NSW GOVERNMENT Department of Primary Industries

primefact

Considerations for developing and managing macadamia on floodplain soils

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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 soils and drainage constraints need to be considered and addressed to ensure long-term success for your 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 macadamias on. Not understanding the risks associated with acid sulfate soils, land elevation and drainage constraints can risk the longevity and potential yield of trees, as well as have detrimental environmental impacts. NSW DPI recommends that land lower than 1.5 m AHD (above sea level) is not suitable for growing macadamias.

It should be noted that recommendations within this Primefact are based on practices that are currently being used successfully and are meant as a guide only.

What do I need to consider?

Acid sulfate soils (ASS)

Floodplain soils usually develop under wetland or waterlogged conditions. As the soils were laid down in low oxygen conditions, iron pyrite (an iron and sulfur mineral) was also laid down. While the soils stay waterlogged, the iron pyrite remains benign. These soils are called potential acid sulfate soils (PASS). When soils with this iron pyrite are exposed to oxygen, for example if they are drained or excavated, the resulting chemical reaction produces sulfuric acid (H_2SO_4) and pyrite (FeS_2). These soils are now acid sulfate soils (ASS). The sulfuric acid generated in these soils kills plants (including young macadamia seedlings) and causes toxicities 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. It is important that you know where potential acid sulfate soils are located on your property and how deep below the surface they occur so you can ensure they are not oxidised by your activities.

Development consent

Disturbing acid sulfate soils 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 soils. Disturbing acid sulfate soils 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 soils. Your local council can advise what classes (Table 1) are present on your property, some councils may have this information on their website.

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

- lowering the water table
- laser levelling
- mounding
- drainage construction

- 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 your local council.

Before any earthworks are conducted on your floodplain property, you must check whether development approval is required. Adherence to the Local Environment Plan reflects on the industry, and new macadamia growers should know the community is aware of the risk of acid sulfate soils and regularly report large scale earthworks on the floodplain to councils for investigation.

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

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

Australian height datum

Understanding the elevation of your floodplain property is essential because this controls drainage following floods and heavy rain, the presence of acid sulfate soils, soil type and frost risk. NSW DPI recommends that land lower than 1.5 m AHD (above sea level) is not suitable for growing macadamias as it is considered to be too high risk for flooding and acid sulfate soils, and too difficult to drain.

This means that not all of a property may be suitable for planting. However, some of these low-lying areas could be put to uses that are complementary both to your macadamia farm and to 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 from the property. 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 you are in any doubt as to the relative height (in AHD or height above (mean) sea level) over the property, you are advised to seek and access satellite digital elevation modelling (or actual measured relative heights) to 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.

Liming

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

They also use lime during drain management to neutralise any acid run-off which may occur. Lime application rates can be calculated using online management tools or by consulting with your local agronomist.

Testing pH regularly will help you to understand how the soils are responding to practices, amendments and liming. It will also help you 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 get an idea of 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 prefer soil with a pH of 5.5–6.0 ($CaCl_2$). Most soils located on the floodplains of the Clarence and Richmond rivers are 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 observed 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 top soil availability might result in mound height being 400 mm. Trial and error have led to the 9 × 4 spacing. Any closer and the inter-row angles are too steep, any wider and the efficiency of productive units per hectare becomes less profitable. While wider and higher mounds provide better drainage and growing conditions, the wider rows lower the number of trees per hectare and so financial viability will be affected. Row widths will be a compromise between achieving optimal growing conditions and tree stems per hectare. Many growers are opting for 9 m rows. Tree spacing down the row is commonly 4 m however, 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. Regardless, the sooner the trees meet in the middle of the row the sooner they have further protection from storm winds.

Rows will be laser-levelled to ensure no ponding occurs and that excess water can drain slowly from the orchard. This ensures minimal erosion and permits grassed inter-rows. Inter-rows should be stabilised with a thick grass cover to prevent soil erosion and to filter any run-off. The shifted soil that is 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 soils are located so they are not disturbed or exposed, as this will generate unsafe amounts of acid.

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

Remember that disturbing more than 1 tonne of acid sulfate soils requires development approval from council. This will require comprehensive soils testing and the lodgement of an Acid Sulfate Soil Management Plan showing how any impacts will be mitigated.

Once planting has occurred (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.

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

Usually this will involve planting natives that will thrive because they will be in their preferred habitat; they will also be the cheapest to grow. A planting guide for native plants was developed for the Ballina coastal floodplain area but your local native nursery will also be able to assist. 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 which flower at different times during the year.
- if your proposed orchard site is adjacent to a river or creek and access is clear, consider using the River mangrove (*Aegiceras corniculatum*) which is shorter and more compact than its estuarine cousin. These enhance fish habitat and will also assist 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.

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

Managing drainage

Many floodplain properties have existing drainage systems and these can be the responsibility of your local Flood Mitigation Authority (your local council), a Drainage Union or the landowner. Before purchasing a floodplain property, you should 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 soils will be disturbed or drained. Again, you must understand what classes of acid sulfate soil are present on your property and whether this will trigger the need for development approval. Ideally this is determined before you purchase the land.

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 council.

Mechanically cleaning drainage systems will usually also require development approval because of the risk of disturbing acid sulfate soils. Development approval must be obtained each time a drain is mechanically cleaned if you are in a class area that triggers consent.

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 may be able to be tidally flushed through the active management of floodgates.

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

Managing acid sulfate soils on a floodplain property and acquiring the necessary development approvals is a costly and lengthy process. This should be factored into purchasing any land on the floodplain for growing macadamias. Ignoring these obligations reflects on the industry and may result in council taking action against you.

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 that the 600 mm mound can be constructed. Ensure also that the soil is free draining. Freely draining soils may dictate a slightly lower mound however, be wary of heavy clay soils.

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

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 soils, http://www.environment.nsw.gov.au/topics/land-and-soil/soil-degradation/acid-sulfate-soils

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

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