Chapter 3

Managing gamba grass

Rowena Eastick

Foliar spraying dense gamba grass in the Northern Territory.

At a glance

- **Limit the spread, establishment and seed production of gamba grass.**
- **There are limited ways to prevent and control gamba grass, but they're effective.**
- **Consider gamba grass control when planning other land management activities, such as burning.**
- **Be flexible – manage gamba grass when it's optimal to do so, rather than only when it suits you.**
- **On grazed lands, establish and maintain competitive pastures and adopt sustainable grazing management practices.**
- **Where gamba grass is used for grazing, reduce seed production and seed spread through rotational grazing and adoption of hygiene protocols.**
- **Burning, slashing or grazing won't reduce gamba grass density permanently – it will grow back and is likely to spread it further.**
- **Permanently removing gamba grass is better and more cost effective than suppressing it.**

This chapter outlines current methods that are available or are being used to control gamba grass. Not all these options will be suitable for your situation, so refer to Chapter 2 ('Setting yourself up for success') and follow the steps to help you choose the right control methods. Chapter 4 ('Case studies') also provides examples of where land managers have put this theory into practice.

This chapter draws on information from the following information sources:

- NT Government https://nt.gov.au/weeds
- Territory NRM https://www.territorynrm.org.au/
- Qld Department of Agriculture and Fisheries https://www.qld.gov.au/search
- WA Department of Primary Industries and Regional Development https://www.agric.wa.gov.au/
- NSW WeedWise https://weeds.dpi.nsw.gov.au/Weeds/

Chapter 3

General tips for successful weed control

Prevention is cheaper than control

- Ensure vehicles, machinery, livestock and produce do not carry weed seeds or propagules (vegetative material that is capable of reproduction).
- Report sale or use of declared plants to your local weeds officer or weed authority.

Find weeds early

- Search for the target weed(s) and act quickly if found.

Prevent weed spread

- Take measures to contain weed infestations and prevent further weed dispersal.

Plan your control approach

- Obtain information about managing the target weed(s)
- Map infestations
- Treat weeds when they are young
- Use the recommended control method
- Minimise damage to non-target plants
- Establish and promote competing vegetation

Undertake follow-up control

- Continue follow-up treatments over several years. Some plants may have been missed, some may not have died and new seedlings may emerge.

Adapted from the Weed Control Handbook for Declared Plants in South Australia (NRM Biosecurity, 2017).

What is best practice management?

Best practice management is the use of control methods that have been found, through experience and research, to be the most effective and practical ways to achieve a management objective (such as reducing the impact of gamba grass). As best practice control methods for gamba grass are evolving, it's important to note that the methods described here are only as good as our current knowledge, and not all methods will have the same level of success in all situations. Also, some control methods currently in use haven't been sufficiently tested or aren't yet approved. Such methods aren't discussed in this chapter except where research is ongoing and preliminary results are promising.

There are still opportunities to improve the effectiveness of gamba grass control. Documenting and sharing the methods and outcomes of your control programs will contribute to the available knowledge base and highlight areas that need further research.

Choosing a management option

Current methods for effectively controlling gamba grass aim to prevent introductions, intercept spread, detect new infestations, and control existing infestations through hand removal or herbicide application. Other methods that don't kill gamba grass can be integrated with these control options to improve outcomes or meet other land management objectives. These include buffers, barriers, slashing, grazing and burning. Table 3.1 summarises these methods, describes the pros and cons of each, and includes other critical information, such as timing.

Table 3.1 Summary of methods currently available or in use for gamba grass control.

	Advantages	Disadvantages / limitations	Caution!	Timing	Integrate with
Prevention methods					
Spread prevention (page 48)	▪ reduces weed entry and spread ▪ avoids future costs and impacts ▪ low ongoing cost	▪ high set-up costs ▪ maintenance requirements ▪ managing spread pathways may not be possible when they are outside your management area ▪ ongoing effort needed to obtain everyone's compliance	▪ must be undertaken alongside surveillance	▪ year-round but especially when in flower and seed (April to August)	▪ surveillance ▪ all on-property activities ▪ all appropriate control strategies
Surveillance, detection and intervention (page 55)	▪ reduces impacts and need for control	▪ time consuming and ongoing ▪ may be made more difficult by other land management activities (e.g. fire)	▪ can be difficult to detect gamba grass unless flowering, by which time it may have set seed	▪ any time if personnel are experienced in identification ▪ easiest when in flower/seed (April to August) ▪ in the early dry season when it remains green and many other native grasses have dried off	▪ spread prevention ▪ all appropriate control strategies if detected ▪ all on-property activities
Control methods					
Manual removal (page 57)	▪ highly effective and low cost ▪ ideal for small infestations and outliers ▪ minimal equipment needed ▪ no off-target impacts ▪ suitable for organic certified properties	▪ time consuming and labour intensive ▪ not practical for large infestations ▪ more difficult for mature plants	▪ must dispose of all plant parts appropriately to prevent spread ▪ follow-up needed for seedlings and missed plants	▪ any time if personnel are experienced in identification (easiest when in flower/seed (April to August) ▪ easiest following rain when soil is damp or when native grasses have dried off	▪ herbicide control – manual removal ideal for removing outliers around core infestations that are being managed through herbicide control
Herbicide control (page 59)	▪ very effective ▪ quick to apply to multiple plants ▪ can be used for isolated plants through to large, dense infestations ▪ several application options, depending on the situation	▪ currently limited herbicide options available* (glyphosate) ▪ appropriateness of available application methods will depend on the situation and time of year ▪ risks of off-target impacts to desirable plants * flupropanate can be used in some situations in Qld only	▪ legal requirements to follow all label instructions ▪ must follow safety directions	▪ for glyphosate, when plant is actively growing ▪ for flupropanate, prior to rains	▪ all other control strategies and suppression methods
Slashing (page 76)	▪ promotes new growth, increasing herbicide uptake and palatability ▪ reduces herbicide usage and costs ▪ can reduce seed set ▪ reduces biomass and fire intensity	▪ doesn't kill gamba grass ▪ ineffective if used on its own ▪ can spread seeds ▪ not cost-effective in the long term	▪ hygiene measures needed to minimise risk of spread ▪ may need to slash multiple times each year	▪ before seed set (approximately September to May)	▪ herbicide control ▪ grazing

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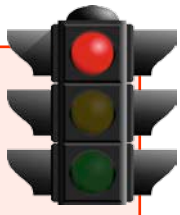
	Advantages	Disadvantages / limitations	Caution!	Timing	Integrate with
Physical barriers (page 73)	▪ may reduce seed spread ▪ may offer protection to adjacent gamba grass-free areas	▪ high maintenance ▪ doesn't prevent seed spread completely ▪ may be unsuitable for fire-prone area	▪ additional surveillance and control activities needed at the barrier	▪ all times of year, especially when in flower and seed (April to August)	▪ prevention and surveillance activities ▪ herbicide control ▪ manual removal ▪ any other management tools (slashing, fire or grazing)
Buffers (page 75)	▪ may offer some protection to clean areas by reducing seed spread ▪ may satisfy legal requirements in some instances (refer to Chapter 5 – 'Further information')	▪ doesn't kill gamba grass ▪ ineffective if used on its own ▪ doesn't prevent medium-long distance seed spread ▪ not cost-effective in the long term	▪ buffers require frequent and ongoing maintenance to be effective	▪ maintain year-round	▪ herbicide control ▪ any other suppression activities (slashing, fire or grazing)
Fire (page 81)	▪ effective in some situations when combined with herbicide control ▪ can improve site access ▪ promotes new growth, increasing visibility and herbicide uptake ▪ reduces herbicide usage and costs ▪ can reduce seeding or kill seeds in some situations ▪ improves palatability	▪ doesn't kill gamba grass ▪ can spread seeds in some situations ▪ can cause mass germination of seedbank ▪ frequent burning can have negative impacts on soils and native plants and animals	▪ must not burn when gamba grass is in seed	▪ late wet season ▪ early dry season	▪ herbicide control ▪ grazing
Grazing (page 78)	▪ reduces biomass ▪ maintains palatability ▪ reduces fire intensity ▪ may reduce seeding	▪ doesn't kill gamba grass ▪ ineffective when used on its own ▪ can spread seeds if present ▪ less effective in large-scale woodland settings	▪ may contribute to degradation in some environments (e.g. conservation areas)	▪ most beneficial during wet season; however, can be grazed all year in some regions if palatable	▪ slashing ▪ fire

Legal requirements to control gamba grass

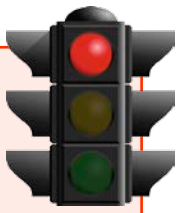


As of December 2024, gamba grass is:

- an eradication target throughout WA
- a containment target in and around Darwin and an eradication target across the remainder of the Northern Territory (refer to NT's gamba grass declaration zones on the NT government website)
- a category 3 weed across Qld, however may be a local prevention, eradication or containment target in Qld, depending on the local government area; contact your local government to obtain a copy of their biosecurity plan.

At a minimum, you're obliged to work towards the management objective of the state, region or local government in which you're operating. Refer to Chapter 5 ('Further information') for the current declaration status of gamba grass throughout Australia. Contact your local biosecurity officer for further information.

Safety and welfare



Safety and welfare should be your top priority when managing gamba grass. The main risks associated with gamba grass management are listed below, along with ways to manage them.

Risk	Mitigation
Risks associated with available control methods (e.g. chemical handling)	Wear personal protective equipment (e.g. leather gloves, eye protection, mask or respirator, long-sleeved shirts, long pants, leather boots). Undertake training in control techniques.
Heat-related risks	Wear personal protective equipment (e.g. sunscreen, wide-brimmed hats, long-sleeved shirts, long pants), drink ample fluids, work in coolest parts of the day, take regular breaks.
Difficult terrain (injury risk)	Wear personal protective equipment. Take communication tools (e.g. phones, EPIRB, UHF radio, etc.)
Injury from wildlife	Take first aid and snake-bite kits.
Vehicle/machinery accident	Work/travel in pairs or groups. Undertake and maintain relevant training.

Managing gamba grass can also affect you psychologically. For example, the impacts of gamba grass and the challenging nature of management can cause stress. Ensure you're well supported and seek help if you need it. The resources below may be helpful for you or someone you know that requires support.

Beyond Blue: www.beyondblue.org.au 1300 224 636

Lifeline Australia: www.lifeline.org.au 13 11 14

Chapter 3

Prevention

The most cost-effective way to manage weeds is to prevent them from spreading and establishing in the first place. Many areas across northern Australia are still free of gamba grass – but they're at risk of invasion. Investing time and money in spread prevention activities will reduce the chances of gamba grass seeds reaching areas that are currently free of the weed. Gamba grass spreads along both natural pathways and human-assisted pathways. Understanding these pathways can help you when developing strategies to reduce the likelihood of spread.

Figure 3.1 shows how gamba grass can spread through the consolidation and expansion of existing infestations. This initially occurs through localised spread mechanisms (such as wind, animals and water) and then by further spread along long-distance pathways (such as roads, machinery and equipment, and intentional introduction). Linear landscape features, such as rail lines, stock routes, power easements and rivers, can also be significant pathways of long-distance spread. Consider both the local scale and the landscape scale in your gamba grass management programs.

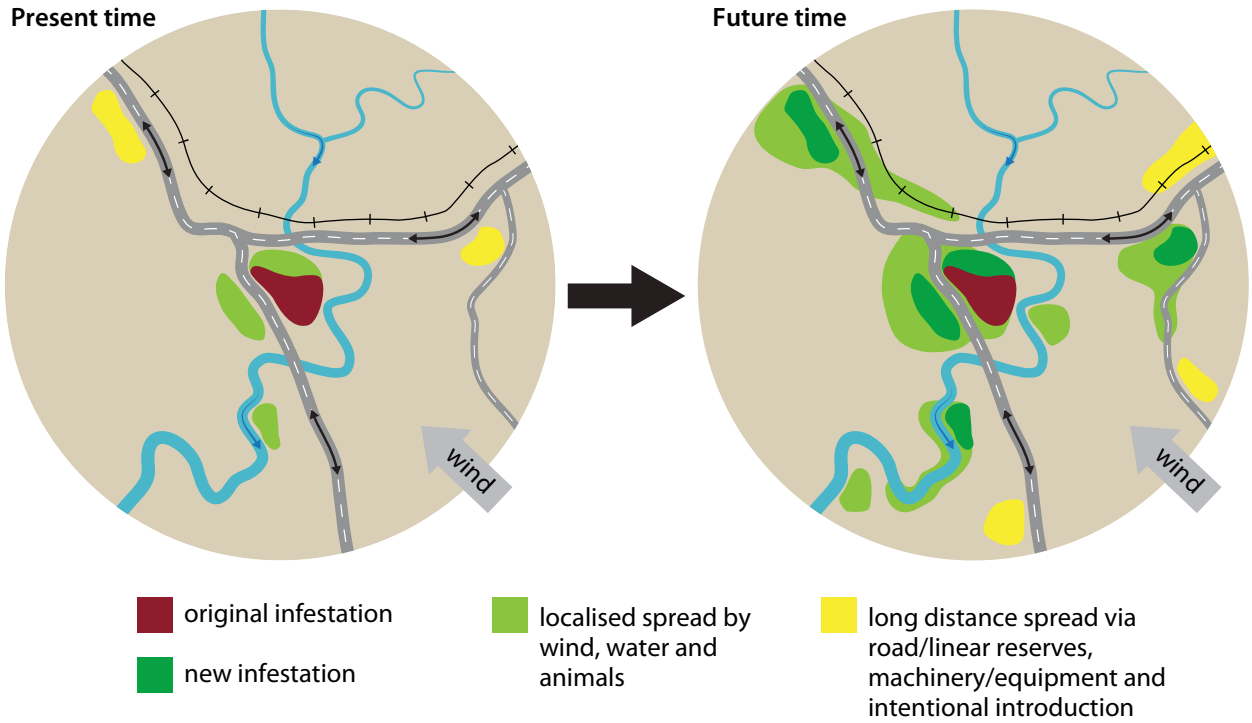


Figure 3.1 Example of gamba grass spread over time at the landscape scale.

The practices outlined in this section will help prevent or limit the spread of gamba grass in all land-use situations. They can also help prevent the spread of other weeds. For example, mission grasses (*Cenchrus* spp.) and Siam weed (*Chromolaena* spp.) can co-occur with gamba grass. If propagules of these weeds are on a vehicle, a hygiene procedure for gamba grass (see below) will assist in preventing the spread of these important weeds too.

Make it a priority to control gamba grass before seed set to reduce risk of spread. If seed is present, use the following to help reduce further spread.

- If small infestations or isolated plants, consider removing seed (see page 57).
- Minimise movement and stay on formed tracks and roads.
- Implement hygiene measures, both personal (clothing footwear and equipment) and on vehicles.
- Try to exclude fire while in seed.

General strategies to reduce weed spread

All people entering the property you're managing should act to prevent or minimise the spread of weeds. This could apply to fellow land managers, friends, tourists, utility managers or contractors who could be unknowingly carrying seeds of gamba grass or other weeds.

- Consider using vendor declarations for buying and selling stock feed, building and landscaping products, or other goods that may be contaminated.
- Request that contractors, vehicle and equipment entering the management area are clean and free from gamba grass seeds. Where possible, use contractors who have a reputation of being weed-aware.
- Share your property hygiene protocol with visitors and encourage them to follow it.
- Consider erecting signage at entrances to the property advising of the measures that are in place to prevent the spread of weeds.
- Carry out periodic surveillance following earth-works on roads, tracks, culverts or other areas to ensure that gamba grass hasn't been introduced or established in these disturbed areas.

It's good practice to take these precautions at all times of the year and in all situations, but it's critically important when gamba grass is flowering or in seed (April to August).

Rowena Eastick

Signage can inform others that gamba grass management is occurring, or of any hygiene requirements that apply to the site.

Follow these general strategies in your day-to-day activities to reduce the movement of gamba grass and other weeds:

Education and awareness

- Learn to correctly identify high-priority weeds, including gamba grass.
- Identify and regularly inspect high-risk areas of spread onto and within a management area, e.g. fence lines, along roadsides, water courses.

Early actions

- Control or report gamba grass as soon as you find it.
- Don't harvest pasture, grain or fodder crops while gamba grass is in seed.
- Determine if any planned activities are likely to intercept known infestations of gamba grass or other priority weeds, and develop a spread-prevention plan.
- Keep roads, laneways and buffer zones free of weeds.

Hygiene

- Avoid entering or working in areas where gamba grass is in seed.
- Inspect and clean vehicles, machinery and equipment when exiting areas of known weed infestations, and be clean before entering areas of high sensitivity (e.g. areas of conservation significance, farms).
- Establish designated clean-down areas and monitor for weed growth.
- Ensure clothing and footwear are free of soil and weed material before stepping into vehicles.
- Where possible, begin work in clean areas or in areas with the least amount of infestation and work towards infested or high-density areas.
- If transporting weeds for disposal following physical removal, secure the load and carry out hygiene procedures.
- Undertake an accredited vehicle and machinery hygiene training course.

Rowena Eastick

Gamba grass establishing following the construction of a culvert. Seed may have arrived on contaminated machinery or fill.

Rowena Eastick

Gamba grass infestation on a power easement that's been slashed during seeding. This practice can lead to further spread along the easement and long-distance spread. Reduce this risk through hygiene measures and by not slashing when the plants are seeding.

Trace forward and trace back

It is important to think about where gamba grass has come from and where it might go and how it might get there. For example, gamba grass often grows in areas where equipment and machinery are stored before being transported to remote communities. It also commonly grows in quarries, where gravel and crushed rock are sourced for various civil works, including road construction. This presents a significant spread risk to areas that are currently free of gamba grass or are part of an eradication management objective.

- Controlling gamba grass at point sources should be considered a management priority.
- Ensure all machinery, equipment, produce and material are seed free before moving.
- Consider establishing inspection and quarantine areas at the receiving environment.
- Carry out routine surveillance at the receiving environment.

Be proactive. If you don't have gamba grass or are in the process of eradicating it, think about all the pathways through which seeds could re-enter. Use Chapter 2 ('Setting yourself up for success') to develop strategies to intercept these pathways and reduce the likelihood of gamba grass seed arriving or establishing at your site.

Weed Management Branch, Northern Territory Government.

Weed Management Branch, Northern Territory Government.

Gamba grass on country often originates from seeding plants at storage facilities where seeds can contaminate freight and vehicles and be transported to remote areas.

Vehicles, machinery and equipment hygiene

Vehicles, machinery and equipment play large roles in spreading gamba grass seeds. Vehicles involved in weed management can easily spread weeds between sites. A simple rule of thumb is to ensure that vehicles, machinery and equipment are free of all weed material (seeds and other propagules) before they enter a property or management area and when they leave. Figure 3.2 highlights areas of a vehicle where reproductive material can become lodged and where inspections and cleanings should be carried out.

Inspect and, where necessary, clean vehicles, machinery and equipment before leaving an infested site. Dustpans and brooms, air compressors and high-pressure wash units are all effective and practical ways of cleaning vehicles and machinery. The Civil Contractors Federation have developed a detailed checklist of inspection points for both vehicles and machinery (Table 3.2).

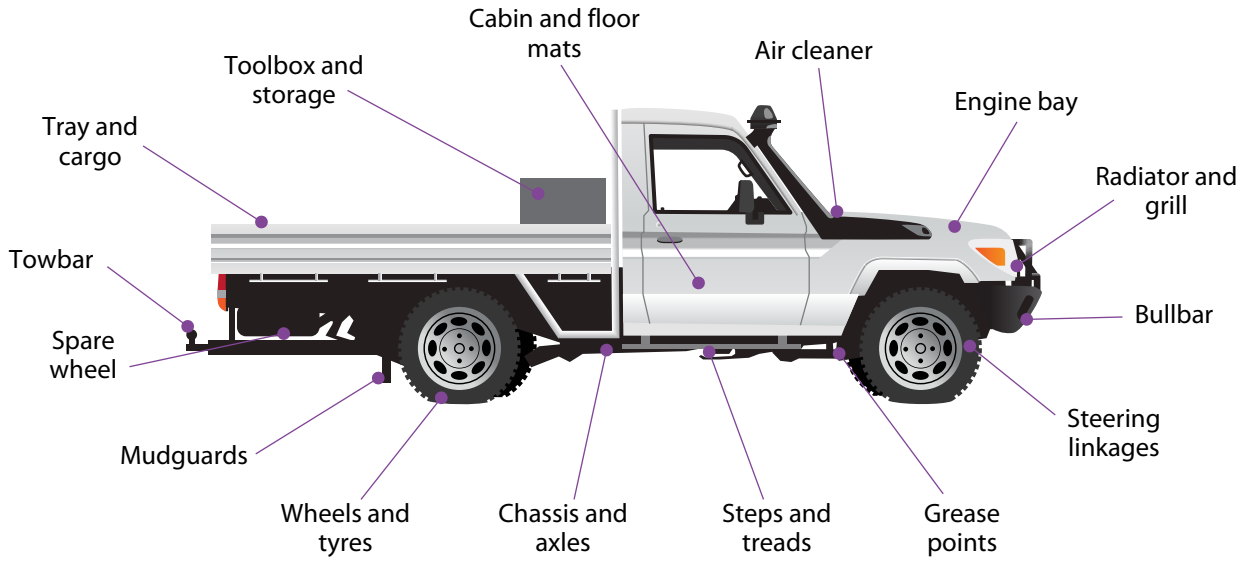
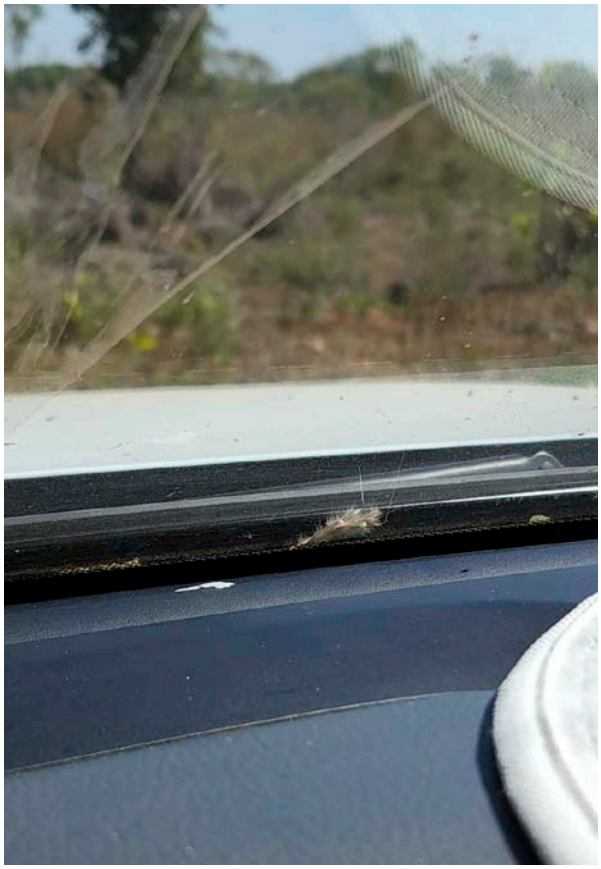


Figure 3.2 Vehicle parts that require attention during clean-down procedures. Symbol courtesy of the NESP Resilient Landscapes Hub, nesplandscapes.edu.au.

Table 3.2 Checklist for inspecting equipment and vehicles.

Best Practice Standards	
Lights and accessories ▪ lights ▪ toolboxes ▪ tynes and rippers ▪ support frames ▪ hoses.	**Slashers** ▪ top ▪ underside ▪ recesses ▪ crevices.
Underside of the vehicle/ machinery ▪ guards and plates ▪ chassis rails and brackets ▪ recesses ▪ around fuel tank ▪ axle housing, spare tyres ▪ ledges, gaps, crevices.	**Wheels and steering** ▪ treads ▪ outside and inside rims ▪ wheel arches ▪ mud flaps ▪ brackets and brakes ▪ steering components.
Track area (for excavators) ▪ shoe ▪ links ▪ sprockets ▪ idler wheels ▪ track adjuster guards ▪ lubrication points ▪ inside the track area.	**Cabin** ▪ carpets ▪ mats ▪ footwells ▪ pedals ▪ controls ▪ seats ▪ air-conditioner.
Engine ▪ chain cases ▪ plates ▪ radiator fins and grille ▪ between cooling cores ▪ engine mounts ▪ recesses ▪ floor of the engine bay ▪ air filter ▪ battery box.	**Blades, buckets and arms (for excavators)** ▪ front and back of cutter edge ▪ teeth ▪ pivot points ▪ turning circle ▪ hydraulic rods ▪ inside and back of bucket ▪ hoses ▪ wear plates.

Source: Civil Contractors Federation (2011) *A guide for machinery hygiene for civil construction*.



Matt Sheehan

Gamba grass seed heads can easily contaminate vehicles and be spread long distances.

Clean-down facilities

Cleanings and inspections minimise the risk of spread. Clean-down facilities should be constructed in a degraded area near the boundary between core infestations and clean areas. Facilities may use high-pressure hoses, compressed air, vacuuming or physical removal (e.g. hand brush). A range of facilities can be constructed based on needs and budgets, and they can be purpose built or developed for general use for a range of purposes.

When cleaning, always:

- appropriately dispose of any seed collected
- monitor the clean-down site for emerging gamba grass or other weed seedlings, and control as needed.

Matt Sheehan

Matt Sheehan

Clean-down facilities. (a) A gamba grass clean-down and inspection bay near Cooktown in Far North Queensland. Coarse aggregate is the base of the bay where physical inspections are carried out, before the vehicle is cleaned using high-pressure water pumped from tanks. (b) A local government high-pressure clean-down facility in operation in Queensland.

Surveillance

Surveillance includes searching for new populations of gamba grass and/or periodically assessing changes to known distributions and their density (e.g. have they increased or decreased?). Importantly, surveillance can confirm that an area is free of gamba grass.

There are many ways that surveillance can occur – actively (e.g. specifically looking for gamba grass using a strategic methodology) or opportunistically (e.g. finding and recording gamba grass while carrying out other tasks). There are also various tools and technologies that can be used to assist with surveillance activities. It is important to decide what type of surveillance to undertake and identify the most effective places to search.

Surveillance provides an opportunity for new infestations of gamba grass to be **detected**, **delimited** and subsequently **eliminated before** they become **widespread**.

Surveillance can also confirm that gamba grass is absent from an area.

Finding new infestations

Conduct regular surveillance to detect new incursions or range expansions of gamba grass. It's important to monitor high-risk sites and control detected plants before they set seed.

Areas to check during regular land management activities include:

- fence lines
- property boundaries
- roads and tracks
- rocky outcrops
- riparian areas, drains and flood-out areas
- infrastructure (e.g. around sheds, yards, tanks, culverts)

- previously treated sites and surrounding areas
- historic pasture trial sites or abandoned pastoral leases
- high-priority conservation areas
- receiving environments of gravel or crushed rock (e.g. roadsides, culverts).

Remember that gamba grass is more likely to establish on bare or disturbed ground than in areas of intact vegetation. Record and map the locations of treated or removed plants so that it's easy to return to the same location to search for new plants.

Chapter 2 ('Setting yourself up for success') has more information on mapping.

Matt Sheehan

Aerial surveillance in Kakadu National Park. This is an effective method for remote locations.

Chapter 3

Control methods

This section outlines the control methods that are currently available for gamba grass. The main methods are manual removal, herbicide control, and other management tools, including barriers, buffers, slashing, grazing and fire.

A critical part of developing your control program is deciding which control method or combination of control methods to use. Key considerations include the size of the infestation (some control options can only be used in certain situations) and whether the infestation is difficult to access or is in a sensitive site (such as an area of conservation significance). Table 3.1 compares the advantages, disadvantages/limitations, timing and other considerations of each method. A summary of situational suitability is also provided in a table under the discussion of each method.

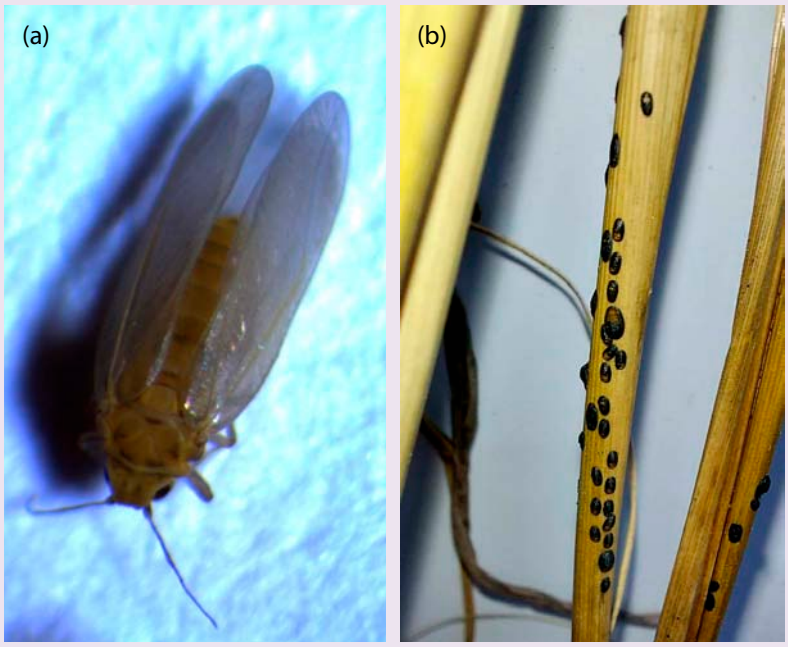
Biocontrol options for gamba grass – early days

Biological control (or biocontrol) uses an invasive species' natural enemies, such as herbivores and pathogens, to help control the pest species. These natural enemies are referred to as 'biocontrol agents'.

While no biocontrol agents are currently available for gamba grass in Australia, the Environment and Invasives Committee has endorsed gamba grass as a candidate for biocontrol. This means that research can begin to identify and test potential biocontrol agents.

Preliminary surveys conducted by CSIRO researchers in gamba grass's native range (South Africa and Zimbabwe) have identified a seemingly host-specific whitefly species (*Tetraleurodes* sp.). Further systematic surveys and studies will be required to understand how this species damages gamba grass and its suitability as a biocontrol agent.

Australian researchers are actively looking for opportunities to commence comprehensive native range surveys for other potential biocontrol agents for gamba grass.



Rhodes University, South Africa

Whitefly Tetraleurodes *sp. in South Africa. (a) adult fly and (b) black sessile pupae attached to culms (stems) of gamba grass.*

Manual removal

Suitable for:	Less suitable for:	Examples of situations
✓ small infestations or isolated plants	× large or dense infestations	→ new plants that have emerged in a drain/ culvert
✓ small plants (<2 m)	× large plants.	→ isolated plants on a roadside in an eradication zone
✓ remote and accessible areas.		→ isolated plants outside a containment line.

Hand pulling or grubbing out plants with a mattock or hoe is a feasible, cost-effective management method for isolated plants or small infestations. Manual removal is particularly good when:

- you come across an isolated plant
- seedlings emerge following earthworks, fire or other soil disturbance
- you want to contain core infestations by removing outlier plants that are starting to spread.

Raitech

Hand removal of gamba grass, El Questro, WA.

Steps to manual removal

1. Remove seeds

Matt Sheehan

Mature seeds detach from stems very easily. If seeds are present, carefully gather a handful of stems, bend them over, and place ends with seeds in a bag before cutting them off.

2. Hand pull or grub out

Casuarina Coastal Reserve Adopt-a-Spot program

Hand pull or grub out whole plants and roots.

Shake off any excess soil to prevent regrowth.

3. Dispose of appropriately

Territory NRM

Territory NRM

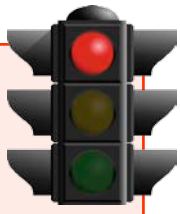
Ideally, bag and remove plants or seeds for disposal in an approved deep-burial facility. In some instances, plants without seed can be dried on site by hanging in a tree or leaving on a track. Ensure that the disposal method is environmentally and culturally appropriate for your situation.

Timing

Manual removal is easiest when the soil is moist – minimising effort and maximising likelihood of removing the entire plant. Remove plants before they set seed to reduce the risk of spread away from the site. While manual removal can theoretically be carried out at any of its life stages, from seedling through to large mature plants, young gamba grass plants that are less than 2 metres in height are the most suitable for this control method. Seedlings are very hard to identify, therefore it's advised that you mark the area and return when it has grown to a stage where it can be more easily identified (ensure this is before it produces seed). Large mature plants can be too difficult to manually remove and an alternative control method should be considered.

Manual removal is commonly integrated with other control methods in a management program. For example, a containment strategy might involve treating a core infestation with herbicide and manually removing any outliers and small plants that re-emerge after treatment.

Follow-up is critical to remove any plants that were missed or have established since the initial control. Follow-up will increase the likelihood of success and should be conducted at least once per year.



Grasses can be very difficult to identify. If you are not completely sure the plant is gamba grass, contact a weed expert or submit a specimen to the herbarium before removing. Refer to Chapter 5 ('Further information') for herbaria contact details.

Weed Management Branch, Northern Territory Government

A young gamba grass plant – a suitable size for manual removal.

Herbicide control

Herbicides are a fundamental tool in the control of gamba grass. This section provides critical information to help you tailor a herbicide control program for your situation based on available application methods and learnings from experienced gamba grass managers.

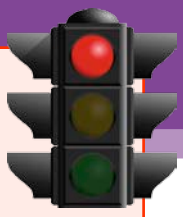
Key points

- You may need multiple treatments per year to control gamba grass – this has time and cost implications.
- Follow-up is critical and should continue for 3–5 years.
- Aim to prevent seeding between treatments. This will deplete the seedbank over time.
- Timing of treatments and integration with other control options will depend entirely on your situation.
- Remember: spray gamba grass when it's ready, not when you are.

This section outlines critical information on:

- herbicides available for use on gamba grass – pages 59–62
- herbicide application techniques for gamba grass – pages 63–72.

A factsheet on how to use herbicides legally, safely and effectively is provided in Chapter 5 ('Further information').



Before commencing any weed control ensure you:

- **read the factsheet Using herbicides legally, safely and effectively in Chapter 5 ('Further information')**
- **are aware of legislation regarding herbicide use**
- **refer to weed control contacts in Chapter 5 ('Further information') for advice and assistance.**

Herbicides used on gamba grass

Glyphosate use on gamba grass can be covered under 'general weed control' for certain situations for several glyphosate products (Table 3.3). While gamba grass is not listed on the label of any herbicide product, two products can be used in certain situations (Table 3.4). Several minor-use permits cover the use of glyphosate on gamba grass in specific situations and a Queensland permit allows the use of fluproponate.

Additionally, state or territory legislation may enable use of certain herbicides where a weed isn't specified on the label. For example, using glyphosate for ground-spraying gamba grass in the Northern Territory is enabled under section 22(3) of the *Agricultural and Veterinary Chemicals (Control of Use) Act 2004* at a rate of 10 mL/L.

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Hand gun application of glyphosate.

Chapter 3

Glyphosate is a non-selective herbicide used on many annual and perennial broad-leaf weeds and grasses. It isn't residual, meaning it only kills existing plants, and it's deactivated on contact with the soil. Glyphosate is absorbed by the leaves and stems and is translocated throughout the plant via the sugar transport system (phloem). It acts by inhibiting an enzyme needed for the production of amino acids used in protein synthesis for plant growth. Only healthy and actively growing plants should be treated. Other factors, such as plant stress, extreme weather, water quality and leaf characteristics (e.g. hairy or waxy) can affect glyphosate uptake. Glyphosate also comes in a range of formulations and concentrations, so this must be considered when diluting herbicides (see Box 3.1 and Box 3.3 for further information).

Flupropanate is a soil-active, residual herbicide that requires rain to wash it into the soil where it can be absorbed through the root system of plants. A single application has the potential to control mature plants and germinating seedlings. Effectiveness and residual timeframes will vary depending on soil type and rainfall. Flupropanate is considered a grass selective herbicide, however it is important to note that it will still cause off target damage to native grasses.

Tables 3.3 and 3.4 contain more details on herbicide concentrations, application methods and situations where it can be used. Use these tables as a guide only, as permits do expire and new products may become available. Check the permit or label before application to ensure it's still valid to use the product.

Box 3.1

Water quality and herbicide effectiveness

Poor water quality can reduce herbicide effectiveness by:

- increasing chemical breakdown in the spray water (hydrolysis)
- reducing herbicide activity (inactivation) through contaminants, such as clay and silt, or trace elements binding to the herbicide
- precipitating the pesticides out of solution
- blocking spray lines.

Key water quality factors impacting herbicide effectiveness are hardness (calcium content), salinity, presence of mud or silt and pH. The table below summarises the effects these factors have on the effectiveness of glyphosate and flupropanate. As a rule, use clean water and avoid dam water, hard water and alkaline water.

Herbicide	Hard water	Saline water	Muddy water	Alkaline water	Acidic water
Glyphosate (e.g. Roundup®)	✗ Reduces glyphosate effectiveness	✓ Doesn't affect glyphosate effectiveness	✗ Reduces glyphosate effectiveness	✗ Reduces glyphosate effectiveness	✓ May increase glyphosate effectiveness
Flupropanate (e.g. Taskforce®)	✓ Doesn't affect flupropanate effectiveness	✓ Doesn't affect flupropanate effectiveness	✗ Taskforce® label recommends avoiding silty water	✓ Doesn't affect flupropanate effectiveness	✓ Doesn't affect flupropanate effectiveness

Read the label prior to mixing and applying herbicide. The effect of water quality will be outlined on the product label, usually in the section on tank mixing.

Table 3.3 General use provisions for use of glyphosate on gamba (current as at April 2024).

State/ territory	Application method	Situation in which the herbicide is registered	Comments
All	**Spot spraying** Handgun/knapsack	Domestic, commercial, industrial, public service and agricultural areas	Covered under a general weed control table e.g. Roundup Biactive® label Rate dependent on formulation – refer to label

Table 3.4 Herbicides permitted for use under minor-use permits (current as at December 2023).

Active ingredient	State/ territory	Application method	Situation in which the herbicide is registered	Permit number
Flupropanate 745 g/L present as sodium salt as the only active constituent	Qld	**Foliar application (e.g. spot gun)** 300 mL flupropanate product + 700 mL of water to make a 1 L solution (refer to permit instructions)	Pastures, non-crop areas, urban open space, woodlands, roadsides, nature reserves and revegetation sites	PER94351 Expires May 2027
Glyphosate 360 g/L	Qld	**Spot spray/High-volume, low-concentration foliar application (e.g. handgun, knapsack)** 1:100 dilution (refer to permit instructions)	Non-agricultural areas, domestic and public service areas, commercial and industrial areas, bushland/ native forests, roadsides, rights-of-way, vacant lots, wastelands, wetlands, dunal and coastal areas	PER11463 Expires April 2027
	NSW, ACT		Native vegetation, forests, non-crop areas, open public spaces, domestic and urban areas	PER9907 Expires April 2027
	Qld	**Low-volume high-concentration foliar application (e.g. splatter gun)** 1:9 to 1:20 dilution (refer to permit instructions)	Non-agricultural areas, domestic and public service areas, commercial and industrial areas, bushland/ native forests, roadsides, rights-of-way, vacant lots, wastelands, wetlands, dunal and coastal areas	PER11463 Expires April 2027
	NSW, ACT		Native vegetation, forests, non-crop areas, open public spaces, domestic and urban areas	PER9907 Expires April 2027
	Qld	**Boom spray** 10 L/ha	Non-agricultural areas, domestic and public service areas, commercial and industrial areas, bushland/ native forests, roadsides, rights-of-way, vacant lots, wastelands, wetlands, dunal and coastal areas	PER11463 Expires April 2027
	WA		Agricultural non-crop areas, non-crop areas, commercial and industrial areas, wetlands, bushland and forests	PER13333 Expires Mar 2025
	NSW, ACT	**Wick-wiping** Undiluted to 1:20 dilution	Native vegetation, forests, non-crop areas, open public spaces, domestic and urban areas	PER9907 Expires April 2027

Table continued on next page/. . .

Active ingredient	State/ territory	Application method	Situation in which the herbicide is registered	Permit number
Glyphosate 450 g/L	WA	**Wick-wiping** Undiluted to 1:5 dilution	Agricultural non-crop areas, non-crop areas, commercial and industrial areas, wetlands, bushland and forests	PER13333 Expires Mar 2025
Glyphosate 540 g/L	NT	**Aerial application** Aircraft (fixed wing aircraft or helicopter)	Fire-break establishment along fence lines, fire-access trails, railways and roadways. Aerial spraying permitted within pastoral and non-arable lands only	PER93598 Expires Oct 2028
Glyphosate 540 g/L	NT	**Aerial application** Helicopter	Fire-break establishment along fence lines, fire-access trails, railways and roadways. Gamba grass control in specific national parks* with heavy infestations	PER93599 Expires Oct 2028

* Refer to permit for the national parks that this permit applies to.

Optimum herbicide treatment time

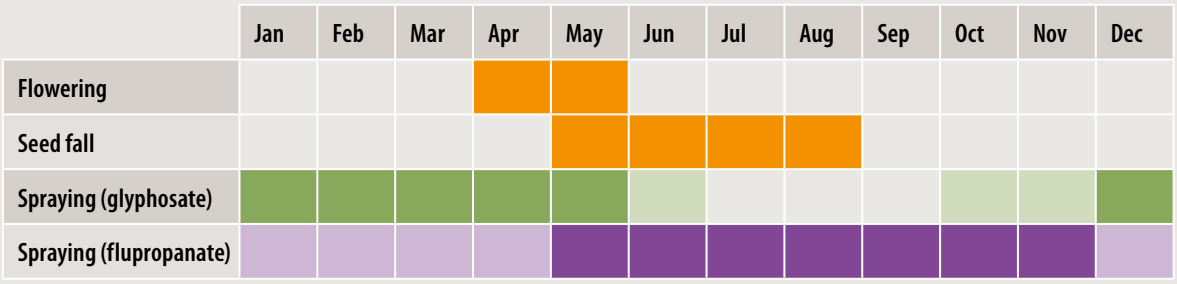
Table 3.5 provides general guidelines for when it's suitable to treat gamba grass with herbicide. Note that times shown are indicative only, as climate is changing and becoming less predictable. There are also climatic differences across the geographic range of gamba grass in northern Australia. This influences the life cycle of gamba grass, when gamba grass will be responsive to herbicide treatment, and when sites can be accessed. Observe the plants' growth stage at your site and respond appropriately.

For glyphosate application, spray when gamba grass is green – it's actively growing and will respond to herbicide application. Ensure you can access the site and the weather conditions are suitable for spraying. Treatment won't be effective if the gamba grass is brown – usually between June and August, but could be as early as May and as late as October.

Avoid spraying during seeding. Herbicide treatment is still effective if a plant is in flower or seed. However, you risk spreading gamba grass further if seed is present. If you must spray then, be sure to put in place hygiene procedures to reduce seed spread (refer to pages 49–54).

For flupropanate application, spray in the late dry season or early wet season (refer to Box 3.1).

Table 3.5 Indicative timing of flowering and seeding and the theoretical best times for spraying gamba grass. Darker colours indicate typical timing, while lighter shades indicate additional months that may be suitable depending on start and end of wet season, which varies across Northern Australia and year to year (e.g. variability of when the plant is actively growing, and when seed is present).



Herbicide application methods

Application methods include:

- spot spray (glyphosate) – handgun or knapsack application (high-volume, low-concentration foliar applications)
- spot spray (fluproponate) – spot gun or metal tree injector (refer to Box 3.1)
- splatter gun (low-volume, high-concentration foliar applications)
- broad-acre treatments, including boom application and aerial application with crewed aircraft or drones
- wick-wiping.

These application methods are discussed in the following sections.

Regardless of application method:

- ensure all spray equipment is correctly calibrated before use
- always use clean water and strictly follow all herbicide label and permit directions and rates (see Box 3.1)
- apply glyphosate when gamba grass is actively growing and not under drought stress
- for glyphosate, complete spraying at least an hour before rain so that the herbicide is absorbed and not washed off
- consider using a GPS tracker, flags, stakes or fence-droppers to help you divide up and mark areas being treated; consider using dye in your herbicide mix
- incorporate hygiene protocols into your spraying programs to minimise spread of gamba grass or other weeds you may encounter at the site (refer to pages 49–54)
- set achievable goals on how much area you can treat in one session
- take your time and have regular breaks.

Integrated weed management

Slashing, grazing or burning gamba grass can sometimes make it easier to traverse a site, see all gamba grass plants, and spray entire plants. Whether or not you should integrate these methods into your management will depend on your situation and objectives. Refer to pages 76–83 for a discussion of both the advantages and potential risks of integrating these methods with herbicide treatments.

For general guidelines for using herbicides, refer to the Herbicide fact sheet In Chapter 5 ('Further information').

Time follow-up treatment to prevent seed production

Regardless of your control approach, you likely won't achieve 100% kill on the first treatment if the gamba grass is dense. Any gamba grass that survives will produce seed, adding to the soil seedbank or spreading to new areas. Your follow-up treatment should be timed to prevent further seed set.

- Carry out your initial knock-down, aiming to spray as much gamba grass as you can.
- When plants start to show signs of dying (e.g. yellowing or wilting), revisit the site and spray any plants or parts of plants that are still green and healthy.
- Ideally, continue follow-up control at intervals to prevent seeding for the next 2–3 years, targeting both missed plants and new seedlings.

While this may sound excessive, investing in intensive follow-up will pay off in the long term. The seedbank of gamba grass only lasts for 1–2 years in the soil. Intensively managing to prevent further seeding means less effort is needed in following years, as long as no further seed is coming onto the site from elsewhere.

Handgun or knapsack

High-volume foliar spraying with handgun or knapsack (spot spraying)

Suitable for:	Examples of situations
✓ most situations (small infestations or isolated plants through to large, dense infestations)	→ roadside management and other linear reserves
✓ remote sites and accessible sites	→ infestations among desirable vegetation and areas with conservation significance
✓ plants of all sizes	→ small-acre peri-urban blocks and built-up areas.
✓ control and follow-up treatments.	

This application method delivers high-volume, low-concentration herbicide to all foliar parts (leaves) of the plant. Also called 'spot spraying', it refers to the direct treatment of individual plants irrespective of density. 'Handgun' typically refers to spray units with high-volume (300–500 L) vehicle-mounted tanks and an automated herbicide delivery system. These units are designed for large or dense infestations. Knapsack or backpack spray units are carried by the operator and are useful for remote work where vehicle access is limited. However, these units can only carry a limited amount of herbicide (typically 15 L) and so this method is most suitable for small, scattered infestations. Spot spraying is the most commonly used and versatile application method, suitable for a range of situations and weed densities.

Application (with glyphosate)

Spray actively growing gamba grass. This includes all growth stages, from seedlings to mature plants. Ensure at least 40 cm of regrowth after the dry season or following fire or slashing.

Ensure every gamba grass plant is completely coated with herbicide spray, including every individual tiller, otherwise the plant will survive. Follow up treatments with further spot-spraying or manual removal, as some plants may have been missed and new seedlings will often emerge.

Rowena Eastick

A partially sprayed tussock that has survived herbicide treatment.

Optimising spot spraying in dense infestations

To kill gamba grass, herbicide (glyphosate) must be applied to all above-ground parts of the plant. This is relatively easy for small or isolated plants but is more difficult for large (>2 m) plants or dense infestations. There are several reasons for this.

- It may be difficult to access and spray entire plants – plants will survive partial spraying and continue to seed.
- Dense gamba grass commonly establishes in wooded areas, making control more complex.
- Handgun-based spraying is limited by vehicle access, hose length and the amount of herbicide that can be carried.

The 'chocolate-block' technique – a structured method for applying herbicide

This method, coined by Northern Territory Gamba Army Team Leader Hamish Clark, is an effective way to spray large, dense gamba grass infestations within wooded areas. It maximises efficacy and operator safety by minimising effort, reducing missed plants and the likelihood of operators walking through treated areas.

The technique (Figure 3.3) uses a linear access feature, such as a fence line, fire trail or slash line. The treatment area is then divided into blocks at right angles to this linear feature.

- Divide the area into blocks based on the length of the hose, terrain, vegetation density and nozzle spray range. This example has a hose length of 100 m and a spray range of 10 m.
- Drag the hose out to its full extent along the centre line (labelled 'A' in Figure 3.3).
- Spray a block to the left of the centre line (labelled '1'), then spray block 2 to the right of the centre line 'A'.
- Sequentially treat blocks 3, 4 and so on, back to the spray rig.

When all blocks are treated, move the vehicle with spray rig along to centre line 'B' (in this case, 20 m to the right) and repeat.

Working in pairs on neighbouring centre lines improves efficiency and reduces the likelihood that areas will be missed.

Remember to:

- consider wind direction and work within blocks to avoid spray drift, either to yourself or adjacent operators
- set up some reference points using flagging tape to mark out the blocks.

Refer to Chapter 4 ('Case studies') for examples of how land managers have tackled large, dense infestations.

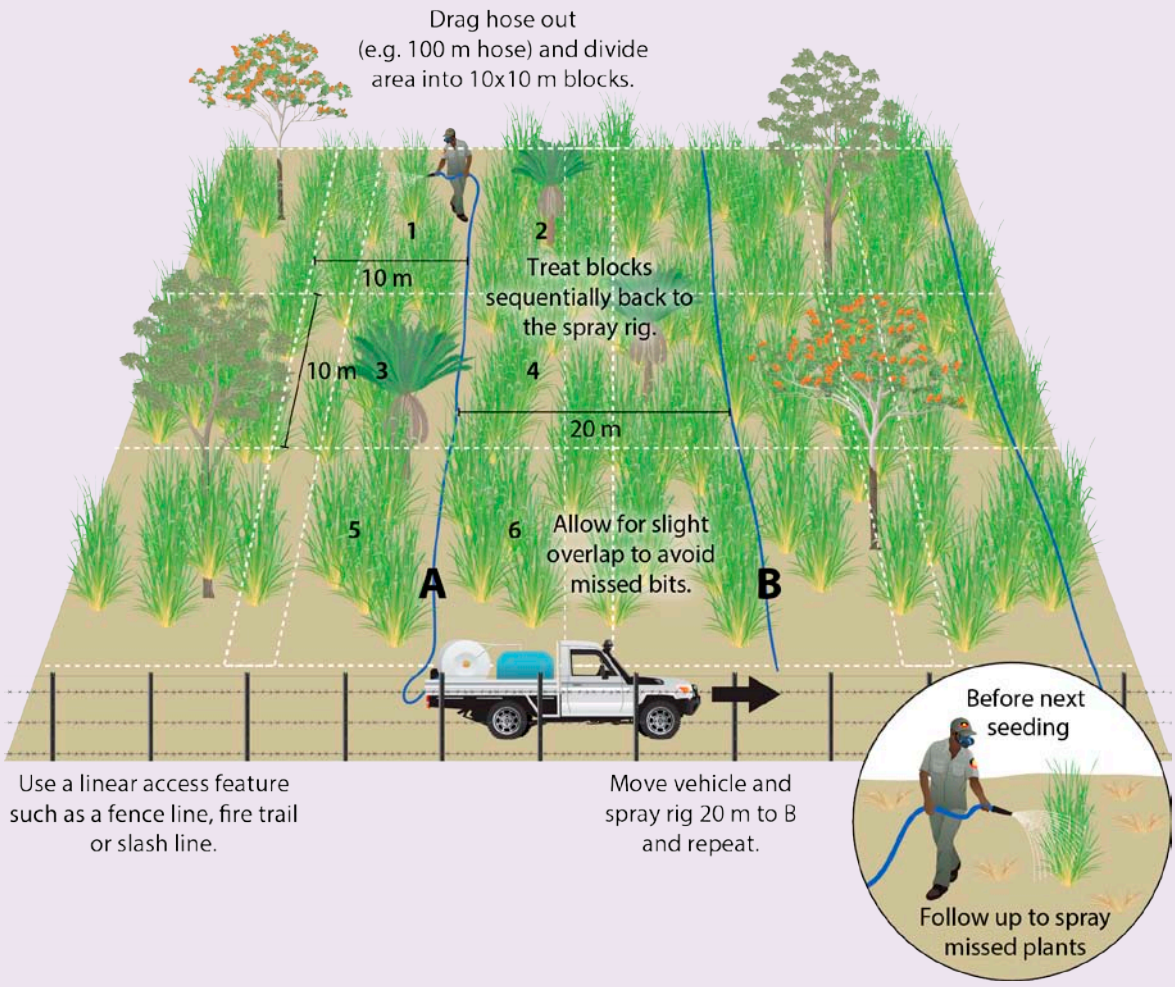


Figure 3.3 Applying herbicide using the 'chocolate-block' technique. Symbols courtesy of the NESP Resilient Landscapes Hub, nesplandscapes.edu.au.

Trials continue in the search for new herbicide options for gamba grass

There's a strong desire amongst gamba grass managers to identify effective herbicide alternatives to glyphosate, including herbicides that are more selective to reduce off-target impacts and herbicides that have residual or lasting effects following initial treatment.

Thanks to researchers at Biosecurity Queensland and The University of Queensland, we now have a permit in Queensland for the use of flupropanate on gamba grass. Trials will continue to understand the effectiveness of these new techniques long term.

Research into other herbicides will also continue, including trials of spot application of the herbicide sulfometuron-methyl for gamba grass control.

Contact your local weed officer for information on changes to herbicide control options or to hear about any opportunities to take part in control trials for gamba grass.

Box 3.2

Spot application using fluropropanate (Queensland only at June 2024)

Suitable for:	Less suitable for:	Examples of situations
✓ small/scattered infestations or isolated plants	× large-scale weed control	→ sites only accessible in the dry season
✓ both remote and accessible sites	× areas with dense gamba grass monocultures	→ infestations among desirable vegetation and areas with conservation significance
✓ plants of all sizes		→ sites in the early stages of invasion
✓ follow-up treatments		
✓ sites with mixed vegetation		
✓ year-round application		

Trials conducted by Biosecurity Queensland and The University of Queensland on the herbicide flupropanate (e.g. Tussock™) concluded that effective control can be achieved when flupropanate is applied to individual gamba grass plants through spot application. While treatment can be applied at all times of the year, it was found to be most effective in the late dry season and early wet season.

Advantages of flupropanate application:

- Flupropanate is a grass-selective herbicide, and therefore has minimal off-target impacts on broadleaf plants. However, care should be taken to minimise impact on desirable grasses.
- Unlike glyphosate, flupropanate is absorbed through the roots and can therefore be applied to the tussock in the dry season, where it will enter the soil following first rainfall. This is good for sites that are hard to access at the optimum time for glyphosate spraying.

In April 2024, a permit was issued by the APVMA to allow spot application of flupropanate on gamba grass in Queensland (see Table 3.4).

Application

Apply one 5 mL shot solution (see Table 3.4 for rate) to the centre of each tussock using a metal tree injector, spot gun or similar applicator.

- DO NOT exceed 3 litres of product per hectare or apply when there are more than 2000 gamba grass plants per hectare.
- DO NOT exceed a maximum of one treatment over the same area per year.

There is also a 14-day withholding period associated with this product, where areas that have received spot treatment cannot be grazed or cut for stock feed.

For more information refer to the permit at the APVMA website https://permits.apvma.gov.au/PER94351.PDF

Box 3.3

Gamba grass typically has hairy leaves which can reduce the absorption of glyphosate. The product beads on the leaf surface and in the northern Australian climate, may evaporate before it's absorbed or be washed off by wet season rainfall. Adding a surfactant or wetting agent improves glyphosate penetration. For information on adding a wetter, talk to your local weed officer or check the APVMA website.

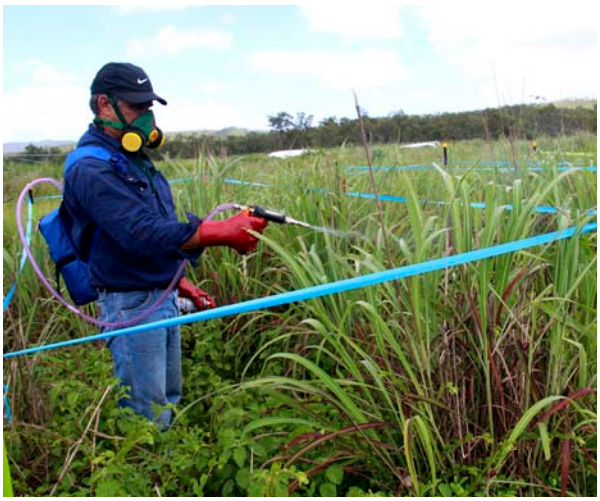
No wetting agent *Wetting agent added*

Rowena Eastick

Splatter gun

Suitable for:	Less suitable for:	Examples of situations
✓ initial knock-down of tall, dense infestations	× scattered infestations	→ natural environment with dense large plants
✓ infestations among mixed vegetation.	× small plants.	→ steep escarpments and riparian areas that are difficult to access
		→ abandoned cropping areas
		→ areas with limited vehicle access.

Splatter guns deliver low-volume, high-concentration herbicide to foliar parts of the plant. They are widely used in the control of woody weeds, such as lantana (*Lantana camara*) and bitou bush (*Chrysanthemoides monilifera*). Recent trials conducted by The University of Queensland concluded that splatter guns showed great promise when used as an integrated management tool for gamba grass control. The high herbicide concentrations knock down stands of mature gamba grass without having to achieve 100% foliar cover. This opens up dense infestations for follow-up control with handguns or knapsacks, reducing chemical use and spraying time.

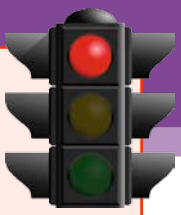


Melissa Setter, Biosecurity Queensland

Splatter-gun application of glyphosate to control gamba grass at a trial site in Queensland.

Application

Apply approximately 4 mL/m in strips across the target vegetation. Further trial work will refine the technique for use on gamba grass.



CAUTION

Broad-acre applications of glyphosate can kill desirable vegetation. Be sure to consider and manage this risk.

- Assess your situation and the appropriateness of boom or aerial application of herbicide.
- Determine the potential off-target impacts and how to mitigate or reduce them.
- Develop a long-term strategy for ongoing management and restoration.
- Use skilled operators with experience in gamba grass control in your situation.

Broad-acre treatments

Broad-acre spraying methods, such as boom spraying or aerial application, may be appropriate on large land parcels with dense infestations of gamba grass. These treatments deliver a uniform blanket of herbicide to the foliage across the treatment area compared to the more selective application achieved with handgun and knapsack application (spot spray).

Boom spraying

Suitable for:	Less suitable for:	Examples of situations
✓ large, dense infestations (90–100% gamba grass cover) with vehicle access	× scattered infestations or isolated plants	→ abandoned cropping areas
✓ degraded or modified areas or where there's been a change in land use	× small infestations	→ some roadsides and tracks
✓ maintained service areas.	× mixed vegetation (among desirable vegetation)	→ historical grazing areas converted to cropping.
	× steep areas or where there's limited vehicle access.	

Boom spraying is usually done with a vehicle-mounted boom or boomless jet. Boom-spraying gamba grass can be cost-effective for large and dense infestations which are readily accessible on the ground.

Talk to your local weed officer to discuss the appropriateness of boom spraying for your situation and specifics on application methods.

Rowena Eastick

Boomless jet sprayer being used to control gamba grass on tracks and track edges in Charles Darwin National Park, Northern Territory.

Aerial spraying

Suitable for:	Less suitable for:	Examples of situations
✓ large, dense infestations (90–100% gamba grass cover)	× scattered infestations or isolated plants	→ degraded savanna on terrain that's steep or hard to access
✓ all terrains, including areas that are steep or otherwise hard to access	× small infestations	→ areas of broad-acre grazing that have been converted to horticulture
✓ degraded or modified areas or where there's been a change in land use.	× mixed vegetation (among desirable vegetation) or where there are canopy trees	→ abandoned cropping areas.
	× built-up areas.	

This section describes aerial spraying by helicopter or fixed-wing aircraft. Refer to the box below for information on uncrewed aerial vehicles (e.g. drones).

Advantages of aerial application:

- You can treat a lot of ground very quickly – multiple strategic sites can be treated in the same period.
- You're less constrained by seasonality, access and topography than with ground-based control. This may increase the treatment window. It's especially useful if you have a short treatment window before seeding.

Parks and Wildlife Commission, NT

Helicopter equipped with a boom spray unit in Lichfield National Park for spraying large, dense gamba grass infestations.

Drones

Uncrewed aerial vehicles such as drones have been used to successfully control grassy weeds such as *Sporobolus* spp. While the application of this technology to gamba grass is not well documented, it is likely to be suitable for small or scattered infestations in remote locations.

Drone-based applications may:

- reduce the off-target impact associated with other aerial herbicide applications by effectively spot-spraying individual plants
- enable treatment of gamba grass in mixed vegetation, including open woodland settings
- be less constrained by seasonality and terrain than ground-based control – increasing accessibility and the window for treatment
- be more cost effective and time effective than ground-based control in areas that are remote or hard to access.

However, limitations must be addressed before drones are a viable treatment option for remote locations. These include sight-line flying restrictions, chemical carrying capacity and battery life.

For further information on chemical control using drones, contact your local weed officer who may be able to put you in touch with an accredited and experienced drone operator.

Note: Drones are considered aerial vehicles and are regulated under Aerial Chemical Application rules. This means that a drone operator must have relevant qualifications and registrations, and they must abide by any aerial application requirements as per the label and as per the APVMA Spray Drift Policy. There may also be different requirements for qualifications and registrations in each state and territory.

Rowena Eastick

Wick wiping

Suitable for:	Less suitable for:	Examples of situations
✓ removing large plants in open production systems	× steep terrain, rocky or uneven areas*	→ abandoned cropping areas
✓ infestations on level ground that's free of rock, logs or stumps.	× areas where there are trees, shrubs or other things taller than gamba grass.*	→ mixed-grass production systems (e.g. humidicola and signal grass pastures)
		→ hay crops.

* Wiper height can't be adjusted automatically, limiting its use in several situations.

Wick Wipers Australia

Wick wiping selectively 'wipes' herbicide onto foliage. It's most effective when the target weed is taller than desirable species. This reduces off-target damage to desirable vegetation and minimises the amount of herbicide needed. Gamba grass is a good candidate for wick wiping because it grows faster than desirable species after slashing. The resulting height difference means that gamba grass is the optimal height for wick wiping. Apply when gamba grass is leafy and 1–2 m tall.

Equipment is mounted onto a vehicle or hand-held. Most devices consist of a rope wick or rotating carpet wiper saturated with concentrated herbicide that's 'wiped' over the plants.

Wick wiping has been successful in managing perennial grassy weeds, such as giant rat's tail grass (*Sporobolus pyramidalis, Sporobolus natalensis*), serrated tussock (*Nassella trichotoma*) and Chilean needle grass (*Nassella neesiana*), in specific pastoral and turf-management settings. While documented use of wick wiping on gamba grass is limited, it's currently in use on Cape York Peninsula for the management of gamba grass in hay crops. Herbicide rates of 1 part glyphosate 360 to 2 parts water (plus wetter) have been very effective. Further trials are currently underway in the Cook Shire, Queensland, for use on gamba grass in humidicola and signal grass. Talk to your local weed-management professional for more information this technique.

Application (based on use on other perennial grassy weeds and current trial on gamba grass)

- Crash-graze pastures to reduce the height of all desirable species. In non-grazing settings, consider slashing and allowing time for gamba grass to re-establish to approximately 50 cm above desirable vegetation. Wick wiping is most effective on green, actively growing foliage.
- Set wiper at a level of 10 cm above the pasture/ desirable species.
- Travel at low speeds (<8 km/hr). Depending on the type of wick wiper, you might need to do two passes in opposite directions to get adequate herbicide coverage.
- Keep wiper wet with herbicide at all times.
- Avoid dripping herbicide onto non-target species.
- Remember that seedlings or young plants will be missed, so monitor treated areas for small, missed plants and remove by chipping or spot spraying, or re-wipe when taller.

Other management tools

A suite of other management tools may make manual removal or herbicide control more effective, or meet other short-term land-management objectives.

These tools are:

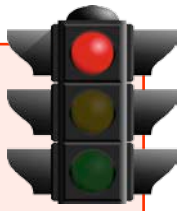
- physical barriers and buffers
- slashing
- grazing
- fire.

These tools temporarily reduce gamba grass impacts by:

- reducing seed set, which reduces spread
- reducing biomass, which reduces fire severity.

These tools are often the go-to approach when maintaining service areas, reducing the public safety hazard associated with gamba grass, and protecting infrastructure. This is because they're a quick fix. For example, slashing gamba grass on a roadside immediately addresses sightline and visual amenity issues and reduces fire risk.

These tools should be integrated with herbicide treatments or manual control to achieve multiple management objectives, such as short-term public-safety outcomes and long-term conservation and cultural outcomes.



WARNING

Remember – while these 'other management tools' may provide short-term benefit, they:

- don't kill gamba grass plants
- don't reduce gamba grass in the long term
- may lead to increased density of gamba grass
- may increase spread
- are more costly long term than herbicide control and manual removal
- won't lead to eradication of gamba grass on their own.

Do not use these methods as your only long-term management tools. Use these methods in combination with manual removal or herbicide control, or as a one-off back-up management option.

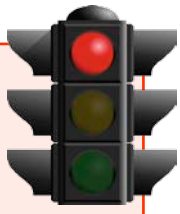
Barrier fencing and buffers

Barrier fencing

Suitable for:	Less suitable for:	Examples of situations
✓ protecting assets from upwind infestations	× large-scale infestations	→ threatened native savanna with adjacent gamba grass infestation
✓ very small-scale areas that can be maintained.	× fire-prone areas.	→ reducing seed spread from a property where gamba grass is being actively grazed.

Physical barriers, such as barrier fences, can reduce the spread of weeds that have wind-borne seeds. Examples include serrated tussock (*Nassella trichotoma*) and thistle species in southern Victoria. While physical barriers don't completely prevent spread, they can help contain weeds at the property scale. Place barriers at the down-wind boundary of the property that has gamba grass to contain core infestations and protect adjacent high-value weed-free areas (Figure 3.4).

Barrier fences are typically made from mesh or shade cloth that's fine enough to obstruct the wind dispersal of seed.



The effectiveness and practicality of barrier fencing for use on gamba grass haven't been documented. Barrier fencing can be maintenance-intensive, and the prevalence of fire in northern Australia may make it impractical in many situations.

ONLY consider barrier fencing:

- **at a very small scale (e.g. to directly protect an asset or to reduce gamba grass seed spreading from your property)**
- **where fire is unlikely or can be excluded.**

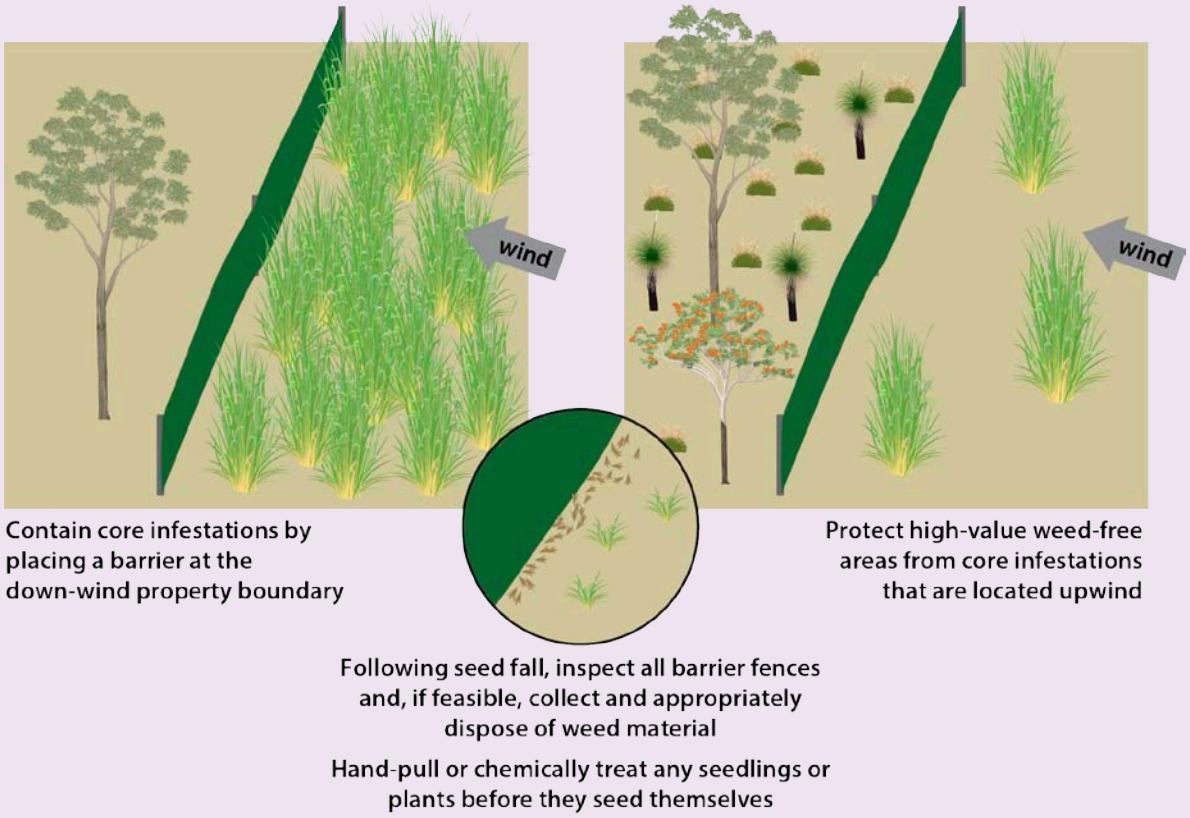


Figure 3.4 Examples of where barrier fencing may be useful in slowing spread. Symbols courtesy of the NESP Resilient Landscapes Hub, nesplandscapes.edu.au.

Buffers

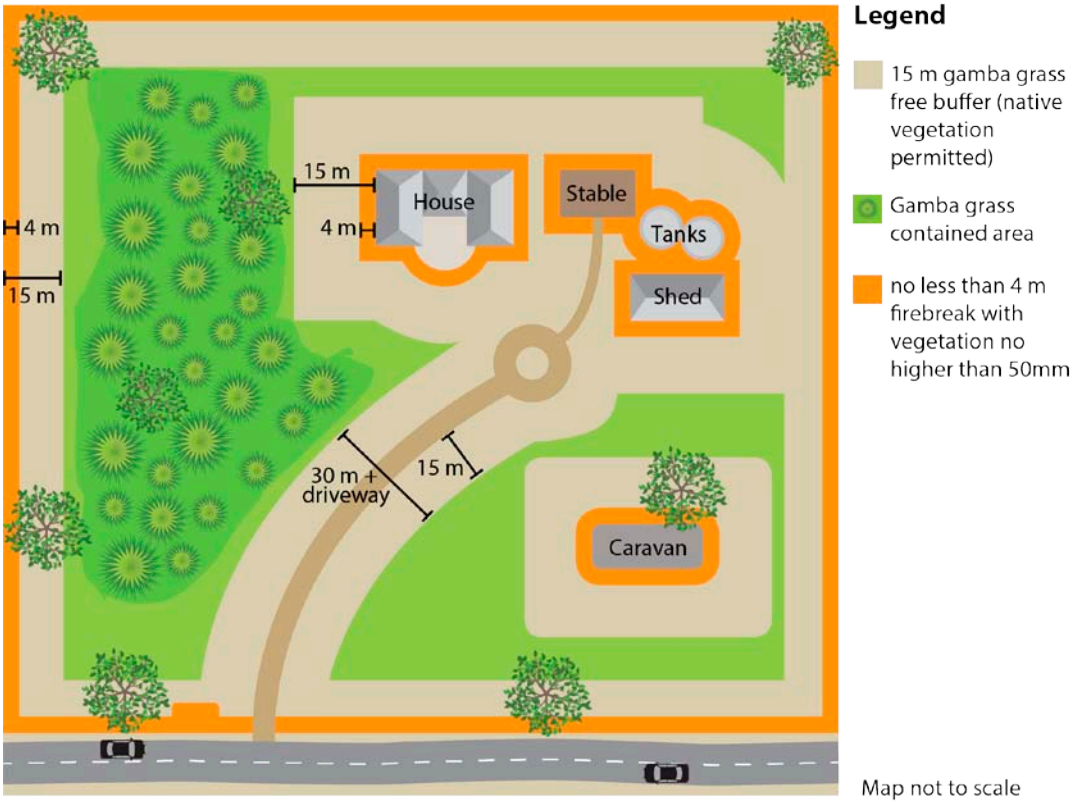
Suitable for:	Less suitable for:	Examples of situations
✓ boundary management ✓ separating clean areas from infestations ✓ small-scale areas that can be maintained.	× large-scale infestations × areas where the management objective is eradication.	→ in the NT containment zone, properties >3 ha must maintain a 15 m wide gamba grass-free area around boundaries, driveways and infrastructure. Properties that adjoin the eradication zone require a 500 m buffer.

A buffer zone is a designated area with no seeding gamba grass that separates an infestation from an adjoining area that's free of gamba grass. This may be the property boundary or other linear feature. In some parts of northern Australia, buffers are a minimum legal requirement when managing gamba grass. Given that most gamba grass seeds fall with 5 m of a parent plant, a well-maintained buffer of sufficient width may reduce seed spreading into adjoining properties.

Key points

- Buffer zones should be wide enough to reduce the spread of gamba grass seed to surrounding properties. Widths of 40–50 m are typically encouraged or required.
- Buffer zones may surround the entire property. However, it's better if a buffer zone only surrounds the area/s containing gamba grass.
- Buffer zones can contain gamba grass, but they must be managed so that no seeding occurs. Ideally, you'd remove gamba grass from the buffer and maintain its weed-free status.
- Buffer zones don't require the clearing of native vegetation. If you want to remove vegetation, you may need permits or other approvals.

Prevent seed set in the buffer zone by controlling plants through herbicide application or manual removal. Slashing, grazing or burning can also be used in buffer zones to reduce seeding.



Slashing

Suitable for:	Less suitable for:	Example situation
✓ reducing biomass ✓ linear reserves, fence lines, vacant land, modified areas and around infrastructure.*	× conservation areas × areas with mixed vegetation.	→ slashing roadsides to reduce fire risk, reduce seed production, and promote growth prior to herbicide spraying.

* Also consider spraying these areas with herbicide or hand pulling.

Slashing isn't commonly used for gamba grass management *per se*, but rather to address other management priorities that are impacted by gamba grass. For example, slashing roadside vegetation (including gamba grass) maintains visual amenity and road safety. Slashing gamba grass in urban areas reduces fire risk.

Slashing doesn't kill gamba grass – in fact, it's a major contributor to its spread. However, if you carefully time slashing and integrate it with herbicide control, you can achieve multiple management objectives, including reducing the density of gamba grass.

Slashing can:

- promote gamba grass growth and remove dry, rank material, which:
  - improve access to tussocks during control
  - improve herbicide coverage and control effectiveness
  - reduce the amount of herbicide needed, which reduces costs
- reduce seed set
- reduce fire risk (short term)
- increase site visibility (short term)
- improve gamba grass palatability
- create opportunities for desirable species to establish and compete with gamba grass.

For best results, slash gamba grass before or as it comes into flower and allow it to regrow to a height of approximately 40 cm (refer to Figure 3.5). Then apply herbicide using the most appropriate method for your situation. Always clean equipment and machinery before moving to new sites.

Slashing as a back-up plan

Sometimes, things don't go to plan. For example, a late wet season may prevent access for herbicide control prior to gamba grass flowering. Or there may be conflicting priorities preventing gamba grass control at the optimal time. In these instances, the most important thing to do is to reduce seed set. Slashing may temporarily reduce seed set so that your previous years' efforts aren't wasted, and you can resume your regular management program the following season.

Timing

Timing will depend on the reason for slashing. Slashing is usually done when gamba grass is tall.

- Slash before seeding to reduce spread risk.
- Slash at a time that allows some regrowth and follow-up herbicide application.
- You may need to slash more than once per season to meet multiple management objectives (e.g. reduce seed production and maintain visibility and visual amenity).

Remember that slashing won't prevent seeding – it will just reduce the number of seeds produced.

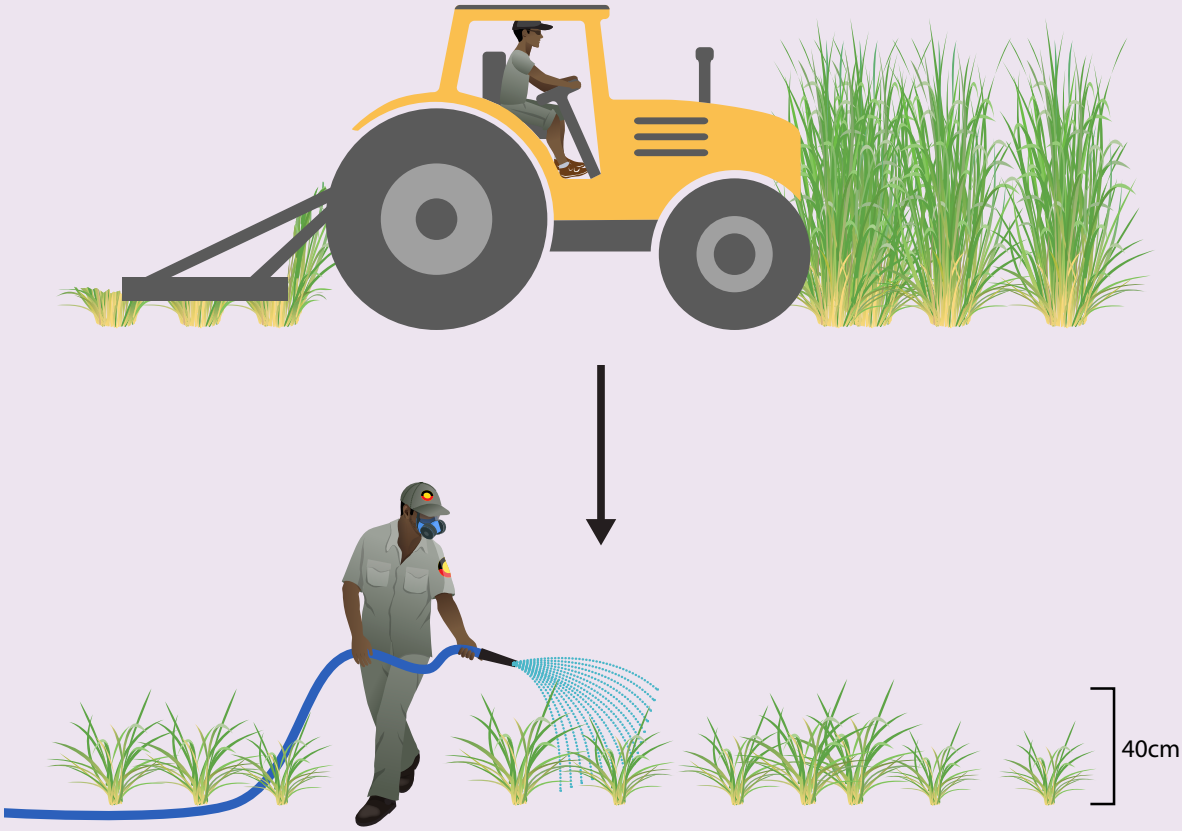


Figure 3.5 Slashing gamba grass and integrating herbicide control. Symbols courtesy of the NESP Resilient Landscapes Hub, nesplandscapes.edu.au.

Matt Sheehan

Slashed gamba grass in a vacant block in an urban area, Darwin.

Matt Sheehan

Grazing

Suitable for:	Less suitable for:	Examples of situations
✓ reducing biomass and seed set ✓ grazing properties ✓ vacant land and linear reserves.	× conservation areas.	→ modified natural areas where grazing has been historically present → crash-grazing of linear reserves and stocking routes.

Grazing doesn't kill gamba grass but may be useful for control in some situations. Where gamba grass is grazed, you can help reduce seed production and the off-farm spread of seed by improving pasture management, grazing practices and farm hygiene.

Controlling gamba grass through grazing

Integrating grazing of gamba grass into other management activities can be a beneficial and effective approach to manage modified systems, such as maintained easements, vacant land, blocks or semi-natural areas with a long history of grazing.

Continuous grazing of gamba grass with low to moderate stocking rates isn't a suitable strategy to manage gamba grass. Grazed gamba grass grows quickly, becomes tall and unpalatable, and will produce seeds and spread. Rather, rotational grazing with high stocking rates keeps gamba grass short and reduces seed set. Trials at the Douglas Daly Research Farm (Northern Territory) have shown that this is very effective at controlling gamba grass (see case study 4 on page 100).

Grazing natural areas

Carefully timed grazing could reduce gamba grass seed set and reduce fuel loads in some natural systems, such as fire-sensitive communities. However, this poses risks to environmental and cultural values and may only be appropriate in some areas. The stock would need a water supply as well as fencing to contain them to the desired area (temporary electric fencing can be used). Before adopting grazing as a management tool, it's important to understand how grazing impacts other values within the management area. Consider a different management option if these impacts are likely with the stock densities needed to reduce gamba grass biomass and reduce seeding.

Pasture management in pastures free of gamba grass

Gamba grass can threaten grazing systems that are free of gamba grass. Maintaining pastures in good condition with high crown and foliage cover, together with on-farm hygiene measures, will help stop invasion by gamba grass. Pastures that are in poor condition or overgrazed are at a greater risk of invasion by gamba grass and other weeds due to bare soil and the reduced vigor of existing grass species. Where gamba grass is present and unwanted, integrate grazing with herbicide control, manual removal and burning.

Intentional grazing of gamba grass

Where you're intentionally using gamba grass as stock feed, all states and territories legally require you to take reasonable steps to minimise spread from the property (refer to Chapter 5 ('Further Infomation'). Four reasonable and practical steps you can take are listed below.

- Keep gamba grass below a height of 60–90 cm to limit seed production and potential spread. This will also help to maintain some palatability and reduce potential fire hazards over the dry season.

Achieve this by doing the following:

- Graze gamba grass with high stocking rates (>10 animals per hectare) to keep it short. This requires rotational grazing or spelling of the paddock so the grass can re-grow before being grazed again. The high stocking rate needed to keep the grass short isn't suitable for long-term set stocking, as the paddock will become over-grazed and there won't be enough feed for the animals. For best results, graze at high stocking rates down to a grass height of about 20 cm. Then remove grazing pressure to allow it to re-grow to about 90 cm before being grazed again. This is a very effective strategy to control gamba grass and optimise cattle growth. Note that gamba grass grows too fast in the wet season to be controlled by low stocking rates (<4 animals per hectare)*.
- Have stock in reserve to increase grazing if grass height nears 90 cm.
- Consider slashing where stocking rates are insufficient to control growth and reduce seed production.

- Eliminate gamba grass from areas on the property where it can't be grazed and may go to seed and spread. For example, around sheds, storage areas, fences, gates, driveways, rock outcrops and within vegetation.
- Follow hygiene measures for all on-farm and off-farm movements.
- Don't make hay from gamba grass while it's in seed or after seeding.

* On smaller properties or where stocking rates are unlikely to minimise seeding, address this by temporarily increasing stocking rates (e.g. buying in cattle) or integrating grazing with other methods, such as slashing.

Refer to Chapter 4 'Case studies' (case study 4 page 100), for an example of grazing management of gamba grass.

Note

If you're in an eradication zone, intentional grazing of gamba grass may not be permitted. You may need to actively control your gamba grass and transition to alternative pastures (see below). Check the legal status of gamba grass in your region and the management requirements.

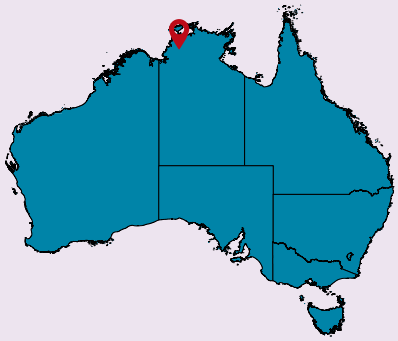
Transition to alternative pasture

Another option is to move away from gamba grass altogether in favour of alternative pasture species that don't have the risks that gamba grass has. This is expensive and will require a determined effort to exhaust the gamba grass seedbank in the soil. This transition takes 3–5 years. Consult your local pasture adviser for recommendations on suitable low-risk alternative species in your region.

Matt Sheehan

Rank gamba grass is actively avoided by livestock.

A grazier's perspective – Tipperary Station, NT



Tipperary Station is a large cattle station in the Northern Territory. It supports mixed enterprises, including grazing, broad-acre farming, horticulture, a carbon-abatement program, tourism and farm-stay work. The property also has outstanding natural assets.

Station managers, have a multi-faceted perspective on gamba grass and managing it for their mixed enterprises and land uses.

> *"Gamba grass, if managed well, can be very beneficial. It increases the stock carrying capacity of the land, grows a huge volume of feed, and has high protein content early in the wet season. But it comes at a major cost. Gamba grass can become a thick monoculture if it's not managed properly or grazed with enough cattle. Vast areas become unproductive, unusable and it can compromise non pastoral enterprises. Cattle avoid tall gamba grass, and you can't walk or drive through it."* David Connolly, General Manager, Tipperary Station.

David Connolly

Gamba grass monocultures negatively impact Tipperary's resting paddocks and carbon-abatement program. It also invades the natural areas on the station and spreads to adjoining Litchfield National Park, where it's significantly impacting natural values.

Fire is also a threat to station infrastructure, horticulture crops and the natural areas on and adjoining the property.

> *"A gamba grass fire is something that no land manager wants to experience. It'll shoot flames 30 metres high, and we've experienced it jumping four kilometres ahead of itself. We've noticed that where we've had hot gamba fires, the eucalypts are suffering - even dying - and ecosystems are changing."*

David Connolly

Recognising the good and bad aspects of gamba grass was an important first step in developing a strategic whole-of-property approach to managing gamba grass on Tipperary Station. Management on the station has two objectives: contain gamba grass to grazing areas (and keep it palatable through rotational grazing), and continually eliminate it from other areas through chemical control and physical removal.

Station managers believe their integrated approach to gamba grass management is reducing seeding and seed spread across the property and to Litchfield National Park. A key learning from Tipperary Station is that gamba grass requires active management even in a production setting.

> *"You only get benefit from gamba grass if you intensively manage it. Otherwise, it becomes a threat and a nuisance to you and your neighbours. With careful integrated management, you can benefit from it and reduce the negative impacts. This is ongoing hard work and expensive. But doing nothing is not an option. If we stop, we'll lose, both in a production sense and a biodiversity sense, on and off the station."*

Fire

Matt Sheehan

Fire scars and active fires in Kakadu National Park, NT.

Fire is part of the landscapes in which gamba grass grows. It has been used extensively to manage land well before the arrival of gamba grass in the 1980s, and often occurs as bushfires in the dry season. Because fire is a permanent feature in the landscapes invaded by gamba grass, it's important to understand the interaction between the two and how fire can help or hinder management of gamba grass.

Gamba grass is extremely tolerant of fire. Fire can kill young seedlings, but mature gamba grass plants survive and thrive following fire. Fire also creates bare ground, and the resulting mass germination of gamba grass seeds perpetuates the cycle of gamba grass growth. Updrafts caused by fires can pick up the light, fluffy seeds and spread them across large distances. For these reasons:

- always integrate fire with herbicide control
- don't use fire as a management tool for gamba grass during seeding
- carefully consider the timing of both herbicide treatment and fire.

Eastick (2016) provides further discussion of the advantages and disadvantages of timing of burning and herbicide application.

This section explores gamba grass management that:

- excludes fire
- uses fire with other management activities (planned burning)
- follows bushfire (unplanned burning).

Matt Sheehan

Gamba grass management at Mary River National Park, NT is achieved through spot spraying with glyphosate and fire exclusion. Dense natives and dead gamba grass tussocks maintain ground cover, reducing gamba grass seed germination.

Excluding fire

Gamba grass seeds are short lived – only 0.1% remain viable after 12 months (see Chapter 1). Research shows that, in some vegetation communities, you can reduce germination of the soil seedbank by excluding fire after herbicide treatment – the mulch of dead gamba grass smothers the seeds, preventing germination. Maintaining this mulch cover for at least 12 months depletes the soil seedbank and needs less follow-up. You can achieve local eradication within 2–3 years by killing any remaining plants and preventing new seed from entering the site. See case study 5 on page 104 for more information about fire exclusion for gamba grass management. Additionally, native perennial grasses can establish when fire is excluded. These compete with gamba grass and increase ground cover, leaving fewer bare patches for gamba grass seeds to establish.

Things to note with this approach:

- Leaving dead gamba grass as mulch may increase fire risk in the short term and could increase fire intensity if a bushfire occurs. However, a single wet season will flatten standing gamba grass to ground level, reducing fire risk in the next dry season and providing good mulch to suppress seed germination.
- Dead gamba grass may also suppress the germination of native grasses. However, native grass seed is typically viable for longer than gamba grass seeds, and they are likely to start germinating after the dead gamba grass mulch has decomposed.
- Excluding fire can result in larger gamba grass plants and denser vegetation.
    - You might need several herbicide treatments in the same season to kill 100% of gamba grass plants.
    - You'll need to use more herbicide to kill large plants.
    - You might have some off-target damage (spraying desirable plants), but it's probably less damage than an intense gamba grass fire would inflict.

Reality check

Excluding fire may be difficult in practice, either because you're using fire for other land management purposes or you're unable to prevent bushfires.

Consider the following:

- Develop a management plan that outlines your fire-exclusion strategy. This may help to justify your approach to neighbours and interested parties. Engage with them to gather support for your approach.
- Put in place risk-mitigation measures, e.g. fire breaks around the management area.
- Have a back-up gamba grass management plan if fire does occur. Include surveillance to identify where gamba grass has spread and apply follow-up herbicide treatments to control any seeds that germinate.

Using fire with other management activities (planned burning)

The effectiveness of fire in managing gamba grass will depend on the timing of the burn, how it is integrated with other control methods and the objective you want achieve.

Burning must be timed carefully to benefit gamba grass management programs. Whether you're burning as part of a gamba grass management program or for other land management outcomes (e.g. road safety), be sure to consider the following:

- Don't burn when gamba grass is seeding (generally May to August).
- Complete any mapping or surveillance activities before burning starts.
- Keep fire intensities and flame heights low. This will minimise impact on desirable vegetation, such as trees, and reduce the risk of a burn getting out of control. Achieve this by:
  - burning when the moisture content in gamba grass is still high (e.g. late in the wet season)
  - avoiding burning when gamba grass has browned off but is still erect.
- Take advantage of the burn by using it as an opportunity to access the site and control plants at the appropriate time following the fire (e.g. before the next wet season and before seeding). For optimal efficacy, allow plants to recover after fire to a height of 40–50 cm, before treating with herbicide.

Rowena Eastick

Wet season burning of gamba grass, integrated with herbicide control.

Matt Sheehan

Surveillance and control are ineffective directly following a burn. Where possible, coordinate burning outside optimum times for surveillance and control activities.

Table 3.6 provides a summary of the main things to consider when deciding when to use fire and how to integrate it with herbicide control. The advantages and disadvantages of timing of burning and herbicide application is also provided in Eastick (2016).

Managing gamba grass following bushfire (unplanned burning)

Bushfires may impact your chosen gamba grass control plan. For example, if you've chosen to exclude fire and a bushfire occurs in your management area, this doesn't mean your management efforts are wasted. Rather, you'll need to adjust your plan and find the positives in the situation to put you back on track. A wildfire presents an opportunity to be adaptive in your gamba grass management program.

Practical actions to implement after bushfire:

- Add surveillance activities into your plan, particularly if seed was present during the fire. Conduct surveillance along the fire scar and any access tracks that were used during response or recovery operations.
- Re-map infestations after the fire, allowing sufficient time for the plants to regrow to a stage where they can be identified.
- Treat infestations with herbicide when gamba grass plants reach 40–50 cm or before they next seed.
- Identify any assets (e.g. threatened species, heritage sites, critical infrastructure) within the burned area where other management activities may need to be integrated with gamba grass control.

Table 3.6 Summary of the main things to consider when deciding when to use fire and how to integrate it with herbicide control.

	No burning (herbicide control only)	Burning before herbicide treatment		Burning after herbicide treatment+
		Wet-season* burns	Pre-control (early dry-season^) burns	
Summary	Preferred for conservation outcomes. Retaining dead biomass by excluding fire in some vegetation communities can: ▪ suppress/prevent seed germination and re-establishment ▪ reduce the amount of follow-up needed. Native perennial grasses can establish when burning is excluded. These compete with gamba grass and increase ground cover, leaving fewer bare patches for gamba grass seeds to establish.	Good compromise when balancing other land-management priorities. Wet-season burns reduce the biomass of gamba grass (old rank material) and surrounding vegetation, improving access and control efficacy. Be prepared to put more work into follow-up to target new seedlings and regrowth.	Not best practice in some situations. Use with caution. Early dry-season burns reduce the biomass of dead gamba grass and surrounding vegetation. While this may improve access and reduce risk of intense bushfires in the short term, plants may take a while to recover from the fire. It's possible that post-fire control in the same season may miss some plants if they have not regrown sufficiently to take up herbicide or if seedlings germinate after control. Be sure to follow-up the following season (early wet season before seeding). Seed may already be present on plants, posing a further risk of spread if burned.	Not best practice in some situations. Avoid burning after control where possible. Efficacy of this approach is timing and situation specific. E.g. Eastick (2016) found that a wet season spray followed by a burn 12 months later resulted in no regeneration in Charles Darwin National Park. Observations elsewhere have shown that post-control burning can result in: ▪ gamba grass seed germination^^ ▪ reestablishment of mature plants not killed by herbicide control. If using this approach: ▪ ensure sufficient time between herbicide treatment and the burn ▪ carry out intensive follow-up with herbicide the following season.
Things to note/words of caution	Large plants are harder to kill and require more herbicide. This approach may conflict with other land-management practices, either on your property or on adjacent land. It may be very difficult to exclude fire.	Timing is critical – both the burn and the herbicide control need to occur before seed set and in a window between rain events. Fire history also needs to be considered (e.g. there needs to be enough dry material to carry the fire).	Plant material dries out and becomes more flammable during the dry season. Burns late in the dry season will be more intense and pose greater risk to desirable vegetation and infrastructure.	If there is tall dead gamba grass it may result in hot fire that could cause damage to desirable vegetation or adjacent built assets. Burning after herbicide control may allow establishment of other high-biomass grassy weeds, such as mission grass or grader grass. Burning too soon after herbicide control can stop the herbicide working and allow the adult plants to reshoot.
		▲ High-frequency burns aren't suitable for all vegetation communities and can negatively impact biodiversity. Understand the vegetation communities that are present and how fire interacts with them. Determine if there are any plants or animals at the site that could be negatively impacted by fire.		
Making the most of chosen approach	Time follow-up to prevent seeding of any remaining plants. Develop a plan that explains your fire-exclusion strategy to interested parties. Consider establishing fire breaks to reduce risk of bushfire. Have a back-up plan if fire does occur.	Follow up regularly with herbicide treatment to control seed germination and regrowth. Incorporate the control of other grassy weeds and opportunistic invaders into your gamba grass control program.	Expect gamba grass germination and spread. Incorporate surveillance and mapping into your management plan. Undertake significant and repeated follow-up herbicide control of both seedlings and regrowth prior to seeding. Monitor wind direction during fire to predict where seed may travel. Carry out surveillance activities in these areas over the following seasons.	

* assumes high moisture content in gamba grass foliage (still green), plants haven't seeded, and plants are likely to regrow sufficiently that season to allow for herbicide treatment.

^ assumes high biomass and that gamba grass has browned off and won't be actively growing again until the following season.

+ assumes treatments kill gamba grass and dead biomass is retained.

^^ based on studies in specific vegetation types, and may not apply to all habitats. Timing of spray treatment and timing of subsequent fire may influence germination.