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Alley farming: new vision for Western Australian farmland

Ted Lefroy
Phil Scott

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Alley farming is a system where crops and pastures are grown in the alleys between rows of trees and shrubs. The concept is new to Western Australia but one that is likely to become more familiar over the next few years. The objective is to use trees and shrubs to decrease the environmental side effects of agriculture, such as erosion and salinity, while increasing farm profit through the direct and indirect value of the trees.

This article describes some examples of alley farming in Western Australia and discusses the challenge of getting the right tree species and layout to maximise the benefits, while minimising competition with crops and pastures for water, nutrients and light.

Origins of alley farming
Alley farming originated in the tropics as a method of reducing erosion on sloping land and preventing decline in soil fertility. In tropical alley farming, nitrogen-fixing shrubs are planted on the contour to control soil erosion and provide mulch from cut branches for the benefit of inter-row crops such as maize and beans. Prunings from the trees are also fed to animals and used as firewood. The alleys are narrow, often only 5 to 10 metres wide, because of the steep slopes and cultivation by hand or draught animals.

In the South-West of Western Australia, similar farming systems have evolved quite independently over the past decade in response to a different set of problems. Responding to salinity, waterlogging, wind erosion, the lack of autumn stock feed and declining terms of trade in agriculture, farmers, foresters and agricultural scientists have been working together to develop solutions that combine trees and shrubs with conventional agricultural crops and pastures.

While the systems have some similarities with tropical alley farming, they differ in several important respects. The most obvious is that the alleys are much wider in order to accommodate machinery. The trees are often planted in straight parallel lines. This is common on sandplain where trees are planted at ninety degrees to the most damaging winds to provide the best protection. On sloping land, following the contour may become a higher priority.

Advantages of farming between trees

Protects the land
It is becoming increasingly obvious that more perennial vegetation is necessary in the agricultural landscape if we are to have any significant impact on salinity, waterlogging, soil erosion, the pollution of waterways and other side-effects of our current farming systems. One approach is to mimic, in a very basic sense, the structure of the original woodland, forest and heath ecosystems of the agricultural areas. This would mean:

- a higher proportion of deep-rooted plants able to draw on water deep in the soil
- a more permanent vegetation that protects the soil surface from erosion throughout the year
- greater diversity of both plant species and forms (such as trees and shrubs), increasing the resilience of our farming systems in the face of a variable and occasionally extreme climate.

Alley farming also means that trees are spread across the landscape rather than being concentrated in a few locations. This improves our chances of controlling large scale processes such as rising water tables, soil erosion and contamination of soil and water. Small blocks of trees alone will not do this.
Current types of alley farming

- Timberbelt alley farming in the high rainfall South-West
- Saline alley farming in the wheatbelt
- Sandplain alley farming on the light soils of the wheatbelt and coastal sandplains
- Mallee alleys for the experimental production of eucalyptus oil in the wheatbelt

Each type has evolved in response to a different set of environmental problems and commercial opportunities. Because most of these examples are too recent for us to know their full impact on farm profit, and because very little is yet known about the degree of competition between the different trees and crops, the examples described represent prototypes only, not fully developed farming systems. With hindsight, they could probably all be improved using different layouts and better species selection. Despite this, they represent important steps towards farming systems that are highly productive and environmentally friendly.
Agroforestry is a general term for any combination of agriculture and tree production on the same land. Alley farming is one form of agroforestry. Other forms include farm plantations or blocks of trees, and wide-spaced (parkland) plantings of trees mixed with pasture.

The distinction between alley farming and other forms of agroforestry is the presence of the discrete alley, wide enough to allow conventional farming between the trees. This is important because it means that flexibility of land use is maintained. This flexibility to change crops or to move from crop to pasture in response to variations in commodity prices and seasonal condition has been a vital factor in the efficiency of agriculture in southern Australia.
Timberbelt alley farming

The first form of alley farming in Western Australia was developed from agroforestry experiments with wide-spaced trees (parkland) established in the late 1970s. This allows simultaneous production of high value trees and pasture. It has been used for centuries in southern Spain and Portugal for cork production and grazing, and more recently in New Zealand for timber and sheep production.

A disadvantage of this design is the long period from planting until the trees can withstand grazing. This means little or no income from the land for four or five years. Richard Moore, Department of Conservation and Land Management forester, saw the alley farming layout as a solution to this problem as it would allow income from cropping or hay production between the tree rows during those early years. In 1981, he planted an experimental area of pines (*Pinus radiata*), Sydney bluegum (*Eucalyptus saligna*) and powderbark wandoo (*E. accedens*) in four-row belts separated by 20 metre alleys near Darkan in the Collie River catchment. The tree rows were planted parallel and oriented north-south to minimise shading of the pasture.

Bridgetown farmers David and Dianne Jenkins used the same approach when they planted a paddock in 1987 to three-row belts of mixed Tasmanian bluegums (*Eucalyptus globulus*) and Sydney bluegums (*E. saligna*), leaving 25 metre alleys between the trees. The Jenkins chose this type of agroforestry because they wanted to maintain some income from hay production and grazing while adding trees as an extra source of income. They also wanted to minimise drought stress on the trees by spreading them out, and needed to increase water use over much of their farm to prevent the waterlogging and salinity that was beginning to show in the valley floor.

Measurements of tree growth and sheep carrying capacity after six years have shown that this paddock has produced 78 per cent of the timber production expected from a plantation of this age, and has produced 52 per cent of its carrying capacity as a pure pasture paddock over that period. This complementarity between the tall deep-rooted trees and the shallow-rooted winter-active annual pasture can be expressed by calculating the Land Equivalent Ratio for...
this paddock. This ratio shows that it would take 30 per cent more land to produce the same amount of pasture and the same amount of timber in separate monocultures.

At the same time, the trees have begun to lower the watertables in the valley floor. Some catchment studies using computer models suggest that the greatest impact on rising groundwater will come from planting trees in wide-spaced rows over much of the landscape, rather than small block plantings. This endorses the Jenkins' approach. On cultivated land, an alternative to narrow alleys with a north-south orientation is to plant below contour banks.

Some unexpected advantages of this system have been revealed recently. First, there was a graphic demonstration of the lower fire risk of the alley farming approach in late 1991. Low fuel levels in the agroforestry area (due to grazing) and low wind velocity because of the trees meant that a fire burning across an adjacent open pasture paddock slowed markedly at the edge of the agroforestry area enabling control. Second, the low tree density of 450 stems per hectare has protected the trees from drought when compared with plantations. Nearby plantations, which normally carry about 1200 trees per hectare, have suffered up to 30 per cent loss over recent dry summers.

In commercial terms, this form of alley farming is obviously best suited to the high rainfall part of the South-West where timber production is viable. An economic analysis of some different designs for alley farming in these areas is covered later in this issue.

Spreading trees into wide-spaced rows does raise the possibility of growing trees for timber in lower rainfall areas than would be recommended for plantations. In ecological terms, timberbelt alley farming roughly mimics the eucalypt forest that formerly occupied these sites.

**Saline alley farming**

Saline alley farming began with attempts to use trees as water pumps to lower saline watertables. The best documented example is at the Boundain property of Graeme Wilson, near Narrogin. This site receives about 500 mm of annual rainfall, and is one of several plantings of this type. Department of Agriculture researcher Ric Engel and adviser Tim Negus designed the planting at this site in 1981 to test the effectiveness of this simple concept. At the time, there was considerable scepticism that trees would even survive on these salt flats, let alone control watertables. These watertables were 1 to 3 metres below ground, with water quality of 500 to 3,000 milli-Siemens per metre, or between 10 and 60 per cent of the salinity of seawater. The experiment involved planting different species of salt-tolerant trees, the swamp oak (Casuarina obesa), flat-topped yate (Eucalyptus occidentalis), salt river gum (E. sargentii), York gum (E. lophostropha), Kondinin blackbutt (E. kondininensis), red river gum (E. camaldulensis), and the swamp mallet (E. spathulata). The trees were planted 5 metres apart in single rows at 25 and 12.5 metre alley widths. These two widths gave tree densities of 80 and 160 stems per hectare respectively.

Watertable monitoring bores placed in the alley farmed areas and an adjacent area without trees showed that watertable drawdown in the alleys began in the fourth year after planting. The rate was similar at both the low and high tree densities.

Subterranean clover was successfully re-established in 1986 following leaching of salts from the soil surface. After that, the groundwater began to recede. After that, the story was not so encouraging. The trees, particularly the flat-topped yate, competed so strongly that after a few years there was very little pasture in the alleys.

Pruning the tree roots did result in doubling pasture production in the following season but it was still very low. Tree roots also made cultivation for cropping very difficult. The trees have fulfilled their role in terms of water use, but may have left the land with little commercial potential.

There are several possible solutions to this dilemma. One is to prune the tree roots from an early age by ripping. Another is to reduce competition by widening the alleys. Experiments are underway to determine which tree species are least competitive with pasture and the optimum tree spacing to give groundwater control and allow maximum pasture production. Changing the pasture species beneath the trees and using trees with direct commercial value would also help to make this system more profitable.

**Technical Officer Jamie Hansen and author Phil Scott measure plant growth in the alleys between rows of 12-year-old flat-topped yates (Eucalyptus occidentalis) at Boundain in October 1994.**

**LEFT:** Timberbelt alley farming with mixed rows of 30-year-old Tasmanian and Sydney bluegums at the Jenkins property near Bridgetown. The plan is to harvest some trees for pulp at 10 years and retain the best for higher value saw logs.
The Melvins also drew on a windbreak study by Department of Agriculture adviser David Bicknell. On Gary and Jan English's farm at Esperance in 1988 and 1989, David recorded an increase in the yield of lupins and oats in the lee of a pine windbreak. That included allowing for the land taken up by the trees and the area of depressed yield caused by competition within one to two tree heights of the windbreak.

Influenced by these two experiences, the Melvins developed their alley farming system. They planted two to three rows of various fodder shrubs in north-south belts, initially with 30 metre wide alleys but more recently with alleys twice that width. The north-south orientation was to give protection against the most damaging winds, north-west erlies, south-westerlies and easterlies.

A neighbouring farmer, John Thomas, has used a spiral design to control wind erosion, increase feed supply and make cultivation easier in an irregularly shaped paddock. The alley width in both cases is based on multiples of the widest implement.

These paddocks, which normally could not produce a profitable wheat crop, have seen a marked increase in productivity. The Melvins have tripled sheep-carrying capacity while greatly reducing the erosion risk associated with autumn grazing. With this layout, they have also maintained the option to crop. This means a greatly reduced erosion risk with early lupin sowing and reduced spray drift, which in turn enables more timely crop spraying. A long-term benefit is likely to be a reduction in recharge and therefore in waterlogging and salinity down the slope.

A combination of these improvements should result in systems of saline alley farming that are profitable as well as environmentally effective. Whether trees can lower groundwater on saline flats in all cases is also uncertain. This sort of treatment is only likely to be effective where there is little lateral movement of groundwater into an area, groundwater salinities are not too high and a sufficient area is planted to trees.

In ecological terms, saline alley farming involves mimicking the native salt-tolerant eucalypt woodlands and saltbush flats typically found in the valley floors of the wheatbelt. Several thousand hectares have been planted in the last few years on cropping land threatened by rising water tables in the wheatbelt.

Sandplain alley farming

The term alley farming was first used widely in Western Australia to describe the approach that Dowerin farmers, Dean, Sherren and Craig Melvin, developed in an attempt to eliminate wind erosion and increase returns on some of their poorer sandplain country. In 1989, the Melvins brought together the results of two separate pieces of research when they began planting widely spaced rows of fodder shrubs across some of their worst sandplain.

The first research was the work of Chris Oldham and his colleagues at the University of Western Australia who were assessing the value of the leguminous shrub tagasaste as a browse plant for sheep and cattle. They had shown that tagasaste could increase the carrying capacity of poor Badgingarra sandplain by a factor of six, from just over one to eight dry sheep equivalents per hectare. Cattle grazing the same tagasaste plantations produced about 300 kg of liveweight per hectare per year.

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Where cropping is the major land use, wider alleys would be preferable. This is because the benefits of shelter, such as reduced physical damage and drought stress, will probably outweigh competition effects only at wider spacings, and may only show in some seasons. The less direct benefits of trees, reduced topsoil loss and reduced recharge, are likely to take some years to appear. The key questions are whether these benefits to crops outweigh the competitive effects of the trees in the majority of seasons.

This form of alley farming represents a rough mimic of the heath and mallee vegetation that grew on these sandplain soils prior to clearing.

**Mallee alleys**

This new form of alley farming is being tried by some wheatbelt farmers in conjunction with the Department of Conservation and Land Management and the Department of Agriculture. The aim is to test the feasibility of combining wide-spaced rows of mallee trees for eucalyptus oil production with conventional crops and pastures. It is hoped that by spreading the trees across the landscape they will achieve faster and more uniform production and have a wider influence on water table lowering and wind and water erosion control than dense plantations. Beneficial shelter effects on the crops and pastures in the alleys are also possible.

The viability of eucalyptus oil is uncertain at this stage, but it may offer another incentive for putting more deep-rooted perennial plants into the wheatbelt landscape and a new source of income for the region. To assess oil yields and the practicality of this approach, a range of mallee species have been planted in various alley layouts at more than 30 sites from Morawa to Esperance.
Further reading


Ted Lefroy can be contacted on (09) 368 3870
Phil Scott can be contacted on (09) 368 3371

The future
Many questions remain to be answered on the place of alley farming in our environment. Tree selection and design are likely to be critical to success.

Tree selection has a major influence on the degree of competition between the trees and the inter-row crops and pastures and how effectively trees fulfill their environmental role. Competition is particularly important in our semi-arid climate, where we want deep-rooted trees and shrubs that grow mainly from spring to autumn. This minimises competition for water and nutrients with shallow-rooted winter-growing crops and pastures.

Very little work has yet been done on the competitiveness of different tree species or on selection of species with growth patterns and structure (especially rooting depth) complementary to our annual crops. The emphasis so far has been simply finding trees that survive and fulfil one major purpose. It may not be easy to find trees ideal for this environment, as well as having commercial value and the ability to perform a much needed ecological role, such as erosion prevention or lowering a saline watertable.

Design of alley farming systems determines the relative yield of the trees and the land between rows. The main design variables are alley width, tree belt width, tree density within the belts and orientation of the tree rows. The challenge is to find a workable combination that achieves the same or higher net returns as crop or pasture grown alone, while satisfying the environmental objectives. If such a layout cannot be found, it may make more sense to grow the trees separately in pure stands, rather than in alley format.

Conclusion
The concept of introducing trees and shrubs into farming in a way that is compatible with conventional agriculture offers potential environmental and commercial benefits for large areas of Western Australia. The ecological imperative for such a modification to our farming systems is strong. It may be that nothing short of transition to a landscape that roughly mimics the structure of the original vegetation will have sufficient impact on rising watertables and soil erosion.

Alley farming has the potential to provide many environmental and commercial benefits. Just how attractive it proves to be will depend on how the following costs and benefits balance out:

• environmental benefits, such as watertable control, soil erosion prevention, soil structural improvement, nutrient cycling and improved nature conservation values
• value of crop and pasture displaced by the trees and lost through competition with them
• more intensive management required
• gains in crop, pasture and animal productivity due to the influence of trees on microclimate and soil conditions
• commercial value of the trees themselves

While the costs are immediate, the benefits tend to be medium to long-term. For a strong commercial incentive, the value of the crop or pasture displaced by the trees and lost through competition with them needs to be compensated by tangible short-term returns. With tagasaste on the sandplain and timber species in the high rainfall areas, such incentive exists. However the high level of interest in alley farming outside these areas indicates that short-term commercial incentive is not the only driving force.

The task ahead is to measure the net benefits to the environment and to farm profit of different combinations of trees, shrubs, crops and pastures. This is particularly necessary on the better cropping country.

If alley farming does find wider application, it will represent a significant step towards ensuring the persistence of agriculture in this environment.

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