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SECTION 6: "USING FOR REVEGETATION"

Restoring native fungi back into revegetation and degraded woodlands

Healthy natural woodlands throughout Australia have a greater diversity of native fungi than degraded woodlands or revegetated agricultural lands. For example three years of surveying in woodlands near Kellerberrin in Western Australia have shown only 10 native fungi occurring in revegetation compared to more than 100 fungi in nearby woodland remnants. **No native fungi were observed in cleared crop lands.** (For further details see the book chapter by **Tommerup & Bougher (2000).**)

Native fungi can be helped back into revegetation or degraded woodlands using simple, low cost methods that are not disruptive to the environment, and are compatible with revegetation techniques currently in use. All it takes is a willingness to incorporate fungi in revegetation programs, and a degree of confidence about what you are doing.

Currently there are no commercially available sources of native woodland fungi to apply to native plants for revegetation on wheatbelt farms. Appropriate fungi need to be chosen from remnant woodlands, such as local fungi suited to local conditions and former natural vegetation type (see **Choosing native fungi**). Spores of decomposer fungi can be applied to any plants. However, effort will be wasted if you apply spores of a mycorrhizal fungus to plants which are not compatible with mycorrhizas. Some notable examples of non-mycorrhizal plants include the banksias and dryandras. (See also the **CSIRO Mycorrhiza**



website for more detail about Australian mycorrhiza and **Using VA mycorrhizal fungi.**)

Fungi can be put directly into revegetation sites before or after the plants. However this is likely to be less successful than raising plants already growing with fungi before they are planted into revegetation areas. There are a variety of methods currently being tested to produce plants already growing with fungi. The recommended methods below (for **Mushrooms** and **Puffballs & Truffles**) have been tested and have successfully introduced native fungi into revegetation trials on Australian farms.

Why are the fungi so different in woodlands and farms?

Fungi in woodland soils are very different to those in agricultural soils. Factors that affect fungi and help explain why there are big differences between the fungi in woodlands and farmlands include:

- **Plant types present** – fungi need certain types of plants as partners. Native fungi need native plants.
- **Soil nutrients** – residual nutrients from fertilizers inhibit many native fungi.
- **Soil organic matter** – different amounts and types of leaf litter occur on crop lands compared to woodlands.
- **Soil disturbance** – disturbance disrupts fungal networks in soil.
- **Soil compaction** – soil can be spongy in healthy natural woodlands, but more compacted elsewhere.
- **Chemicals** - the effects of residual herbicides and insecticides on native fungi are mostly unknown.

When woody plants are revegetated on former farmland, most native fungi are unable to colonize and thrive in such an alien soil environment. Practically all native fungi which are the symbiotic partners of woodland trees and shrubs are destroyed in agricultural fields. Most do not re-establish even in 20 year old revegetation.



Just as we put back plants, we also need to help put back the original fungi into revegetation.

Why?

Many hundreds of native fungi have long helped maintain the health of woodlands, e.g. by building organic matter, sustaining soil nutrient cycling processes, soil fertility, and directly assisting better plant growth of native trees like eucalypts and sheoaks.

Native fungi are not self re-establishing in woodland revegetation on farmland. Only a very low proportion re-establish in revegetation on badly degraded land or cultivated land at least in the short to medium term. The fungi need help to be re-introduced from Australia's native remnant woodlands into revegetation.

When we put the trees and shrubs back we should also be putting the fungi back to help re-establish diverse soil biodiversity and to kick-start healthy soil processes. This can help support long-term health of the plants, and additionally this simultaneously contributes to biodiversity conservation below-ground as well as above-ground.

Race against time

As a parallel matter of urgency, native fungi also need nurturing in natural woodlands and poor quality native vegetation remnants too, as these are **Australia's only biological reservoirs of native fungi** for using in farmland revegetation now and in the future. This genetic resource bank **is rapidly diminishing**. It is a race against time to use native fungi to help restore farm landscapes before the fungal resource has gone.



Currently there are no commercially available mixes of native woodland fungi to apply to native plants for revegetation on wheatbelt farms. Therefore **remnant woodlands are the only source**.

Goals of efforts to restore native fungi back into revegetation

Before considering obtaining native fungi from natural woodlands and trying to help them get into revegetation and degraded woodlands, it may be timely to define the goals of undertaking such effort. To help determine goals, three major points need to be recognized:

1. The benefits are primarily for long-term sustainability of biodiverse, self-sustaining revegetation and woodlands, not for short-term gain - such as expectations of faster growing trees.

**LONG-TERM
SUSTAINABILITY**

2. There are not likely to be obvious signs or differences in revegetation with or without native fungi. This is because the presence of fungi is not easily measured as they are out of sight except when they fruit, and the jobs they do which contribute to landscape health occur mainly out of sight.

**SIGNS NOT
OBVIOUS**

3. It is unrealistic to expect to be able to help all of the fungi present in local remnant woodlands to return into revegetation on farmland. A more practical goal is to target helping some fungi to return, and to encourage others to self-follow later by retaining and nurturing remnant woodland nearby.

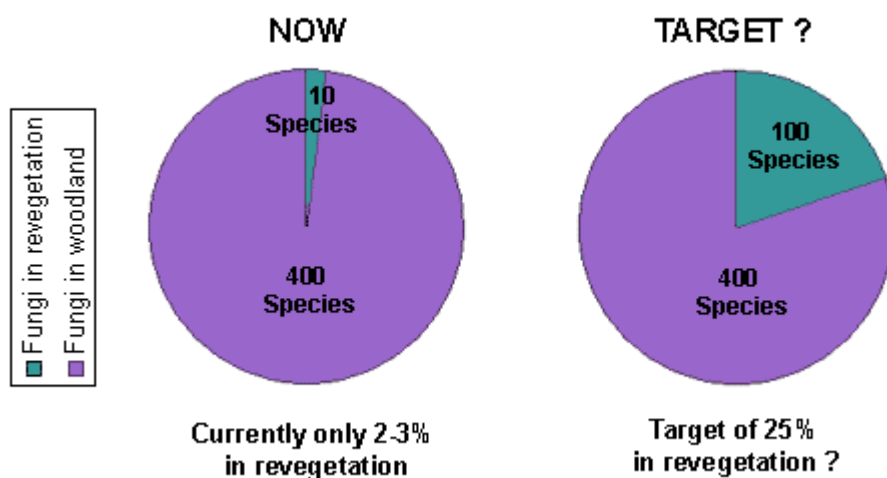
**ESTABLISH
SOME FUNGI**



How many fungi to help get back into revegetation and degraded woodlands?

It is not realistic to attempt re-introduction of all native fungi that occur in Australian natural woodlands of local or regional areas - not even all of the larger fungi. However if at least some fungi are assisted to return this may encourage others to self-follow later as the environmental conditions in revegetation become more similar to those of woodlands. Hence there **should be no set target** for how many, and which, fungal species will be needed in different regions. If broad targets are needed, knowledge of fungi enabling estimation of fungal diversity in local woodlands and revegetation would help to decide targets.

An arbitrary scale of desirable improvement can be visualised as below.



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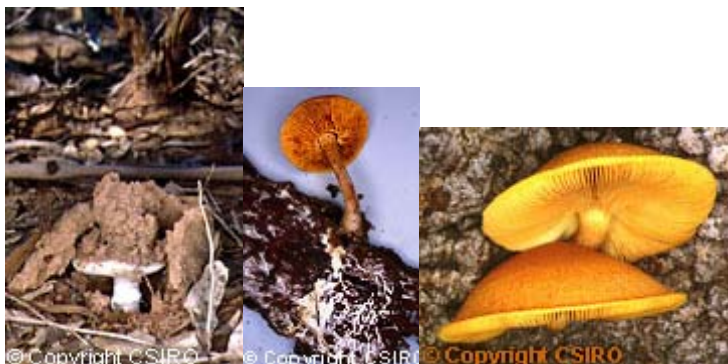
The Process

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Choosing native fungi

As a basic rule, we suggest trying any or many different fungi. If any of these fungi establish in revegetation then that will be a success. The activities of the successfully restored fungi will contribute to a gradual shift in the revegetation from a soil environment that is alien to native fungi to one which may encourage self-colonization of other native fungi from nearby woodlands.



Revegetation programs may choose to source and re-introduce a broad range of local fungi, choose some conspicuous species, or choose to re-introduce some rare and endangered fungi.

They may choose to include certain native fungi which have "weed-like" attributes enabling them to thrive in soil recently held under crops or grazing. Or they may choose a selection of fungi representing different ecological types – decomposer and mycorrhizal.

One good premise is to **choose local fungi suited to local conditions** and former natural vegetation type. Variations in topographical, geological, soil and vegetation conditions within remnant patches of woodland greatly influence the types and diversity of fungi. Lateritic sites with thickets of sheoaks and wattles may have some different fungi to sandy loam sites with eucalypts dominant nearby.

More informed choices of fungi can be made when armed with an understanding of how to recognize different types of fungi, including particular species, ecological types, and how the fungi propagate. The following topics are particularly relevant:

- **Characteristics of fungi and how to identify the fungi.**
- **How, when and where** to collect fungi, and build up a **knowledge base about local fungi.**
- **How fungi propagate.**

What not to do

Do not collect soil from healthy natural woodlands with a shovel, in a front-end loader, or by any other means. This is likely to cause irreversible damage to the precious remnants, including disruption of soil structure and root and fungal networks in soil. It may also risk transfer of disease and unknown soil organisms that can destroy revegetation efforts.

Do not risk using soil from remnant vegetation



Method for restoring native fungi into revegetation or degraded woodlands:

Mushroom Fungi

The method is suitable for nursery-raised seedlings to be planted in new or established revegetation areas.

Click on the image below to download the method file (in Adobe Acrobat PDF format). This file opens in a new window. Approximately 185k bytes.



Method for restoring native fungi into revegetation or degraded woodlands:

Puffballs and Truffle Fungi

The method is suitable for nursery-raised seedlings to be planted in new or established revegetation areas.

Click on the image below to download the method file (in Adobe Acrobat PDF format). This file opens in a new window. Approximately 185k bytes.



Factors affecting development of fungi in pots

Many of the conditions for raising healthy seedlings of native plants also favour growth of fungi. Plants and fungi require moderate temperatures, good aeration, good drainage, and consistent but not too much or too little water. High levels of fertilizers can reduce the growth of some fungi, but this should not be a problem as the levels used for native plants are usually quite low. Most pesticides, fungicides,



herbicides selectively target groups of organisms. Although some native fungi may be affected by some such chemicals, the affects are mostly unknown or untested. Some fungi prefer a particular soil pH or level of organic matter. But because there are so many native fungi, and the optimal requirements of each fungus are unknown, it is best to simply use the soil or potting mix and growing conditions which suits the plants.



Native plant nursery at Kondinin - one of many regional nurseries in rural Australia for large-scale revegetation of farming catchments.

How to check seedlings for fungi

It is probable that some seedlings will have better growth of fungi than others. This inconsistency doesn't matter because in the revegetation site fungal mycelia will spread widely from infected "nurse plants" to other plants.

Depending on the type of pots and soil mix, it may be possible to lift out the entire soil and plant to observe the sides of the soil. This is the best chance of seeing any fungal growth. Sometimes it may be possible to see fungal threads growing in the potting soil either with the naked eye or with a hand lens. But it is more likely that germinated spores will not have proliferated by the time of planting, and the threads will be difficult to see. Sometimes mycorrhizal roots may be visible, but again most of those are difficult to see with native fungi and native plants.





Eucalypt seedlings in a pot, showing fungal mycelium amongst roots. Two fruit bodies appeared in this pot, but usually none are produced in pots.

Using VA mycorrhizal fungi

The methods described above are suitable for fungi that produce large fruit bodies. The large fungi include species which produce mycorrhizal partnerships with many woodland plants. They form mycorrhizas called **ectomycorrhizas**, and these are the predominant type of mycorrhizas in many woodlands. Another important type of mycorrhizas occurs in woodlands. They are called **endomycorrhizas** and include many special types of specific mycorrhizas, e.g. those associated with orchids or with epacrid plants. Endomycorrhizas also include the so-called VA mycorrhizas. There are far fewer species of VA mycorrhizal fungi than ectomycorrhizal fungi in woodlands. VA mycorrhizal fungi are more dominant as partners of herbaceous plants and shrubs than with trees. Fungi which form VA mycorrhizas are generally not visible to the eye as most of them **do not produce large fruiting bodies**. Some VA mycorrhizal fungi are available commercially overseas. We do not advocate importing foreign inoculum into this country. (For mycorrhizal suppliers see the **Mycorrhiza Information Exchange website**) These are generally non-specific fungi suitable for agriculture and horticulture and may not be appropriate or effective for native plants used in revegetation. Currently little is known about the types and biology of VA mycorrhizal fungi in natural woodlands (see the **CSIRO Mychorrhiza website** for further information on VA mycorrhizas in Australian ecosystems).



Planting in revegetation or in degraded woodlands

Plants with fungi can be planted in the same way as plants without fungi. If only a portion of the plants for a particular revegetation site have had fungi applied to them, those plants can be dispersed at intervals among plants without fungi. The plants with fungi can serve as "**nurse plants**" from which fungi will spread and infect other plants. Similarly, "nurse plants" can be planted in degraded woodlands to infect other plants.



Monitoring success of restoring native fungi

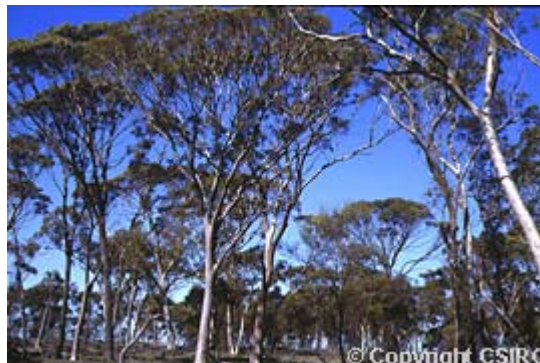
SUCCESS = *healthy, self-sustaining revegetation with a high biodiversity of native fungi, plants and other organisms.*

The goals of efforts to encourage native fungi back into revegetation ([click here for that topic](#)) are primarily long-term and there are not likely to be obvious signs or differences in revegetation with or without native fungi. The presence of fungi is not easily measured as they are out of sight except when they fruit, and the jobs they do which contribute to landscape health occur mainly out of sight. Over a number of years, you may begin to see more fruit bodies of native fungi in your revegetation that resemble those in natural woodlands. However, the success of re-introducing native fungi ought not only be measured in terms of how many different types of native fungi have returned. The activities of



any successfully restored native fungi will contribute to a gradual shift from a soil environment that is alien to native fungi to one which may encourage self-colonization of other native fungi from remnant natural woodlands nearby. This will accompany restoration of healthy soil processes.

Ultimately, the success of re-introducing native fungi into revegetation can be best judged over many years into the future.



This is the End of this Section: "Using in Revegetation"

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