussock regrowth after burning may be more susceptible to herbicide. However, gain approval to burn from your fire authority.

Slashing before seed set does not reliably prevent all seed production.

Some landholders use burning or slashing before cultivation to stop seed set, and remove excess tussock and grass, as part of a pasture improvement or cropping program.

Cultivate as part of a pasture improvement or cropping program. Mature serrated tussock is controlled well with thorough cultivation. In winter use a disk plough, set to cut 10 cm deep, to turn the tussocks over. Fallow and cultivate in summer to remove the soil from the roots. A chisel plough will not kill serrated tussock, so a broadacre knockdown herbicide, such as glyphosate, will be necessary to kill serrated tussock and other weeds.



Special note on chemical control

Herbicides can be used to kill or suppress both adults and seedlings of serrated tussock.

Spot treatments, boom spray, rotating wipers, or aerial techniques may be used to apply herbicide.

Agricultural chemicals should be applied only by trained and competent people using equipment that is in good condition. Carefully read and follow all labels.

Determine the treatment you need by reading the *Treatment choices guide*.

Herbicides may cause off-target damage. To minimise this:

- identify all plants present before you choose the treatment
- adopt techniques discussed in chemical user training courses
- directly apply the herbicide to the target plants
- use a partly selective herbicide
- apply when desirable vegetation is least susceptible.

When landholders rely on herbicides alone, their serrated tussock programs typically fail—the weed re-establishes from seed in the soil, or blows in. you must reestablish desirable dense vegetation to out-compete seedlings.

Carefully read and comply with the labels of herbicides containing flupropanate or glyphosate. Read and comply with Material Safety Data Sheets, permits and other instructions. Read the sections below for further information on flupropanate and glyphosate herbicides.

A population of serrated tussock that is resistant to flupropanate has been discovered. Landholders can minimise the chance of resistance by using a broad range of techniques and investigating instances where weeds have failed to respond to treatments.

The cause of most failures is application at the wrong time, or poor calibration—always use carefully calibrated equipment and a competent operator. Do not apply herbicides at higher than label or permitted rates.



Special note on flupropanate

Flupropanate is a residual herbicide that is absorbed through the roots. Higher rates of flupropanate kill larger serrated tussock plants, increase off-target damage, and have a longer soil residual activity. Serrated tussock managers should be aware that flupropanate behaves differently with various soil textures and that the length of residual activity is dependent on rainfall. Flupropanate has a long stock withholding period.

Important warnings on labels

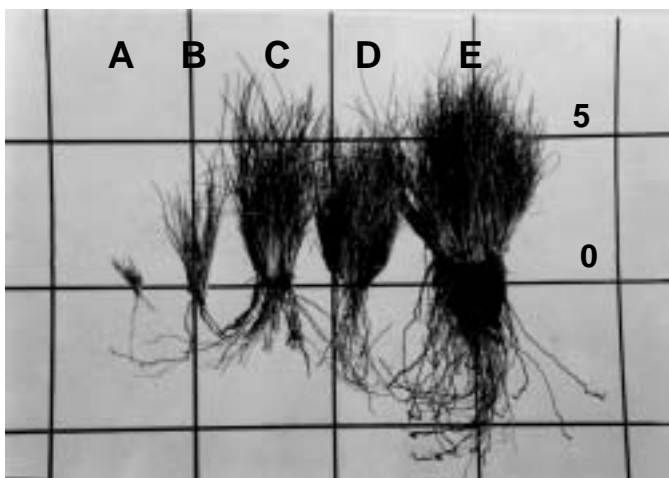
- Do NOT apply this product to steeply sloping sites when applying at rates above 3 L / ha.
- Do NOT allow spray drift on to susceptible crops and ornamentals.
- Do NOT spray near desirable susceptible trees. Obtain advice from an agricultural adviser.
- Do NOT apply in dry winters or severe droughts.
- Do NOT use higher rates than recommended because useful species will be killed.
- Do NOT apply to tussock retarded by burning or grazing.

Mode of action

Flupropanate enters mainly through the roots. Effects may be noticeable after 3–5 months. If flupropanate is applied after early August, serrated tussock is still likely to set viable seed. To prevent seeding, other options can be considered.

Flupropanate and weed size

Seedlings can be selectively removed from improved pastures by shading and the application of flupropanate at low rates. A vigorous pasture must be maintained after spraying. Apply in early spring before pastures bolt in the spring flush, or in summer when improved pastures are dormant. Serrated tussock seedlings will be susceptible if they are less than 10 cm tall and have fewer than 80 leaves.



This photo shows small plants - only plants A and B would be considered as “seedlings” under this recommendation, as they fit the criteria of fewer than 80 leaves and less than 10 cm tall; typically they have a basal diameter less than 7 mm and are less than 18 months old. The other plants (C, D, E) are small because they have had a hard time or have been grazed, but all have more than 80 leaves—they are “sub-adults”.

Photograph: Michael Michelmore



Normally you must search on hands and knees for quite a while to determine whether broadacre treatment of seedlings is warranted.

Selectivity

Flupropanate provides reasonable selectivity. Phalaris, cocksfoot and demeter tall fescue will be affected but will recover. Young subterranean clover will be severely affected. For best selective treatment of these species apply herbicide in October–November and use the lowest rate that will kill the serrated tussock.

Austrodanthonia spp (wallaby grass), *Austrostipa* spp (spear grass) and *Microlaena stipoides* (meadow rice grass) will be killed by flupropanate, especially at higher rates. *Bothriochloa macra* (red grass), *Themeda australis* (kangaroo grass), and *Poa labillardieri* (poa tussock) are generally tolerant at label rates.

Residual activity

A residual effect in the soil provides control of serrated tussock, particularly seedlings, but causes some damage to susceptible non-target plants for a period. This depends upon the rate of application, the soil type, and leaching rains. Carefully follow critical comments on the label and ensure that 100 mm of leaching rain falls before sowing susceptible species.

Effect of soil type

NSW Agriculture recommendations (PER4910 for the ACT only) allow for lower rates of flupropanate on slate, shale and granite soils. Use lower rates on infertile soils and low rainfall areas. Use higher rates on fertile basalt soils and high rainfall areas. Seek an analysis of your soils if you are uncertain.

Application methods

Flupropanate may be applied by spot treatment, boom spray, aerial spray, or by rotating wick wiper, as outlined on the label or special permits.

Flupropanate and bushland

Aircraft in hill country have applied flupropanate without damage to trees such as eucalypts or acacias. Considerable damage will occur to desirable susceptible grasses and other species. You should seek local advice on the tolerance of bushland species in your area. Consider using the lowest feasible permitted herbicide rate.

Benefits of reduced application rates

Recent research has suggested that in certain instances the rate of flupropanate can be reduced. Also, mixtures with other products may sometimes give better results. Application of this research should decrease the amount of herbicide used (resulting in environmental, agronomic and economic benefits) and allow increased flexibility in serrated tussock management. If this research is applicable in your region, then it has been included in the *Treatment choices guide*.

Please see <http://www.apvma.gov.au> to get copies of relevant permits. Please carefully read the label and any permit. Consult your chemical reseller or agronomist for further information.



Special note on glyphosate

Glyphosate is an effective option to kill actively growing serrated tussock. Glyphosate is non-residual and has no stock withholding period.

Glyphosate is a non-selective herbicide. Off-target damage can be substantial. Carefully use a direct spray or consider using a shielded nozzle when spot spraying. Use broadacre boom spray treatments as part of a pasture improvement program prior to sowing pasture or crop. In this situation glyphosate is the preferred choice because of no residual activity. Crops and pasture can be sown soon after spraying. Use ropewick application on pastures to prevent serrated tussock and other weeds from seeding only if there is a height differential between the pasture and the weeds. In grazing country, replacing serrated tussock with competitive species, strategic grazing and ongoing pasture management is the long-term answer to serrated tussock management. To achieve best results, serrated tussock must be actively growing and stress free when sprayed. Critical comments on the label and any permit must be read carefully. Variable results will occur if plants are stressed by adverse environmental conditions. Higher rates are required to kill tussock on high fertility soils such as basalt and under less than desirable growing conditions.

Research carried out by NSW Agriculture in the Southern Tablelands and on the Monaro between 1999 and 2003 has shown that mature serrated tussock plants can be killed with rates as low as 980 g / ai / ha at any time of the year. To get good results at these low rates plants must be actively growing. Use equipment that will give good spray coverage of the entire serrated tussock plant. A medium spray droplet applied at rates of 100 L water / ha has given excellent results. Do not spray on moist, frosty, or cloudy days. In winter spray after the dew has gone and before noon. As large plants shelter smaller plants, allowing the smaller ones to survive, repeat treatments will be necessary for full control. Ensure that serrated tussock plants are not covered in trash such as old seed heads and excessive dead leaf material. Burning before herbicide application can be used to remove trash but to ensure adequate leaf uptake of the herbicide the serrated tussock must have recovered adequately before you apply the glyphosate.

Associated useful pasture species can be retained when using glyphosate for serrated tussock control. However, landholders considering this option need to develop a good understanding of the growth cycles of the species present, including both serrated tussock and background plants, to time the glyphosate application for maximum efficacy while minimising its effect on desirable species. Glyphosate applied in an annual pasture situation after the annual species have set seed in late spring and before they emerge in autumn will have no effect on these species. Likewise, damage to perennial species such as phalaris may be minimised by applying glyphosate when they are completely dormant in summer, or with some native species, when they are frosted in winter.

Please carefully read the label and any permit. Please see <http://www.apvma.gov.au> to get copies of relevant permits. Consult your chemical reseller or agronomist for further information.

Further reading: Verbeek, B., Ayres, L. and Leech, F. (2001), *Using Glyphosate for Serrated Tussock (Nassella trichotoma) Management in Southern Tablelands of New South Wales*, 11th Biennial Noxious Weeds Conference, 4-6 September 2001, Moama NSW, pp. 206-9.



Community and landscape management programs

Serrated tussock is a weed with serious community implications: it spreads readily between paddocks and properties throughout a region; many common land management strategies allow the weed to establish; vigorous and ongoing treatments are needed; and some infestations may appear daunting or irreversible and beyond the abilities of individual landholders to control. Communities must respond to address this difficult weed.

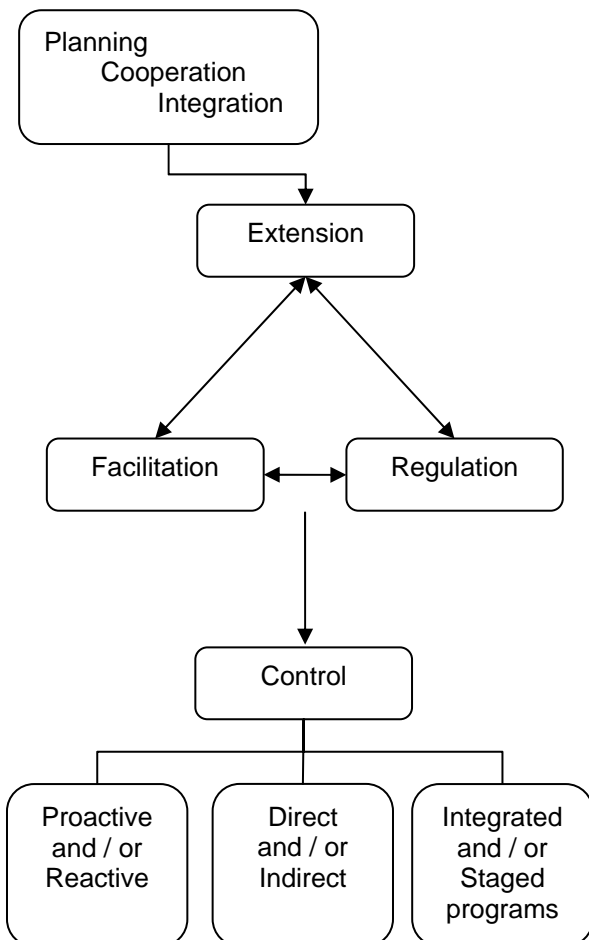
The National Strategy for Serrated Tussock has three goals:

Managing the weed is about ensuring that serrated tussock is controlled.

Reducing the impact is about making landscapes more resilient to reinvasion.

Community approaches is about ensuring people have the capacity to work together to achieve the first two goals.

Management of each infestation of serrated tussock needs to address these three goals and is best approached by a planned combination of extension, facilitation, and regulation.



Each district with serrated tussock needs to carefully plan its approach to determine how to ensure that the best serrated tussock management occurs in the field and to help maximise opportunities from regional, state and national programs. The diagram illustrates how planning and coordination is needed to develop and implement community programs. These programs typically need a combination of extension, facilitation, and regulation. These are outlined in the following sections. The outcome of these community programs should be improved control of serrated tussock and landscapes that are more resilient to invasion.

What threat is serrated tussock to you?

Climatic suitability will determine whether serrated tussock can survive and pose a threat in an area if it were to be invaded. Climate modelling tools can assess this threat.



By raising the awareness of communities in vulnerable areas of the threat posed by weeds, we can take precautions to prevent invasion, and to identify invasion sites early.

Every community with a serrated tussock threat should have a planned coordinated approach.

Landscape scale management

Management at the landscape level is concerned with minimising invasion between paddocks and properties. Current legislative frameworks are largely concerned with ensuring that adequate control work is undertaken on all properties to minimise the invasion threat from uncontrolled infestations. Minimising the invasion threat at this scale can take the form of direct control of infestations (killing plants), making the landscape resistant to wind dispersal, and invasion-proofing through managing for dense and vigorous desirable perennial vegetation. The success of directly killing plants depends upon how thoroughly the plants are controlled across clusters of properties.

Community programs often include field days and demonstrations, equipment sharing, and subsidies for treatments. The biggest impact communities can make is to develop schemes that promote dense pastures, native vegetation, or forests.

At the very least, communities should adopt the simple network liaison systems of:

- inform;
- acknowledge;
- recommend.

Communities that adopt these simple communication processes will reduce conflict.



Extension programs for serrated tussock

The more complex an issue is, the more information people may need before starting a major program. Information must be extended to serrated tussock managers to meet their needs. No single message is enough, and messages may need to be repeated.

Weed control extension includes personal visits, group talks, pamphlets, media releases, demonstration sites and field days. Extension improves knowledge, attitudes and skills. It helps people to know that it is right to control weeds and the right way to control them.

Extension: to enlarge the scope of, or make more comprehensive, or influence.

Programs for extension and awareness need coordination from the local to the national scales. Preparation of extension materials takes considerable time and can be costly. Extension officers should find out what existing materials are available from their regional, state or national serrated tussock coordinators. However, extension officers should also consider the benefits of having an extension package that has been specially prepared for their group's needs – a simple pamphlet titled, for example, 'Serrated tussock control in the Cooma–Monaro Shire' may have more influence to people from that area than a State-produced colour pamphlet.

When planning an extension program your group should consider:

- What is the key message?
- What other messages could particular market segments require?
- Who should provide these messages?
- What variety of methods is necessary to deliver these messages to the group?

The key messages include identification, understanding the impact, control, regulations, and planning.

Identification is the first step towards preventing and controlling serrated tussock. Landholders need to be able to identify serrated tussock before it has become an obvious problem in their area.

Classification of the community into groups so that appropriate messages go to appropriate people is called 'market segmentation'. To organise serrated tussock infestations into manageable areas we need to segment the community according to type of landholding, current infestation level, and land-use constraints. One important aspect in planning the education market segments is identifying what triggers each group of stakeholders to act against serrated tussock. Possible triggers include:

- recent acquisition of land in infested areas
- property planning for higher levels of production



- regulation.

There needs to a balance when determining **who should provide each message**. Where ever practicable the message should come from people closest to the landholders who will implement the advice. From time to time, however, the message should come from the people who completed the original research. The researchers should always make sure that the local agronomists and weeds officers understand the message and how it could be used locally. Also consider the other people who can help present each message, such as chemical resellers, or Landcare staff.

The **variety of methods** used to get the message across include written material (handouts, Internet, media releases), demonstration sites, signage (pictured right), landholder examples, forums and seminars. There are some people who are best motivated by a one-page pamphlet; others want detailed texts, such as a bulletin. Some even want to go to scientific conferences to help confirm that they are doing the right thing.

Photograph: Michael Michelmore



Repetition is normally needed from a number of message providers using a variety of methods.



Regional case study 8 – Armidale NSW

Justin Billing, Serrated Tussock Project Officer,
New England Tablelands Noxious Plants Country Council,
Armidale NSW

This successful extension program has identified the key messages and has determined alternative methods to deliver the messages to each 'market segment'.

Because of the relatively low incidence of serrated tussock plants and patches in the Northern Tablelands region, identification is one of the greatest problems associated with managing the weed. The New England Weeds Authority and Southern New England Landcare address the issue of serrated tussock identification through weed identification workshops and field days, Landcare groups and other landholder meetings, sale days, and mobile displays at a range of rural outlets. Workshops and field days are conducted by the district weeds officers or field staff of NSW Government and non-government organisations—including National Parks and Wildlife Service, Agriculture, Department of Infrastructure, Planning and Natural Resources, State Forests, Telstra, Rail Infrastructure Corporation and Country Energy—as well as by local rural outlets, spraying contractors and landholders. Regular media releases are also published in local and regional newspapers, and interest group newsletters, outlining the different identification characteristics of serrated tussock plants throughout the year.

Right: District Weeds Officers James Browning and John Gordon explaining to field staff the key identification characteristics and control techniques for serrated tussock on the Northern Tablelands, NSW.



Photograph: Justin Billing



Facilitation / Landcare programs

Facilitation is an essential ingredient in ensuring a community's approach to serrated tussock control is integrated and coordinated.

People who can assist with facilitation include:

Council weed officers;
Government agency representatives;
Community group representatives; and
Landholders.

Facilitation means that the land manager is provided help to find a spray contractor, or to get the job done. This is the “carrot”, or the “oil can.” Facilitation includes arranging contractors, equipment sharing, organising group control schemes, subsidising chemicals, helping with district or property planning, and the Landcare approach.

Facilitation: to make easier or less difficult; to support.

Recognition

The first step towards communities working together to control serrated tussock is one of landholders recognising that their serrated tussock situation may be a bigger problem than they can handle on their own, and realising that they need to work with others in their local areas to have any success in controlling serrated tussock. Landholders need to make a number of ‘discoveries’ about Landcare and the community serrated tussock problem.

Who can participate in “Landcare” facilitation? “Landcare” is not necessarily confined to established, government-funded bodies. Landcare coordination and management can include individuals, groups of neighbours, community groups and groups made up from surrounding areas.

How can individuals find help? Local council weed officers, state government departments and Landcare Coordinators will be able to provide you with information on serrated tussock control.

What questions should you ask when seeking help? Examples are:

- “How can I get information on serrated tussock?”
- “Who can help?”
- “Can you put me in touch with others in my area who are working on serrated tussock?”

What to do next? Examples are:

- Ask your neighbours what they are doing about serrated tussock.
- Attend field days, workshops or farm walks.
- Have a barbeque and invite a specialist to speak.
- Visit other community groups who are working on serrated tussock.



- Seek out someone who has been successful in their campaigns against serrated tussock and ask them for advice and ideas.
- Don't forget to include serrated tussock control in your farm planning.

Planning. All of the following types of planning can be done on an individual landholder level as well as on a community group level:

- Map serrated tussock infestations.
- Which areas need attention first? Remember to prioritise when planning your control strategies.
- Work out which control strategies you will use.
- What sort of commitment will you make to serrated tussock control? Develop a long-term plan.
- Pasture production management: how can you make serrated tussock management a financially viable part of your whole farm plan?

What actions can you take? Think about:

- Equipment sharing.
- Group control schemes, such as bulk purchase of herbicide.
- Group training and education, such as farm chemicals use courses.
- Share information on available contractors, contacts and ally landholders.
- Build relationships with public land managers who own adjoining lands by including them in group activities. Let them know which areas of public land are of most concern to you or your group.
- As a community group adopt a “mother lode”—a hard to manage area or seed source—and work together on this area.
- Find out if there is any funding or volunteer help available to your area for controlling serrated tussock. Be aware that there may be public liability issues, occupational health and safety issues or insurance issues involved with volunteers working on your land—they effectively become employees.
- Consider how your group could be supported by external funding opportunities, such as Envirofund. The Australian Government Envirofund is the local action component of the Commonwealth Government's \$2.7 billion Natural Heritage Trust. Envirofund does not normally fund direct control of weeds on private land, and will fund control on public land only in limited circumstances. However, several groups with serrated tussock have successfully received funding by focusing projects on the main objectives of the Natural Heritage Trust: biodiversity conservation; sustainable use of natural resources; and community capacity building and institutional change. For more information, visit <http://www.nht.gov.au/>.

This section prepared by Andrena Jones, with support from Geoff O'Connor, Sheryl Wright, Cathy Crawford and Michael Michelmore.



Regional case study 9—Crookwell, NSW

Robin Taylor,
CRC for Australian Weed Management
Adelaide University,
Adelaide, SA

In the Southern and Central Tablelands of New South Wales, landholders are trying to develop improved control strategies for perennial grass weeds. This approach includes optimising the use of herbicides, grazing management and pasture establishment, and assessing the use of forestry as a potential control for serrated tussock and other perennial grass weeds.

The area around Crookwell in the Southern Tablelands is severely affected by serrated tussock. More than 60% of grazing land is infested, 10% severely (greater than 80% cover) with serrated tussock. With the help of Natural Heritage Trust funding, the Upper Lachlan Landcare network is trying to break the cycle of spraying and reinfestation. They have negotiated agreements with landholders in the district to suppress serrated tussock and re-establish competitive vegetation. This will involve a change in management practices whereby landholders recognise that to control serrated tussock they need to maintain competitive background vegetation.

On one 200 ha site covered by tussock grass on the side of a steep hill, helicopter spraying was used to reduce the level of tussock grass seed that blows all over the district. The site was then aerially seeded with a mixture of phalaris, cocksfoot and clover, species recommended by local agronomists to persist in hot dry summers, out-compete serrated tussock, and establish by aerial seeding. In some places native trees and bushes will also be planted as windbreaks to reduce the amount of seed dispersed through the district by wind.



Regional case study 10—Bacchus Marsh, Vic

Peter and Fiona Bailey,
Pentland Hills,
Bacchus Marsh, Victoria

Peter and Fiona have realised the importance of facilitation and regulation to assist with the control of serrated tussock on their own property and in their local community.

What was the land like 10-20 years ago?

Peter and Fiona Bailey moved onto their 69 ha Pentland Hills property (just near Bacchus Marsh) in 1992. They moved in thinking they had acquired a “real bargain” when they were looking for only 10 acres and got an extra 160 acres for about the same price at a mortgagee’s auction. It wasn’t until a few months later that they found out their “native grasses” were, in fact, serrated tussock plants, and that this serious weed covered nearly 100 per cent of their property.

On some days when they had a good westerly wind they couldn’t get out of their back door for a “snow drift” of serrated tussock seed. It was so thick they had to go out the front door and clear it away before they could use the back door again.

Peter and Fiona were thinking their pastures could support at least 10 cows, a few sheep and their horses on the property, but reality hit early and they realised that they would be lucky to graze two horses on their entire property.

What triggered a reason to change?

The first trigger for change came in 1995 when the local Pest Plant and Animal (PPA) Officer started inspecting the properties in the area and immediately administered an enforcement approach on this property. It took a few years before anything really changed because Peter and Fiona didn’t know what to do or where to start, or how serious their situation was.

Then in 1998 a new Land Protection Act was passed. It insisted that properties must develop a whole farm plan and which outlined a program to remove both the current plants and any seed bank. Peter and Fiona believed they had no other option than to burn all the paddocks. This approach caused an enormous amount of grief, as not only were their paddocks completely black and lifeless but they had lost the surrounding fences and many small native trees they were hoping would cover the farm in years to come. At this stage the Departmental officers kept sending prosecution letters to the Bailey’s threatening to take them to court.

It wasn’t until a couple of years later through their local Landcare group, that the local Landcare facilitator and a new enforcement officer organised some funding and coordinated an aerial spraying exercise across the region. “All of a sudden instead of hitting us over the head with a big stick, they said—here, we’re going to help you”. The



change in personnel and approach really made a huge difference. In particular, the monetary support administered through the Landcare group rapidly progressed the management program.

What is the land management like today?

Today the Bailey's have built the management of serrated tussock into their farm program. They spot spray across the property (particularly over the flat country) for about one hour each week to ensure any new plants are killed early and quickly. They plan an annual exercise with an 800 L spray unit, borrowed through the Landcare Group, for a full week of spraying over the steeper country. Peter and Fiona will also work in with the other Landcare group members whenever there is another aerial spraying exercise.

What are the benefits and the costs of this management?

The chemicals needed to fully suppress the tussock plants and seeds cost a lot of money (approximately \$14,000 for aerial spraying). The Bailey's maintain that they would not have been able to afford that sort of "investment" (50% subsidy of chemical) if it were not for the support through the program. The additional costs occur in time spent continuing the spray program and ensuring any new plants are dealt with rapidly. Without the support of their neighbours (all doing their bit) and the Landcare group it would be almost impossible to get on top of the problem.

The benefits of all the work the Baileys have done is that their property is now not completely covered in serrated tussock and they are able to graze five horses instead of two all year round, even in a drought. They have also seen some of the native trees returning after the devastating "burn" experience. A final advantage has been getting the neighbours to work together on this problem rather than trying to sort it out on their own.

What if the Serrated Tussock Program finished today?

"In the short term there would be no effect, but in the long term there would be enormous problems because there won't be anyone to coordinate the activities next spring". Peter and Fiona are very aware that if the program finished they would continue spraying the areas they can get to, but the steeper, rockier country would start to build up seed stores and subsequently new plants would emerge over the next year that would not be controlled. "Unless we keep at it, it will just come back!", says Peter.

Where does the Serrated Tussock Program need to go in the future?

The Baileys see a real need for the Serrated Tussock Program to continue and to also expand it's repertoire to look at what you do with the land once the serrated tussock has been controlled. The Program needs to explore and advise landholders on what can be resown to reduce erosion, eliminate further weed infestation and possibly provide some sort of nutritious feed option for grazing stock.

"I would personally like to see a 'bigger picture' program starting to happen...serrated tussock is just the first step, we have to start looking beyond serrated tussock and managing the land for what happens next", says Peter Bailey.

Source: Department of Primary Industries (2003), *Serrated Tussock Program Case Studies*, Victoria: Department of Primary Industries.



Regulation programs

Serrated tussock is a noxious weed throughout most of its potential range. This means that some legal proceedings may occur if the weed is not adequately controlled.

As serrated tussock spreads easily, has a very large impact and, once established, is difficult and costly to control, it is generally considered that landholders have a moral obligation to control it. State laws require landholders to control noxious weeds like serrated tussock.

Regulation: to control or direct by rule, principle, or method.

Regulation means that the landholder knows that if the job is not done, then some enforcement will be used to punish the landholder or to get the job done. This is the “stick”.

Regulations are often presented as policies that outline minimum accepted practices or benchmark levels of control. Control authorities need to carefully consider and plan how their regulatory programs will be implemented. A regulatory program that is carefully presented and meets the needs of most of the community will have a high success rate. Considerable conflict can be anticipated when a regulatory program is presented as ‘hostile and draconian’.

To reduce conflict, control authorities should:

- discuss the weed situation, environment, and community needs with community weed managers
- determine the ultimate goals of their regulatory programs and the required stages needed to achieve those goals
- determine priority areas and provide resources and commitment
- implement their programs in collaboration with extension and facilitation programs
- regularly review progress.

Landholders should be encouraged to consider developing a program for managing serrated tussock on their property and discussing it with their weeds officer. When a landholder develops their own program, without any regulation, then they will feel they have “ownership” of the plan—people tend to implement plans that they develop. The more that people are told what to do, the more they may resent implementing the program. Regulation should be presented as a ‘last resort’, but, a weed control authority that fails to define what the ‘last resort’ is may fail to meet the needs of the community.

Noxious weed programs for serrated tussock through Australia

Control requirements vary between and within states. Landholders should discuss control requirements with their weeds enforcement officer.



In New South Wales, the *Noxious Weeds Act 1993* requires landholders to control serrated tussock. Enforcement of the Act is the role of shire councils. Weeds officers of the council may inspect land and apply the regulations.

In the Australian Capital Territory serrated tussock is a 'Declared' pest plant under the *Land (Planning and Environment) Act 1991*. The declaration requires that a plan be prepared to control the spread of serrated tussock.

Landholders in Victoria must comply with control requirements set under the *Catchment and Land Protection Act*. Enforcement of the Act is the role of Catchment and Land Protection Boards. Catchment Management Officers of the board may inspect land and apply the regulations.

In Tasmania serrated tussock is a declared weed under the *Weed Management Act 1999*, and landholders are required to undertake control measures. For all declared weeds, a weed management plan describes the level of control; depending on distribution this may vary throughout the State. Weed inspectors appointed by local councils and the state government will use the weed management plans to provide direction and guidance in undertaking their regulatory duties.

In both South Australia and Western Australia, serrated tussock is absent. Weed control authorities have declared the weed to have the most vigorous regulatory program. This puts them in the position to be able to take swift and complete actions to eliminate the weed if ever it is found.

Successful regulatory programs for serrated tussock

Generally, the more aggressive programs have succeeded, while serrated tussock infestations have expanded in areas with poor regulatory programs. Regulatory priorities will depend upon the situation—type of landholding, current infestation category, resources available, land capability, agricultural enterprise / landuse and its cash flow, landscape and vegetation type, ease of control, likelihood of spread. For each 'market segment' determine the minimum accepted practice by asking: 'If a landholder fails to implement best practices, what are the consequences for:

- their own land
- their neighbours land
- land in the district?'

Possible solutions include

One weed, one notice. In areas where serrated tussock is still scattered and at the spot spraying stage, then the Weeds Officer will be doing the landholders a service by forcing them to control the weed. In arable areas, where the land could be cropped or vegetation destroyed then resown, there should be few excuses for allowing serrated tussock to get out of hand. If a single serrated tussock plant is seen, then the landholder gets a legal notice to comply.

Protect valuable non-arable areas. Valuable non-arable areas, such as areas of high conservation value, that are relatively free of the weed, consideration should be given to keeping the weed out for as long as possible. Landholders could develop plans to protect these areas, and regulation could be used to keep the landholder accountable to the plan.



Implement staged programs. Where a landholder cannot reasonably get to every serrated tussock plant every year, then a staged program should be agreed to. This may be appropriate in some of the variable landscapes where serrated tussock is relatively common. There are large areas where the legal requirements could never be fully met in a single year. Instead, a staged program is agreed on that annually makes the best progress towards meeting the legal requirements, such as: keep clean areas clean, use low stocking rates, apply fertiliser, plant pine trees, plant wind breaks, aerially seed pastures, control near the boundaries, carefully control near areas of environmental significance. For - instance, control in north-east paddocks this year, then in north=west paddocks next year. Where there are patches that can reasonably be spot sprayed or are arable, then the 'staged program' might be close to the 'one weed, one notice' standard. Landholders could develop plans for these areas and regulation could be used to keep the landholder accountable to the plan. Weed authorities should seek legal advice.



Regional case study 11—Rowsley Valley, Vic

Graham Simpson,
“High Plains”
Rowsley Valley, Victoria

Graham has been fighting serrated tussock on his property for 20 years, just to stay on top of it. It is only through continuing control that his land has not lost its production and economic value.

What was the land like 10 or 20 years ago?

Graham is a first generation farmer, and he first bought his first 160 ha in the mid 1950's. The property was then expanded in 1962 by purchasing an adjoining 690 ha. The new land Graham acquired was largely unimproved and rabbit-ridden, with older sandy-clay soils that were prone to erosion and degradation.

It was in 1983 that Graham first noticed a small corner of his property had some serrated tussock on it, “but nobody took it seriously back then—not us, not the department”. At this stage the tussock didn't move much—it seemed under control. Then, in 1988, after a series of dry years with late spring and summer rains, the tussock just “took off”. The tussock has manifested itself at an incredible rate ever since.

“Little did we know how it was going to descend upon us in such horrific proportions”, says Graham.

It became obvious to Graham that the seeds had spread over his property many years beforehand, and were just waiting for optimal growing conditions in order to germinate. Ever since then it has been a constant management issue, as surrounding properties have allowed their tussock to set seed and continually infest Graham's property. Even very recently Graham has noticed seed continuing to blow over his property.

“I'll never forget the day, the 21st of December 2001, the tussock just blew over across our place....it was even up in the power lines, it was caught in the fence, it went 700 metres across our place and blocked up against the fence...slowly it would make a ramp for itself and blow over until it hooked-up in the next fence. From the air you'd think you were in England with all these hedgerows!”, Graham said.

What triggered a reason to change?

Graham started managing his serrated tussock early compared with many others in the region. The main trigger for changing his management practices was that he could see that his business was going to “go down the gurgler” if he didn't do anything. This realisation was not shared with all the neighbouring properties, and over the years Graham has seen a lot of anguish and angst expressed in the community over who is controlling the weed, who deserves the grants, and the effectiveness of the compliance orders.



For a lot of people it was ultimately the efforts of the compliance officer that triggered a change. With someone constantly “on people’s backs” it meant that eventually something was done. Unfortunately, this took some time and potentially two seasons of seeding had occurred in the district before those untreated areas and non-compliant landholders were managed.

“It’s been an unhappy saga, and it’s continuing to be. A lot of spraying was done last year and the year before, and that’s just settled [the serrated tussock] down, but it will be back in three year’s time”.

How has the land management changed over the years?

Over the years Graham has employed several methods to control the serrated tussock spread. Back in 1989–90 Graham had some fixed wing aerial spraying done, but only in the worst areas because of the expense of the chemical. Although this method managed some parts of the property it still meant there was a massive seed set, and by 1995 Graham’s place was declared at Level 2. It was with this shock that Graham decided to get “fair dinkum” about managing this weed.

Graham aerially sprayed 50 ha in 1996 and another 60 ha in 1997, and followed this up with an average of 2 days / week spot spraying from 1999 to 2001. From this concerted effort Graham thinks he has the weed to a “manageable” point—“under control is not the word”. Over that period of time Graham had sprayed 69 000 L of mixed glyphosate (RoundUp®) in spot spraying and he has still sprayed roughly at the same rate since then.

Today Graham gets 12 ha aerial sprayed every three years (where it is too steep to spot spray) and continues spot spraying at a fairly regular rate to keep on top of it all.

The next option that Graham took was to cultivate some areas and put crop in, out-competing the tussock. And finally his next project will be to start some revegetation blocks around the property that will “do their job, but they are not going to get rid of it”.

What are the benefits and the costs of this management?

The real benefit of this management has meant that Graham’s business has not “gone down the gurgler”. The whole experience has been a difficult one for Graham, his family and the community.

Graham has had to spend an enormous amount of money on this aspect of his business, instead of on something more constructive like soil erosion control and top dressing.

Graham has it worked out that to this point he has spent about \$50,000 on chemicals and that doesn’t include the expense in time over the years. “With the money I spent I could have flown around the world twice first class.”

What if the Serrated Tussock Program finished today?

Graham knows that the Rowsley Valley area has been particularly looked after through the Serrated Tussock Program, and he realises that the district has been very fortunate with grants and rebates being offered through the program and through Landcare.

Graham sees that if the program is stopped the problem would simply return to the way it was. It is high probable that one or two people will not manage their own tussock spread



and the whole district will be infected once again. As Graham sees it, if the program stopped, within 3-4 years all the millions of dollars that have already been spent in the program would be wasted... "it's just got to be kept up".

"I would say the program's got to go for another 15 years at least. In an ideal world if everyone continued the spraying program we'd get rid of it... I'm convinced it is going to take 15 years".

Where does the Serrated Tussock Program need to go in the future?

From Graham's point of view, the program needs to keep going the way it has been going. The compliance efforts need to be kept at the level they were in September 2002, because if no one keeps reminding landholders and enforcing the rapid change required, then the spread will continue at its current rate.

A major barrier for many people continuing any sort of control is the cost of the chemical, so rebates, incentives and grants are also an essential part of the program for the future. As Graham says, "It's a case of the stick and the carrot approach".

"This is a weed that should never have happened... it's so easy to kill... why we've got it, and why we continue to have it, is due to the huge cost of the chemical."

Source: Department of Primary Industries (2003), *Serrated Tussock Program Case Studies*, Victoria: Department of Primary Industries.



Special note for serrated tussock advisors

This section contains information that may be useful for people who provide advice to land managers. It contains some in-depth information that may not be readily available in the literature and comments on why some treatments are not included.

Herbicides

Not all warning statements, directions and critical comments have been included in this document. Chemical users have been advised to refer to them. You must obtain, read and understand all labels, material safety data sheets, and permits before providing advice or comment.

Flupropanate

Under the National AgVet Chemicals Code, label directions may be varied to apply lower than label rates unless specifically prohibited. In the ACT and NSW label directions may be altered, according to permits issued by the APVMA and pesticide laws. The permits may allow for off-label recommendation and application of herbicide in ACT and NSW for:

- application at alternative times
- selective removal of seedlings from improved pastures
- application by rotating wiper or other application
- spray topping to prevent seeding
- application in alternative situations.

Tank mixing glyphosate and flupropanate

NSW Agriculture research has found that glyphosate reduces the effect of flupropanate; it is best not to mix them. It should be added only as a marker when absolutely necessary. If quick brown-out is desired close to seeding, then use straight glyphosate or a mixture of flupropanate and glyphosate.

Soil types

In NSW and ACT, recommendations may be made to use the lower rate of flupropanate on light infertile slate, shale and granite soils and to use the higher label rate on heavier basalt or clay soils. Herbicide rate should be based upon the soil texture. This should be tested using normal field techniques.

Glyphosate

The permit PER4910 allows for off-label application of glyphosate products in the ACT for:

- spot spraying
- spray topping to reduce seeding
- broadacre treatment in preparation for pasture improvement or cropping
- application by rotating wiper.



Glyphosate labels describe a spray topping treatment to prevent seed head emergence. The treatment is normally used as part of a pasture improvement program. The alternative treatment—glyphosate at higher rates—provides better control of serrated tussock and better preparation for pasture improvement.

Diquat as a marker with flupropanate

Diquat spray mist that is inhaled can damage the lungs. This is essentially a risk associated with hand spraying. Spot spraying bipyridyls is a high risk application method and NOT recommended, not only because of inhalation but also dermal exposure. Extensive personal protective equipment is required for spot spraying, and this brings with it the associated risk of heat stress in most conditions. The treatment is not registered or permitted and is therefore illegal.

Other treatments for serrated tussock control

2,2-DPA is registered for control of serrated tussock but does considerably more damage to desirable species than flupropanate. At the lower label recommended rate in combination with fire, 2,2-DPA can be a useful control measure.

In pine forests, the use of hexazinone (e.g., Velpar®) might be carefully considered. Rates required are very high and chances of off-target damage are considerable.

Steam and hot water have produced variable results. They are not applicable to broadacre treatments, kill desirable plants and soil biota, are expensive, very dangerous and use considerable energy.

Biodynamics and other organic treatments have been considered. No quantitative data for the results of such treatments exist.

Please see <http://www.apvma.gov.au> to get copies of relevant permits.



RESOURCES

There are many people who can provide competent advice on serrated tussock management. Local farmers that have been successfully controlling the weed are often a good starting point. Also discuss weed control with your agronomist, weeds officer, or chemical reseller.

Texts in the following bibliography were used in the development of this fact pack or are referred to.

- Agriculture & Resource Management Council of Australia & New Zealand, Australian & New Zealand Environment & Conservation Council and Forestry Ministers (2000), Weeds of National Significance Serrated Tussock (*Nassella trichotoma*) Strategic Plan, Launceston: National Weeds Strategy Executive Committee.
- Auld, B.A., Coote, B.G. (1981), Prediction of Pasture Invasion by *Nassella trichotoma* (Gramineae) in South East Australia, *Prot. Ecol.* 3.
- Badgery, W.B., Kemp, D.R., Michalk, D.L, King, W.McG. (2002), Competition Between Native Grasses and Serrated Tussock at Low Fertility – Initial Results, *Plant Protection Quarterly*: 17(3).
- Badgery, W., Kemp, D., Michalk, D. and McGKing, W. (2003), Rethinking the Management of Serrated Tussock, Our Worst Perennial Grass Weed, Victoria: 11th Australian Agronomy Conference.
- Campbell, M. (2003), Serrated Tussock – Identification and Control, Agfact P7.6.54, 1st ed., Orange: NSW Agriculture, <http://www.agric.nsw.gov.au/reader/18121> (accessed August 2003).
- Campbell, M.H. (1997), Effect of Low Rates of Flupropanate on Selective Removal of Serrated Tussock, *Plant Protection Quarterly*, 12(4).
- Campbell, M.H., Nicol, H.I. (1996), Establishing Trees on Non-Arable Land to Control Weeds, in Proc. 11th Australian Weeds Conference, Melbourne.
- Campbell, M.H., Vere, D.T. (1995), *Nassella trichotoma* (Nees) Arech., in *The Biology of Australian Weeds*, Volume 1, Melbourne: R.G. and F.J. Richardson.
- Campbell, M.H., Vere, D.T., Nichol, H.I. (2002), Long Term Control of Serrated Tussock (*Nassella trichotoma*) by Applying Flupropanate at 3 Year or 10 Year Intervals, *Plant Protection Quarterly* 17(2).
- Dellow, J.J. (2003), Herbicides for Control of Serrated Tussock and Various Perennial Grasses. Agnote DPI469, Orange: NSW Agriculture.
- Dellow, J.J., Scott, M.C. (2002), Weed control in lucerne and pastures 2001/2002, Orange: NSW Agriculture.
- Department of Primary Industries, Victoria (2003), Serrated Tussock Program Case Studies, Victoria: Department of Primary Industries.
- Department of Primary Industries, Water and Environment, Tasmania (2002), Serrated Tussock (*Nassella trichotoma*), <http://www.dpiwe.tas.gov.au/inter.nsf/WebPages/RPIO-4ZV3UE?open> (accessed August 2003).
- Harden, G.J. (ed) (1993), *Flora of New South Wales: Volume 4*, Sydney: New South Wales University Press.



- Keith Turnbull Research Institute (1998), Serrated Tussock, Victoria: Department of Primary Industries, Landcare Note PP0005.
- Keith Turnbull Research Institute (2003), Serrated tussock - Identification, Victoria: Department of Primary Industries, Victoria, Landcare Note LC0175.
- Lamp, C.A., Forbes, S.J., Cade, J.W. (1990), Grasses of Temperate Australia, Melbourne: Inkata Press.
- Mudford, D. (2000), Serrated Tussock: Annual Control Calendar, Victoria: Department of Primary Industries, Landcare Note PP0102.
- Taylor, U. (2003), Tasmanian Serrated Tussock Information Kit, Tasmania: Department of Primary Industries, Water and Environment.
- Taylor, U., Sindel, B. (2000), The Pasture Weed Management Kit: A Guide to Managing Weeds in Southern Australian Perennial Pastures. Adelaide: CRC for Weed Management Systems.
- Verbeek, B., Ayres, L., Leech, F. (2001), Using Glyphosate for Serrated Tussock (*Nassella trichotoma*) Management in Southern Tablelands of NSW, '11th Biennial Noxious Weeds Conference', Moama: NSW Agriculture.
- Wheeler, D.J.B., Jacobs, S.W.L., Whalley, R.D.B. (2002), Grasses of New South Wales, Armidale: University of New England.

