Factsheet – E2 (insert) Land and soil management for Banana cultivation

This factsheet covers:

- **Best Management Practice - Bananas**
- **Managing land and soil**
- **Soil structure management and remediation**
- **Soil erosion management and remediation**
- **Salinity management and remediation**
- **Soil acidity management and remediation**
- **Sodicity management and remediation**
- **Management of contaminated soils**
- **Additional resources**

The following resources may assist with land and soil management priorities:

- Australian Soil Resource Information System: www.asris.csiro.au Providing access to key sets of Australian soil information.
- Australian Collaborative Land Evaluation System: www.clw.csiro.au/aclep/ Providing information on soil and land resources.
- Climate Kelpie: www.climatekelpie.com.au or Bureau of Meteorology: www.bom.gov.au providing climate information.
- The Australian Banana Growers' Council: www.abgc.org.au

Best Management Practice - Bananas

The Australian Banana Growers Council developed the Banana Best Management Practice (Banana BMP) Environmental Guidelines for the Australian Banana Industry, to help growers self-assess their own environmental practices against the wider industry, including an assessment of their land and soil management.

The Banana BMP aligns with Queensland Government reef regulations and the Freshcare Environmental – Edition 3 – Code of Practice (ENV3).

Growers are encouraged to complete the Banana BMP self-assessment checklist and management plan as part of their Freshcare Environmental Action Plan, continuous improvement cycle.

For more information on the Banana Environmental BMP refer to the Australian Banana Growers' Council website: abgc.org.au/environmental-bmp

Managing land and soil

Healthy, productive soils are essential for farming. Businesses should always implement practices that maintain or improve soil condition. The priorities for soil management vary depending on soil types, topography of the land, surrounding environment, previous land use and climate.

Soils are classified into a range of soil classes. Bananas grown in better class soils have higher yields and are more profitable. Bananas prefer soils that are not prone to water logging. They should be free-draining, have good internal structure and be suitable for cultivation. It is important to understand the soil types on your farm, their characteristics and the best way to manage them.

Soil structure management and remediation

Select farming practices that will maintain or improve soil structure to ensure optimal productivity. Potential ways to manage or remediate soil structure are provided under sub-headings in this section.

Crop Rotation

Planting a fallow crop in between each banana crop rotation helps to maintain or improve the soil structure. In any fallow period, it is important to kill volunteer bananas as they can harbour pests and diseases from one crop rotation to the next. The longer the block can be left fallow, the better for soil health. Ideally, blocks should be left with a fallow crop for a minimum of 12 months.

A break in production by introducing a fallow crop is important and can provide the following:

- **Banana pest control** – introducing a crop that is not a host for pests such as banana weevil borer or plant-parasitic nematodes, breaks the pest life cycle, effectively removing them from the block.

- **Soil biology** – introducing a new crop encourages a diversity of microorganisms and maintains an environment that is conducive to growth, as an active root system is required for a healthy food web.
- **Organic matter** – incorporating fallow crops into the crop rotation helps to improve soil organic matter levels.
- **Erosion protection** – a fallow crop provides ground cover and protection against the impacts of rainfall and surface water runoff.
- **Compliance with regulation** – if you are in a reef catchment area, you must maintain adequate covered ground during the fallow period.

Selecting the fallow crop in a banana rotation depends largely on two factors:

- the presence or absence of plant-parasitic nematodes
- the length of time the block will be left fallow

If plant-parasitic nematodes are present, it is important to identify which nematodes cause the main economic problem and select a fallow crop that is not also a host.

If plant-parasitic nematodes are not present, select the fallow crop by simply choosing a crop that suits the climatic conditions and will provide maximum organic matter:

- In the tropics, suitable crops are sorghum and rhodes grasses.
- In the east coast subtropics, molasses grass, lotononis and broadleaf paspalum are suitable.
- In the west coast subtropics, crops such as sorghum are also suitable, but will need irrigation.

If a fallow crop cannot be planted, volunteer grass or a weedy fallow is preferable to a bare fallow as it will still protect the soil from erosion and provide an active root zone for microorganisms. Bear in mind, however, that it could continue to host plant-parasitic nematodes, if they are present.

The agricultural environmentally relevant activity (ERA) standard for Banana cultivation in the Great Barrier Reef catchment prescribes that at fallow, all blocks must have a grassy fallow or cover crop established that maintains adequate covered ground.

Increasing organic matter

Organic matter is an essential component of a healthy soil because it increases the soil's nutrient and water holding capacity, improves the soil structure and provides a food source for soil organisms. It can be difficult to increase the amount of organic matter because it decomposes rapidly in the warm climate of most banana production areas.

Increased organic matter can be achieved by implementing the following practices:

- Growing fallow crops in between banana crop rotations.
- Applying compost and manures.
- Applying sugar cane by-products such as mill mud NOTE: Mill mud has the potential to introduce pests, diseases and weeds.
- Returning harvested stems and leaves to the row.
- Using a side-throw slasher to put the vegetation slashed from the inter-row onto the rows.
- Applying mulch.
- Reducing cultivation.
- Avoiding high rates of nitrogen fertiliser.
- Encouraging earthworm activity, which incorporates organic material deeper into the soil.

Cultivation method and timing

For most of the banana industry in Australia, mechanical cultivation is essential.

While cultivation prepares the bed for planting and removes any potential compaction zones, it leaves the soil exposed to erosion.

Too much cultivation or poor cultivation techniques can be detrimental to the soil structure. This can lead to surface crusting and loss of air spaces preventing water, air and root access. Fertility may be reduced, if less fertile subsoil is being brought to the surface.

Several things should be considered to improve cultivation outcomes including:

Factsheet – E2 (insert) Land and soil management for Banana cultivation

- **Cultivation timing** - cultivate at times of the year when there is a lower risk of rainfall to minimise the chance of erosion
- **Minimal tillage - r**educe the impact of cultivation by minimising the number of passes, which will conserve the soil structure.
- **Cultivate at the correct moisture level -** soil should not be worked when too wet or too dry. If the soil is too wet, it can cause large clods and compaction below the cultivation zone. Too dry, and the soil can be pulverised into a fine dust, losing structure and potentially causing surface crusting or wind erosion.
- **Maintain the same row location (permanent beds)** - if the irrigation system does not need to be moved, plant successive crops back into the same row. The frequency of mechanical operations such as bagging, picking and spraying in a banana plantation means that a lot of traffic travels each banana row. Over time, this soil can become very compacted. Marking the rows on a GPS provides the opportunity to plant back into the original row configuration. This avoids planting into the compacted inter-row regions.
- **Permanent beds** - consider switching to a permanent bed system. As long as drainage is adequate, there is no real need to work up the inter-row space. This effectively means only half the block is being cultivated.
- **Pre-forming beds** - form beds at the time of year when heavy rainfall is least likely, and sow with a cover crop. The benefits of this approach include good soil cover during wet periods and mounded rows dry the bed out more quickly. This gives more flexibility in planting times, as minimal cultivation is then required to prepare for planting.
- **Crop removal** - consider eradicating the old banana crop by injecting with glyphosate rather than cultivating. Control volunteer bananas with herbicide rather than cultivation.

Improvement activities to increase ground cover, soil structure and soil organic matter should be documented in your Environmental Action Plan (EAP), for more information refer to *Freshcare Factsheet E1: Environmental action planning*.

Soil erosion management and remediation

Managing soil erosion is especially important in the subtropics on the east coast, where bananas are grown on relatively steep gradients, and in the tropics of Far North Queensland, where significant, high intensity rainfall is received.

The west coast subtropics are also vulnerable to wind erosion and water erosion during flooding events.

It is a minimum practice agricultural standard of Queensland's Reef Protection Regulations that banana growing activities minimise sediment loss to waterways by having appropriate erosion and sediment control measures in places where there is a high risk of soil loss from the farm.

There are two main principles for managing soil erosion:

- Maintaining ground cover.
- Controlling runoff water.

Ground cover

Good ground cover is essential for managing soil erosion. Ground cover can provide the following benefits:

- Intercepts rainfall, reducing the surface impact of raindrops.
- Slows the velocity of surface water.
- Increases water infiltration.
- Stabilises the soil.

A suitable ground cover is:

- Shade tolerant.
- Not invasive or too competitive.
- Perennial.
- Tolerant of traffic (tropical production or row configuration plantings).
- Short growing and has a spreading habit.
- A non-host for the main plant-parasitic nematodes if they are present.

Factsheet – E2 (insert) Land and soil management for Banana cultivation

Maintain a minimum 60% ground cover

While a living ground cover is preferable, a dead cover can also provide protection from erosion. If spraying the inter-row cannot be avoided, allow the vegetation to grow and then spray with a knock-down herbicide. This will preserve the root system and provide a mulch layer to protect the soil. Regardless of whether it is living or dead, a minimum of 60% ground cover is required.

The agricultural environmentally relevant activity (ERA) standard for Banana cultivation in the Great Barrier Reef catchment prescribes that at all blocks must have adequate covered ground at appropriate times in the banana crop cycle.

- Inter-rows on plant blocks have **at least 60%** covered ground before 1 November (wet season) (unless undertaking renovation works).
- Inter-rows on ratoon blocks have **at least 60%** covered ground (unless undertaking renovation works).

There are several ways to maintain and promote ground cover in the plantation, as provided under sub-headings in this section.

Promote vegetation around the farm

Maintain vegetation and slash rather than spraying it out, especially during periods when there is a high risk of erosion. If it is not possible to maintain slashed inter-rows and headlands across the farm all year round, ground cover should be a priority:

- In plant blocks.
- During the wet/storm season.
- On steeper slopes.
- On lighter soils that are prone to erosion.

Mulching the inter-row space

In drier climates, where organic matter decays more slowly, mulching trash material in the inter-row space provides an effective ground cover and contributes to the required 60% coverage (if in a reef catchment area).

Mulching on the row

Where cultivation is limited, establish a fallow grass crop and then spray this out before planting, leaving a mulch layer over the ground. Other, low-growing cover crops may only require spraying in the immediate row area where the banana is to be planted. In the tropics, use a side-throw slasher to put mulch on the row.

Good drainage in paddocks

Paddocks that drain well are less likely to become water logged and boggy and will maintain a better ground cover.

Wider row spacing

Adopting a wider row spacing allows more sunlight to reach the ground which will help with better ground cover.

Reduce traffic in the rows

Keep out of new paddocks to allow them to establish and reduce traffic when its wet.

Companion crops

Planting a quick establishing companion crop is recommended for plant crops or bare ground, especially during high risk rainfall periods. In the east coast subtropics, white clover and summer grass are suitable.

Place leaves and harvested heads on the row

This provides soil cover and prevents the inter-row grasses from being smothered.

Plan the timing of crop removal and cultivation

Plan banana crop removal and general cultivation activities for the time of year when there is the lowest risk of rainfall. Time the inter-row maintenance for the dry times of the year.

Factsheet – E2 (insert) Land and soil management for Banana cultivation

Eradicate the old banana crop by injecting

Remove the old banana crop by injecting with glyphosate rather than cultivating. Also, control volunteer bananas with herbicide rather than cultivation.

Ensure ground cover is maintained during other farming activities

Maintain ground cover on buffers/headlands between the blocks and creeks or drains. For example, maintain the ground cover when installing a pump near a creek bank.

Controlling runoff water

Controlling the speed and direction of runoff water is critical for minimising erosion. Measures and structures should be introduced to slow water where slopes are likely to produce high velocity water flows. Surface water should be directed to suitable waterways that are capable of carrying high velocity water.

The minimum agricultural practice standards under the Queensland's Reef Protection Regulations require banana producers to minimise sediment loss to waterways by having appropriate erosion and sediment control measures in places where there is a high risk of soil loss from the farm.

For more information on the minimum agricultural standards under Queensland's Reef Protection Regulations, refer to the Qld Government website: www.qld.gov.au/environment/agriculture/sustainable-farming/reef/reef-regulations/producers/bananas

Or, the agricultural environmentally relevant activity standard for banana cultivation: www.qld.gov.au/__data/assets/pdf_file/0013/113143/banana-era-standard.pdf

The following information provides measures that may be implemented on your farm to reduce sediment run-off.

Not all measures would be suitable for your property and it is recommended that you seek professional advice in particular where the topography makes the soil more prone to erosion.

Farm design

Use farm maps and topographical maps to design or improve the farm layout, to provide permanent, all-weather access and good drainage. These plans need to take into account soil types, current and future land use, gradients, existing waterways and irrigation layouts.

Block selection

Avoid growing bananas in low-lying areas that may be prone to flooding, especially where high velocity flooding occurs and on steep slopes where erosion cannot be managed.

Block design

Use structures such as diversion banks, contour banks and constructed waterways to manage the direction and velocity of surface water. Engage a consultant to help plan where to place these structures.

- **Contouring** - as a general rule, any land with a gradient greater than 3% (a 3 metre fall in 100 metres) should be contoured. Contouring stops water running off slopes too fast and subsequently eroding soil. Seek professional advice before developing contours. Unless major modifications are required, maintain these rows as permanent beds.
- **Diversion banks** - these are often used to catch surface water from above a paddock, diverting it away from the block and into a suitable waterway.
- **Constructed waterways** - these are wide, vegetated, flat-bottomed structures designed to collect runoff and slow the water before conveying it at a safe velocity to a drainage line or natural waterway. They are often called a spoon drain. They differ from constructed wetlands, which are planted with vegetation to capture and hold runoff water (for at least two days), allowing time for fine sediments and nutrients to be removed from the water. The drain should be wide and shallow to slow run-off, with gentle sloping banks to prevent slumping or bank erosion, allowing coarse and medium sized sediments to settle. The spoon drain may require occasional sediment removal or maintenance to ensure discharge capacity is maintained. You should

reestablish vegetated cover (e.g. grass) immediately following any maintenance works.

- **Silt traps** - these are structures that cause suspended sediment in run-off water to be collected and detained, allowing the medium to coarse sediments to settle within the trap. The silt trap will require ongoing maintenance to ensure its effectiveness. These are a last line of defence against sediment leaving your farm and are not effective on their own. Excess sediment in the silt trap demonstrates that the farming system is failing elsewhere. Professional advice on the design and positioning of silt traps will save time and money, while ensuring the desired impact.
- **Laser levelling** - on farms with little gradient, blocks should be laser levelled, where practical and affordable, to ensure a constant fall and prevent water from collecting in the paddock and creating wet areas. Afterwards leave blocks to consolidate as long as possible before planting and consider forming beds early, then planting with a cover crop.
- **Vegetative ground cover -** maintaining grass or vegetation cover wherever possible on the farm helps to stabilise the soil, reduce the velocity of surface water and provides filtration before the water leaves the farm. Living or dead vegetative ground cover contributes to the minimum standards required under reef protection regulations.
- **Land clearing -** do not clear vegetation from steep land where soil conservation practices cannot manage potential erosion problems. Each state has different land clearing legislation. Clearing native vegetation is regulated by both Commonwealth and State Government departments, contact your state natural resource department to get the necessary permits before clearing land.

Plant crop

The plant crop stage is the most susceptible to erosion and should receive the most care and attention for the following reasons:

- The soil has not yet consolidated following recent cultivation.
- There is limited ground cover as it has not yet established.
- There is limited plant root mass to hold the soil together.
- There is limited plant canopy to intercept rainfall before it hits the ground.
- There is limited banana 'trash' to provide ground cover.

Planting a rapidly establishing companion crop is recommended for plant crops or bare ground, especially during high-risk rainfall periods.

It is a requirement that by the start of the wet season all plant blocks must have at least 60% covered ground in the inter-row, except when undertaking renovation works (for example, to remove wheel ruts).

In a system where cultivation is not required before planting, (such as a pre-formed bed system or in plantations established by hand-planting), an effective management strategy is to establish a fallow crop and spray this out before planting. This will provide a thick mulch layer that will cover the soil. Care is needed because this mulch layer may harbour plant pests and diseases such as bacterial corm rot (*Erwinia*).

Drains

- Use pipes and culverts to reduce the need for machinery to drive across drains and put rocks on those where access cannot be avoided.
- Natural gullies and waterways should not be disturbed or redirected.
- Consider installing a diversion drain at the top of a sloping block to keep the water out of the block altogether.
- Broad, shallow spoon drains are most suitable as they are less susceptible to erosion and allow vegetation to be easily maintained with slashing. This is particularly important on lighter soils.
- Use 'drop structures' in drains where there is a significant fall to reduce water velocity and therefore subsequent erosion.
- Maintain living vegetation on drains during the wettest periods of the year.
- Slash rather than spray drains or, if spraying, let the grass at the side of the drain get tall before spraying with a knock-down herbicide. This will preserve the root structure of the plants and protect the bank with a mulch layer.
- Inspect drains regularly, especially during heavy rainfall, to ensure they are working effectively.

- Carry out drain maintenance during the low risk rainfall periods.
- Stabilise drains with coarse aggregate/ballast where necessary.

Roads

The roadway should never be used as a drain unless it has been specifically constructed and stabilised for this purpose. The roadway may only be used to help direct water to an appropriate drainage line as long as they were constructed for this purpose.

- Stabilise main headlands with sand and rock, as they pack hard. Remove wheel ruts and repair roadways as necessary.
- Put a suitable batter on 'built up' roads to prevent erosion from the sides of the road, and maintain vegetation beside the road batter.
- In steeper areas, for example on the subtropics east coast, concrete the roads that receive a lot of traffic and the corners where vehicles are constantly turning and disturbing the soil.
- Use pipes/culverts under the road, where necessary, to prevent water from damming. This ensures good drainage so that water does not pond in traffic areas.
- Build roads on the contour or build whoa-boys or inverts to allow water to cross the road.

Inter-rows

- Encourage traffic to stay on the roadways/headlands instead of taking short-cuts through paddocks.
- Make the main picking rows wider to allow extra sunlight and air flow, which enables them to dry out more quickly and makes conditions more conducive for vegetative ground cover to grow. It will also mean that less damage is caused to the fruit hanging in the picking row during harvest.
- Maintain grass in the inter-row space. Vegetation will reduce the raindrop impact (splash erosion), increase water infiltration, decrease the speed of surface-water runoff, reduce soil movement with machinery and improve the soil structure.
- Where necessary, use a 'V' blade to make the centre of the inter-row the lowest point, rather than the wheel tracks.
- Repair wet areas in inter-row spaces as soon as possible either with coarse aggregate/ballast or by improving the drainage. Once ruts are established in a block, they are hard to manage and can potentially cause sediment loss in surface runoff water.
- Consider switching to a permanent bed system.

Creeks

- Leave riparian vegetation along the creek/river banks.
- Revegetate and/or stabilise eroding creek banks where significant erosion is evident.
- Avoid constructing roads or tracks through creeks that would affect hydrology and fish passage and that can lead to erosion.

Contact your local, state-based natural resource department and seek professional advice before conducting any work on waterways or riparian vegetation, including works to prevent stream bank erosion.

For information relating to revegetation, refer to the stream bank planting guidelines and hints available at the Queensland Department of Natural Resources, Mines and Energy website.

Contact your local, state-based fisheries department for works that may interfere with fish passage.

You may also seek professional advice from your relevant River Improvement Trust.

Salinity management and remediation

Most of Australia's banana production areas are free of salinity problems. However, as the industry seeks new production regions for geographical diversification, this may become a greater issue in the future.

Some regions or particular farms within a region may experience salinity problems related to irrigation water.

Factsheet – E2 (insert) Land and soil management for Banana cultivation

Growers irrigating from underground water sources should test their water source and manage accordingly. To reduce the salinity of irrigation water, it may be possible to mix it with a better-quality water supply.

Growers irrigating out of tidal reaches should avoid irrigating at high tide to ensure they are only using fresh water. It is also recommended that the water between high tides is tested to ensure the salinity levels are acceptable.

Soil acidity management and remediation

Soils can be naturally acid or alkaline. Soil pH may also change with irrigation, fertiliser and crop management practices. As soil pH changes, the availability of soil nutrients may also change.

A pH (water) within the range of 6 – 7 is ideal for bananas. Depending on the farming location, this could be higher or lower without intervention. For example, Carnarvon soils are naturally more alkaline (high pH), whereas in the east coast tropics soils are naturally more acidic (low pH). Bananas will grow outside of this range, although the closer the pH is to neutral, the better for production.

- Monitor your soil pH and test it at least annually. Continuity in a declining pH at lower levels in the soil profile may indicate that nitrate from ammonium based fertilisers is being lost in deep drainage or leaching.
- Apply soil amendments based on your soil test results to maintain an optimal pH. This will vary depending on your location (refer to the *Freshcare Factsheet E5 Fertilisers and soil additives* for more information).
- Incorporate pH amending products into the soil before planting.
- In low pH (acidic) conditions, lime and dolomite will help to increase the pH. In higher pH (alkaline) conditions, sulphur and ammonium products will help to reduce the pH level. Professional advice should be sought to test for and correct pH.
- In dry periods when spider mites are causing a problem, the extra dust from lime may provide conditions that increase mite populations. More frequent pest monitoring may be necessary in this case.
- Some fertilisers reduce pH, so the fertiliser program needs to be managed accordingly.
- pH conditions outside the optimum range (too acid or too alkaline) can restrict the availability of micro and macro-nutrients as well as influencing soil microbiology.

Acid sulphate soils

Acid sulphate soils can harm banana production and can have a major impact on farm infrastructure. Acid sulphate soils are formed when seawater or sulphate-rich water mixes, in the absence of oxygen, with land sediments containing iron oxide and organic matter. Acid sulphate soils are commonly found less than 5m above sea level. Mangroves, salt marshes, floodplains, swamps, wetlands, estuaries and brackish or tidal lakes are ideal areas for acid sulphate soil formation.

The presence of acid sulphate soil may not be obvious on the soil surface as it is often buried beneath layers of more recently deposited soils and sediment.

When exposed to air due to drainage or disturbance, these soils produce sulphuric acid which in turn can release toxic quantities of iron, aluminium and heavy metals.

Potential ways to manage or remediate acid sulphate soils

Acid sulphate soils can be associated with areas that are poorly drained or scalded and should not be drained, cleared or exposed without first consulting your local state-based agriculture department. Draining, clearing or exposing the soils in these areas will prevent mobilising the acids and toxic elements in the profile.

Management strategies can only be successful if based on adequate mapping of the sulphide contents. Soil reactivity and depths to which sulphuric and sulphidic horizons occur, may include:

- Re-flooding trials utilizing existing freshwater, tidal and saline ponds in constructed wetlands and brackish water in a ponding basin.
- Bioremediation trial to re-establish reducing conditions to stop pyrite oxidation by the addition of sulphate-reducing bacteria and various organic wastes.

- Slotting trials using soda lime by-product to treat acidic discharging meteoric water or groundwater leachate.

Sodicity management and remediation

Sodic soils are those where the amount of sodium held on to the clay particles is 6% or more of the total cation exchange capacity. They have an unstable structure and are poor places for plants to grow. Sodic soils are generally not very suitable for banana production and unlikely to be used unless there is no other soil type available. Sodic soils have poor soil structure, which means they are prone to surface crusting or sealing, can have poor water infiltration and low water holding capacity. They are dispersive when wet, which is visible as 'cloudy' water, rather than the soil particles staying together. Drains will be susceptible to erosion if constructed on these dispersive soil types.

Gypsum, deep rooted plants and improving soil organic matter can help to improve the soil structure.

Remediation activities for areas identified on-farm as being highly degraded or eroded should be documented in your Environmental Action Plan (EAP), for more information refer to *Freshcare Factsheet E1: Environmental action planning*.

Management of contaminated soils

Persistent chemicals

Soil contamination occurs from persistent chemicals, old dips, dumps, heavy metals, fuels, oils or hydraulic fluid.

- On a farm map, identify areas that have been contaminated and ensure measures are in place to prevent soil from moving from these sites. Avoid these areas, maintain vegetation to prevent soil movement and if necessary fence or bund the contaminated area.
- Provide bunding or a containment method where products that could cause contamination are used.
- Control erosion on the site to help contain contaminated soil.
- Do not plant bananas in contaminated areas.

Soils can be contaminated by the application of chemicals and fertilisers. Persistent chemicals belonging to the organochlorine (OC) and organophosphate (OP) groups may be present on farms due to past use, dumping or spillage. As well as application to previous crops, 'hot spots' such as old dip sites, disposal or dumping areas, remnant building sites and areas near power poles may have persistent chemical residues present.
How long chemicals remain in the soil will depend on soil type, climatic conditions and how they were used (e.g. cover spray, dip, dump site).

Examples of some persistent chemicals used in agriculture include DDT, Lindane, Chlordane, Aldrin, Endrin, BHC, Heptachlor, Methoxychlor, Hexachlorobenzene and Toxaphene.

Areas used to dip or treat livestock or grow sugar cane, sweet corn, some vegetable crops and orchard crops have the highest risk of being contaminated.

In Australia, a common example of a persistent chemical is dieldrin. Dieldrin is an insecticide that belongs to the OC group. Although dieldrin has been banned from use since the 1980s (along with all organochlorine and organophosphate pesticides), it was once applied routinely as an agricultural, industrial and domestic insecticide for the control of termites (white ants), household pests, ants and soil insects.

Heavy metals

Heavy metals are the group of metals with a specific gravity of five or higher, meaning they are five or more times heavier than water. Examples are cadmium, lead and mercury. Heavy metals may occur naturally in soil or they can be introduced in small amounts through the use of fertilisers (especially phosphate) and soil additives (such as gypsum and animal manure), and from industrial uses (either past or present).

Cadmium is the heavy metal of most concern to fresh produce. Most cadmium (Cd) occurring naturally in the soil is present at levels of 0.1-1.0 mg Cd/kg of soil, and is in an insoluble form, so uptake by plants is low. Cadmium is mobilised and

uptake increases where soils are very sandy, saline or acidic, low in zinc or organic matter and if irrigation water is salty.

Lead can contaminate the site as a result of fumes from nearby heavy vehicle traffic, dumping of old paint or weathering of paint from buildings, and from previous use for storage or discharging of firearms (e.g. rifle range).

Other contaminants

Other soil contaminants include hydraulic fluids, oils and fuel from storage areas and machinery. Ensure oils, fuels and hydraulic fluids are stored so as to prevent contamination of soil or groundwater. Regularly maintain machinery and check hydraulic, oil and fuel lines for leakage.

Managing off-site movement

Soil testing in paddocks or areas assessed as being a risk, can be undertaken to determine whether residues are present or not.

Disturbance of affected sites can lead to erosion and off-site movement of contaminated soils, affecting the surrounding environment and wildlife.

Property managers should aim to minimise soil movement off contaminated sites by:

- Identifying these areas on a property map.
- Maintaining groundcover on contaminated sites.
- Implementing effective soil erosion control strategies for larger cultivated sites (see the section on 'Soil Erosion' for erosion control strategies).
- Fencing off, erecting signage, or preventing access or disturbance to smaller 'hotspot' sites.
- If the contamination is significant, affected soils may need to be removed from the site and disposed of at an appropriate facility.

Remediation activities for areas identified on-farm as being contaminated should be documented in your Environmental Action Plan (EAP), for more information refer to *Freshcare Factsheet E1: Environmental action planning*.

Additional Resources

The following additional resources can provide online information to assist banana growers with land and soil management priorities:

The Australian Banana Growers' Council – Environmental Best Management Practice: abgc.org.au/environmental-bmp/

Queensland's Reef Protection Regulations - Bananas: www.qld.gov.au/environment/agriculture/sustainable-farming/reef/reef-regulations/producers/bananas

Environmentally Relevant Activity (ERA) Standard for Banana Cultivation: www.qld.gov.au/__data/assets/pdf_file/0013/113143/banana-era-standard.pdf

Australian Soil Resource Information System: www.asris.csiro.au

Providing access to key sets of Australian soil information.

Australian Collaborative Land Evaluation System: www.clw.csiro.au/aclep

Climate Kelpie: www.climatekelpie.com.au

Bureau of Meteorology: www.bom.gov.au