NSW GOVERNMENT Department of Primary Industries

primefact

Considerations for developing and managing macadamia on floodplain soil

August 2020, Primefact 1656, Second edition

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Introduction

Establishing any crops on floodplains requires different considerations from other locations. Apart from the risk of flooding, other factors such as soil acidity, acid sulfate soil and drainage constraints need to be considered and amended to ensure long-term success for macadamia trees and to prevent environmental damage.

It is the individual's responsibility to understand the constraints of the land they wish to purchase or grow macadamia on. Not understanding the risks associated with acid sulfate soil, land elevation and drainage

constraints can risk the longevity and potential yield of trees, as well as have detrimental environmental effects. NSW DPI recommends that land lower than 1.5 m AHD (above sea level) is not suitable for growing macadamia.

Recommendations in this Primefact are based on practices currently being used successfully and are meant as a guide only.

What do I need to consider?

Acid sulfate soil (ASS)

Floodplain soil usually develops under wetland or waterlogged conditions. As the soil was laid down in low oxygen conditions, iron pyrite

(an iron and sulfur mineral) was also laid down. While the soil stays waterlogged, the iron pyrite remains benign. This soil is called potential acid sulfate soil (PASS). When soil with this iron pyrite is exposed to oxygen, for example, if it is drained or excavated, the resulting chemical reaction produces sulfuric acid (H_2SO_4) and pyrite (FeS_2). This is now an acid sulfate soil (ASS). The sulfuric acid generated in this soil kills plants (including young macadamia seedlings) and causes toxicity in the soil and water. It also causes problems for fish and other aquatic wildlife downstream. The pyrite can cause problems later by contributing acid salts to the soil. Growers should know where potential acid sulfate soil is on their property and how deep below the surface it is so they can ensure it is not oxidised by their activities.

Development consent

Disturbing acid sulfate soil requires development consent and you will need approval from your local council each time you want to disturb more than one tonne of acid sulfate soil. Disturbing acid sulfate soil without development approval is a breach of the Local Environment Plan and is an offence.

The floodplain is divided into different classes depending on the risk of encountering acid sulfate soil. Your local council can advise what classes (Table 1) are on your property; some councils might have this information on their website.

he classes indicate how deep you can disturb the soil without the risk of encountering acid sulfate soil. The risk is generally related to the elevation of your land, with the lowest lying areas having the greatest risk. Activities that might disturb acid sulfate soil include:

- lowering the water table
- laser levelling
- mounding
- constructing drainage
- redesign
- maintenance.

Development approval will require comprehensive laboratory testing of the soil or sediment that will be disturbed, developing an acid sulfate soil management plan (usually by a consultant) and a development application to be submitted to the local council.

Before any earthworks are conducted on a floodplain property, you must check whether development approval is required. Adherence to the local environment plan reflects on the industry. New macadamia growers should know the community is aware of the risk of acid sulfate soil and regularly reports large-scale earthworks on the floodplain to councils for investigation.

Where work is to be carried out on waterfront land, it should not be assumed that state approvals negate the need to seek local approval from the council. Advice should always be sought from all regulatory bodies (e.g. the Natural Resources Access Regulator [NRAR], Fisheries, Water NSW, Council).

Australian height datum

Knowing the elevation of a floodplain property is essential because this is what controls drainage after a flood and heavy rain, the presence of acid sulfate soil, soil type and frost risk. NSW DPI recommends that land lower than 1.5 m AHD (above sea level) is not suitable for growing macadamia as it is too high risk for flooding and acid sulfate soil, and too difficult to drain. This means that not all of the property will be suitable for planting. However, some of these low-lying areas could be used to complement the macadamia farm and the general environment. For example, establishing native plants.

Particular care should be taken to obtain data reflecting the relative fall over the whole of the property to gauge how water is drained. Issues are likely to become apparent in extreme situations such as high tidal levels, dry periods and excessive rainfall on properties at or below 1.5 metres AHD. If there is any doubt about the relative height (in AHD or height above (mean) sea level) over the property, satellite digital elevation modelling (or actual measured relative heights) can provide this information.

Land elevation data can be difficult to obtain and is not freely available on the internet to individuals. Potential purchasers and new growers are encouraged to contact industry groups for advice and support in obtaining this information.

Table 1. Class of land works that will trigger the need for development approval.

Class of land	Specified works
1	• Any works
2	• Works below the natural ground surface • Works by which the water table is likely to be lowered
3	• Works beyond 1 metre below the natural ground surface • Works by which the water table is likely to be lowered beyond 1 metre below the natural ground surface
4	• Works beyond 2 metres below the natural ground surface • Works by which the water table is likely to be lowered beyond 2 metres below the natural ground surface
5	• Works within 500 metres of Class 1, 2, 3 or 4 land which are likely to lower the water table below 1 metre AHD in adjacent Class 1, 2, 3 or 4 land

Source: Ballina Shire Council. 2018. Acid Sulfate Soil Management Plan for Minor Works, https://www.ballina.nsw.gov.au/cp_themes/default/page.asp?p=DOC-CVM-05-57-30

Liming

Established floodplain macadamia farmers use lime extensively to manage their acid sulfate soil. Even though they are not regularly disturbing the soil, the lime is used to manage the soil pH, the water moving through the soil profile and for feeding the macadamia trees.

Lime is also used when managing drainage to neutralise any acid run-off that might occur. Lime application rates can be calculated using online management tools or by consulting with your local agronomist.

Testing pH regularly will help to understand how the soil is responding to practices, amendments and liming. It will also help calculate the amount of lime to be applied.

Remember to check the pH of both puddled areas of water as well as the water in drains to see how the paddock responds after rain. This site-specific knowledge is very useful to you and to any contractors or advisors you are employing.

Mounding

Macadamia prefers soil with a pH of between 5.5 and 6.0 ($CaCl_2$). Most soil on the Clarence and Richmond River floodplains is acidic, having levels of aluminium that are toxic to macadamia. Consequently, macadamia trees are planted on mounds that are approximately 600 mm above the natural soil surface. This height will vary depending on several factors including soil type, ability to drain and presence of ASS. In some cases, the mounds will be created below this height and then top-worked to this height a few years later. This has been shown to invigorate the plants.

To create a 600 mm mound, 300 mm is shaved off the soil and rows are developed at 9 m apart. In some locations, topsoil availability might result in a mound being 400 mm high. Trial and error have led to the 9 × 4 spacing. Closer spacing makes the inter-row angles too steep, and while wider and higher mounds could provide better drainage and growing conditions, the wider rows lower the number of trees per hectare, potentially reducing profitability.

Several growers are experimenting with closer spacing. The cost of trees will increase with closer spacing, and at some point, it is a case of diminishing returns. Row widths will be a compromise between achieving optimal growing conditions and tree stems per hectare. The sooner the trees meet in the middle of the row, the sooner they have further protection from wind.

Rows will be laser-levelled to prevent ponding and allow excess water to drain slowly from the orchard. This ensures minimal erosion and permits grassed inter-rows. Stabilising inter-rows with a thick grass cover will prevent soil erosion and filter any run-off.

The soil that was used to create the mound is then limed to create a more suitable environment for the plant to survive. Liming will likely be an ongoing annual exercise (Figure 1).

It is essential that when these mounds are constructed, you understand where acid sulfate soil is, so it is not disturbed or exposed, as this will generate unsafe amounts of acid.

Remember that disturbing more than 1 tonne of acid sulfate soil requires development approval from the council. This will involve comprehensive soil testing and lodging an acid sulfate soil management plan showing how any effects will be mitigated.

Once planting is done (trees being 4 m apart within a row), the inter-row space is left untouched. This allows:

- minimal drainage flow, thus less chance of erosion
- the ASS layer to remain undisturbed
- protection of the water table
- the macadamia trees to establish a root system within the controlled environment.

Figure 1. Row mounds will be limed to support tree growth.

Using the 'leftover' land: not all floodplain land is suitable for macadamia

Usually this will involve planting native species that will thrive because they will be in their preferred habitat; they will also be cheaper to grow than other species. A planting guide for native plants was developed for the Ballina coastal floodplain area, but your local native nursery will also be able to help. There are several other issues to consider including:

- Planting near drains to provide a filter between run-off from the farm and the drains, keeping them cleaner for longer. However, the drains will need to be cleared, possibly every couple of years.
- Integrated pest management (IPM) will be greatly enhanced by smart planting, providing a home and breeding grounds for the beneficial insects in your IPM program. You will need to ensure that there is sufficient habitat over time for them to thrive. This means keeping flowers available as a food source for as long as possible; therefore, plant different species that flower at different times during the year.
- If the proposed orchard site is next to a river or creek and access is clear, consider using the river mangrove (*Aegiceras corniculatum*), which is a short, compact tree. These enhance fish habitat, will help with filtering run-off from your property and stabilise river banks (Figure 2).
- Connecting native plantings with other natural areas enhances the environmental benefits of these plantings and provides additional habitat for local wildlife.

Managing drainage

Many floodplain properties have existing drainage systems and these can be the responsibility of the local flood mitigation authority (the local council), a drainage union or the landowner. Before buying a floodplain property, find out who is responsible for any existing drains and what level of drainage they will provide.

Constructing new drainage systems on the floodplain is likely to trigger the need for development consent because acid sulfate soil will be disturbed or drained. Again, you must understand what classes of acid sulfate soil are on the property and whether this will trigger the need for development approval. Ideally, this is determined before you buy the land.

Figure 2. Grey mangrove overstorey and river mangrove foreground. Photo: NSW DPI Fisheries.

Development approval must be obtained each time a drain is mechanically cleaned if you are in a class area that triggers consent. Development approval will require comprehensive laboratory testing of the soil and sediment that will be disturbed, the development of an acid sulfate soil management plan (usually by a consultant) and the submittal of a development application to the council.

Mechanically cleaning drainage systems will usually require development approval because of the risk of disturbing acid sulfate soil.

Existing floodplain drainage systems can be a source of poor water quality into the estuary, and landowners are encouraged to work cooperatively with their local council to explore options to improve this. Some drains could be tidally flushed through the active management of floodgates.

Planting out of drains is best on the northern side, where possible, as this creates a shady habitat for fish and again helps with managing weeds in drains.

Managing acid sulfate soil on a floodplain property and getting the necessary development approvals is a costly and lengthy process. This should be factored into buying any land on the floodplain for growing macadamia. Ignoring these obligations reflects the industry and might result in the council taking action.

Frost

Macadamia do not like frost, so check the history of the area and ensure that it is a location free of frost.

Shallow soil

As a rule of thumb, ensure the soil has enough depth so 600 mm mounds can be constructed. Also ensure the soil is free draining. Freely draining soil might influence a slightly lower mound; however, be wary of heavy clay soil.

More information

Ballina Shire Council. 2018. Acid sulfate soil management plan for minor works, https://www.ballina.nsw.gov.au/cp_themes/default/page.asp?p=DOC-CVM-05-57-30

NSW Government. 2019. Acid sulfate soil, http://www.environment.nsw.gov.au/topics/land-and-soil/soil-degradation/acid-sulfate-soil

For updates, go to https://www.dpi.nsw.gov.au/agriculture/horticulture/nuts

Reference number: PUB20/762.

Figure 3. Ensure drainage management is sufficient to minimise damage downstream.