Soil ripping for revegetation establishment:
A new approach in the WA wheatbelt

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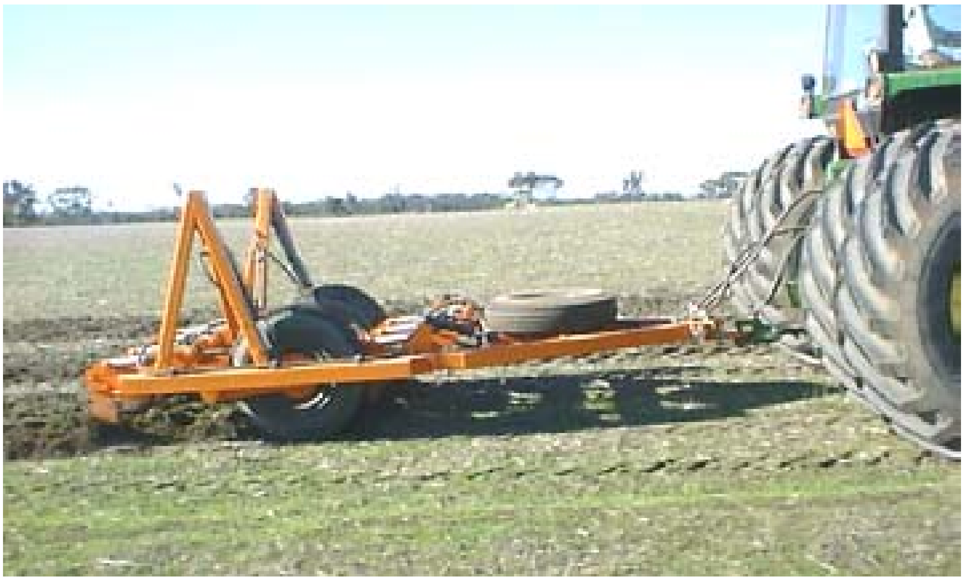

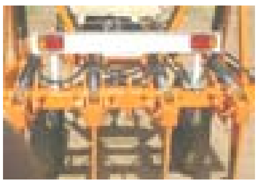

DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

Bushcare
The National Vegetation Initiative

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Recommended Reference for this report

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For further information on revegetation site preparation in the wheatbelt, see:

Mullan, G. D and White, P. J. 2001. *Revegetation Site Preparation in the Central Wheatbelt of WA – Ripping and Mound Ploughing*. Bushcare and the Department of Conservation and Land Management, Western Australia.

Main front cover photograph: *The Department of Conservation and Land Management's multi-tyned ripping implement in action (Dongolocking, Western Australia).*

Lower photo's show some of the features (clockwise from left): multi-tyne; accumulator (part of hydraulic breakout mechanism); hydraulic displacement rams enabling hydraulic breakout; portable rear lights for highway transport.

All photo's taken by G D Mullan unless otherwise stated.

Introduction

Opportunities to improve on ripping technique and decrease the cost of ripping for revegetation establishment in the WA wheatbelt were identified during the implementation phase of the Dongolocking (landscape management) Project. In 2001, the Department of Conservation and Land Management (Wheatbelt Region) contracted the construction of a purpose built ripping implement. This implement was designed to reduce the cost of, and improve site establishment for revegetation.

This report outlines the benefits of using a ripper with the design characteristics of the Department's new purpose built implement.

Developing a new design

The development of a new design was primarily driven by on-the-ground involvement with revegetation establishment in the wheatbelt. The features of the new design address most, if not all, of the limitations experienced in the wheatbelt with current ripping implements. Multi-functioning of design features characterises this implement. For example, the multiple tynes create a 1.5 m width of cultivation. This allows for either improved moundploughing, i.e. the discs of the moundplough are operating in loosened soil; or an increased surface area to plant into, being particularly useful in accommodating nature conservation objectives through varied planting layouts, i.e. seedlings are not restricted to a single rip line.

Thirteen solutions relating to existing ripping implement limitations in the wheatbelt are listed below. The solutions are divided into three categories. Each solution is then explained. The new ripping implement will be referred to as the MTR (multi-tyned ripper) from here on.

The thirteen solutions addressed in this report are:

Rip line characteristics:

1. *The 'soil trench'* effect is minimised.
2. *Plant stability improved* through increased width of ripping.
3. *Air pockets* greatly reduced.
4. *Dilution of topsoil-with-subsoil* decreased.
5. *Waterlogging risk* in rip lines reduced.
6. *Increased water conservation* through breaking a greater area of the agricultural hardpan.
7. *Planting design opportunities* improve through increased width of ripping.

Ripping implement construction:

8. *Hydraulic tyne breakout* outperforms rigid tyne construction.
9. *Ripping width* improves moundplough operation.
10. *Depth indicator* helps minimise cost of ripping.
11. *Trailable ripper* is more versatile than three point linkage (3PL).

Ripping implement availability:

12. *Best-practice and affordable* ripping implement now available to wheatbelt farmers.
13. *Best-practice and affordable* ripping implement now available to the Department of Conservation and Land Management (Wheatbelt Region).

RIP LINE CHARACTERISTICS

1. The 'soil trench' effect is minimised (figure 1).

Ripping in the wheatbelt with a rigid single tyned ripping implement usually results in a large gaping trench, especially in clayey soils. This is an undesirable surface for establishment and subsequent seedling survival. Subsoil air pockets are one problematic result (see point 3). The angle and shape of the digging tip, excessive ripping depth and the width of the ripper tyne are the main contributors to the trench effect.

The MTR has ripping tips that minimise soil disturbance (in particular, lifting of subsoil boulders). These tips are traditionally used on agricultural soil renovating implements such as Agroplough® and Ausplow® equipment. Soil renovating implements are designed to break through agricultural hard pans and loosen the soil profile. Minimisation of both soil mixing and surface disturbance is a characteristic of these machines. For example, in sandy soil, it's difficult to distinguish where the machine has operated.

The current thinking on ripping depth is that where a native plant species is generally matched to an appropriate soil type, there is minimal benefit in ripping any deeper than about 5 cm below either one of the physical agricultural hardpans, i.e. cultivation and traffic hardpans. The biggest implication of this is on clayey soil types. Clayey soil types are likely to have a cultivation hardpan between 5 - 15 cm deep. Therefore ripping to a depth of about 20 - 25 cm is the maximum required. In this case, the benefits of ripping to a specified depth (instead of the commonly practiced 'as deep as possible') include reduced cost, reduced air pockets (see point 3), reduced trench effect and reduced time.

The tynes on the MTR are constructed from toughened steel (bisalloy). This feature together with the tyne breakout mechanism (see point 7.) allows for the tynes to be as narrow as possible (25 mm) without compromising effectiveness. Many home made 'rigid' (with no breakout mechanism) rippers use thick steel (greater than 25 mm) for tyne construction to achieve adequate strength. This in turn produces a trench effect, being counterproductive to effectiveness.

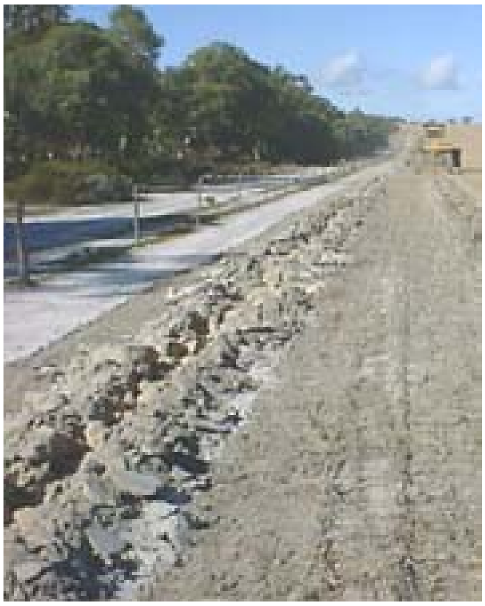

Figure 1. The presentation of a rip line following ripping with a single tyned dozer ripper to a depth of 70 cm. The central part of the rip line is like a trench. Subsoil boulders are lifted to the surface by the deep ripping and the angle of the tyne digging tip.

2. Plant stability improved through increased width of ripping.

Providing the means to optimise plant root conformation has shown to be very important to plant stability in the plantation industry and also in the WA wheatbelt (figures 2.1, 2.2 and 2.3). The increased area of disturbance achieved, combined with other factors optimises plant root conformation and subsequent plant performance. The other factors are:

a) the tyne and digging tip dimensions are designed to optimise roughness of the cultivated / uncultivated soil interface and

b) ripping to the minimum depth required. The risk of clay glazing is likely to increase with depth as the soil moisture content increases.

Figure 2.4 shows the 1.5 m wide rip line implemented by the MTR. The ripping depth varied between 25 and 30 cm at this site. The depth was predetermined based on the need to fracture the soil to about 5 cm below the cultivation hardpan. The existence of a cultivation hardpan is a given character in high clay content soils that have been used for agriculture.

Figure 2.1. *Melaleuca strobophylla* planted into a deep single tyne rip line in a clay soil (see figure 2.3). This site is in the Toolibin area and was planted in 1997. The lean indicates poor root development in the uncultivated zone.

Figure 2.2. *Eucalyptus loxophleba* subsp. *loxophleba* (York gum) planted in the same site and same year as per figure 2.1. The percentage of this species leaning was less than for the *Melaleuca strobophylla* and the lean was less pronounced. However, poor root development in the uncultivated zone is problematic to the productivity of this species at this site.

Photo by Wayne O'Sullivan

Figure 2.3. An 80 cm deep single tyne dozer rip line in a high clay content soil at Toolibin. This rip line was part of the site preparation for the planting of species shown in figures 2.1 and 2.2. Lack of soil fracturing and glazing of the disturbed / undisturbed soil interface were the likely major factors in limiting root development beyond the rip line.

Figure 2.4. The 1.5 m wide rip line implemented by the MTR. The soil type was similar to that of figure 2.3 (high clay content - Toolibin valley flat). Ripping depth was 25 to 30 cm. This technique of ripping eliminates all the risks associated with other techniques and subsequent plant survival and performance.

3. Air pockets greatly reduced (figure 3).

The Department's MTR is designed to fracture subsoil with the least amount of air pocket formation. This is achieved partly through design and partly through ripping depth.

The design incorporates the use of narrow (45 mm width digging tips that minimise movement of subsoil boulders. The appropriate ripping depth is determined on the basis of soil type and the presence and depth of agricultural hardpans that limit seedling growth (see point 1). Thus, avoiding ripping deeper than necessary will also minimise the risk of producing air pockets (also see point 10 re depth indicator).

Figure 3. Three rows of mallee eucalypts. The two left rows were ripped to 70 cm with a dozer and the outer right row was ripped to a depth of 25 cm with a narrow tipped ripper. The white lines indicate sections of seedling mortality suspected to be a function of multiple subsoil air pockets.

4. Dilution of topsoil-with-subsoil decreased (figure 4).

Diluting topsoil with subsoil effectively reduces the fine (particle size) organic matter content of the planting zone and thus also reduces the availability of nutrients. Accessibility to soil nutrients (and soil water holding capacity) increases when the cation exchange capacity is increased by way of fine organic matter. Any dilution of the topsoil will reduce nutrient access and water holding capacity.

Minimising topsoil dilution is achieved partly by ripping implement design - using narrow digging tips and partly through ripping depth (see point 3.).

The practice of moundploughing is a contrasting example. Moundploughing concentrates topsoil and thereby increases the access to nutrients and the water holding capacity of the soil.

Figure 4. Deep ripping with a dozer dilutes the topsoil. Subsoil boulders and loose subsoil particles are lifted to the surface in the centre of the rip line. A combination of ripping implement design and predetermined ripping depth can greatly minimise topsoil dilution.

5. Waterlogging risk in rip lines is reduced *(note: in this instance, in the absence of mounds)* (figure 5).

The risk of waterlogging in a single rip line is higher in the western wheatbelt. However, rip line waterlogging can also occur in the central and eastern wheatbelt, especially where mounding is absent. For example, when best-practice site preparation is implemented (the site is bare from weeds and ripped on or near to the contour), surface water run-off usually occurs between the rip lines. This water inevitably saturates the full depth of each rip line. This causes problems when follow-up rainfall maintains a saturated rip line soil profile. These conditions can allow fungi, (detrimental to plant growth), to build up and can also cause plant death from waterlogging. Reduced growth rates and increased risk of insect attack are also allied with stressed seedlings.

The seven tynes on the MTR will provide for a wide (1.5 m) planting strip. Ripping the soil over a width of 1.5 m with a MTR will substantially minimise the risk of soil saturation directly around the seedling root zone. For example, if an increased area of the total site is ripped (on the contour), then there will be less surface water run-off in most cases, i.e. increased water infiltration. Therefore more water will soak in where it falls. The overall volume of water falling on the site will be more evenly distributed.

There is still the potential for the wider ripped area to become waterlogged, however, this will require rainfall above that which results in single rip line waterlogging. Note that if surface water is moving onto the revegetation site from upslope and causing waterlogging, this must be acknowledged as an off-site drainage issue requiring off-site management.

Figure 5. Single rip lines are at increased risk from waterlogging as compared to multi-tyned rip lines, i.e. the bare areas between rip lines (good weed control) are likely to shed surface water into the nearest down-slope ripline.

6. Increased water conservation on the site through breaking a greater area of the agricultural hardpan.

As suggested in point 5, the 1.5 m width of cultivation will minimise surface water run-off from the overall revegetation site (figure 6.1). For example, at 4 m ripping intervals, the MTR disturbs about 26 percent of a given area. In contrast, a single tyne rip line spaced at the same 4 m intervals disturbs about 2.5 percent of a given area.

Reducing the 4 m interval to 1 m will give a coverage of about 60 percent for the wider implement. Reducing the ripping intervals to less than 1 m will give near 100 percent coverage. Thus, an increase in water retention over the whole site is likely.

Increased water conservation improves the conditions for survival and early growth performance. The improved conditions are very important to achieving a range of outputs. For example, reducing stress on seedlings minimises secondary threats such as the likelihood and severity of insect attack; and in the case of tree crops, optimises rotation length and minimises the agricultural 'stock exclusion' time.

Observations in the wheatbelt show that seedlings planted into multi-tyne rip lines or into areas cross-ripped with a single tyne show increased survival and performance.

In the absence of moundploughing, it's recommended to roll the full width of the ripping to produce a smooth flat planting surface. This is necessary for effective herbicide application and subsequent weed control. Rolling will not lessen the water retention capabilities of the overall site. A roller suitable for the purpose will have enough weight to crush boulders and leave a smooth flat surface (figure 6.2).

Figure 6.1. The 1.5 m wide rip line implemented by the MTR. This approach gives greater opportunity for moisture conservation on the revegetation site. About 40 percent of the surface area is disturbed at this site - given the spacing between rip lines. This percentage can be increased to nearly 100 percent is desired.

Figure 6.2. A roller suitable for rolling rip lines flat and smooth (note: in this instance, in the absence of mounds).

7. Planting design opportunities improve through increased width of ripping (figures 7.1 and 7.2).

This limitation is exclusive to nature conservation plantings. Revegetation for nature conservation can be improved by creating densely planted areas to mimic thickets. Thicket areas are a characteristic of wheatbelt woodland and are stated as a habitat requirement of many south west WA fauna.

The seven tynes on the Department's MTR will provide for a wide (1.5 m) planting strip. This will greatly increase the opportunity to create clumps of vegetation and incorporate understorey species over a greater percentage of the site, i.e. revegetation won't be confined to single rip lines. Note that if moundploughing is implemented, this will limit the area available for planting.

Figure 7.1. Traditional ripping has one single rip line to plant along as illustrated by the seedlings in the foreground.

Figure 7.2. A wider width of ripping provides opportunities to improve on the revegetation design when nature conservation is a priority. The above ripping width is 1.5 m and has seedlings planted over this width.

RIPPING IMPLEMENT CONSTRUCTION CHARACTERISTICS

8. Hydraulic tyne breakout outperforms rigid tyne construction (figures 8.1, 8.2, 8.3, 8.4 and 8.5).

Rigid tyned rippers have one major disadvantage. When a rigid tyne hits an immovable object in the soil, the ripping implement is at high risk of damage. This is partly influenced by speed of operation and traction of the towing vehicle. However, with many tractors operating with 'front wheel assist', or four wheel drive - reducing the likelihood of wheel slip, the risk of damage to the ripping implement is very high.

The two alternatives to a rigid tyne design (figure 8.3) are a shear pin tyne breakout (figure 8.4) or a hydraulically activated tyne breakout system (figure 8.5). The shear pin system is the cheaper alternative however, it has major limitations. These include, 'down time' associated with replacing shear pins (this may be considerable where soil conditions are difficult), and the risk of shear pins being replaced with tougher bolts. The use of tougher bolts results in excessive (beyond design capacity) loads on the ripping implement and can result in severe structural damage.

The hydraulically activated tyne breakout system works independently on each tyne. Tynes have the capacity to release at a predetermined force and re-enter the soil. The maximum breakout force is less than the structural capacity of the implement. The hydraulic breakout eliminates the need for shear pin replacement and is an essential mechanism to protect the implement from damage, especially when used by multiple operators (Figure 8.1 and 8.2).

Figure 8.1. Each tyne is fitted with a hydraulic displacement ram. Breakout pressure can be adjusted.

Figure 8.2. The accumulator contains pressurised nitrogen gas. The pressure set in this cylinder governs the hydraulic breakout rating.


Figure 8.3. A rigid single tyned ripping implement (left) and a site after ripping (right).


Figure 8.4. A five tyned three point linkage (3PL) Agroplough (left) and this implement in operation (right). The Agroplough has a shear pin breakout on each tyne. The shear pin mechanism limits this implement to a narrower range of soil types in comparison to a hydraulic breakout system (below). The 3PL system also has limits compared to a trailed implement.


Figure 8.5. The MTR (left) with hydraulic breakout on each tyne and this implement in operation (right). This implement was designed specifically to improve revegetation site preparation in the wheatbelt.

9. Ripping width improves moundplough operation.

Ideally, prior to moundploughing, ripping should be used to loosen the soil where the discs of the moundplough will be operating. A single rip line does not provide cultivation (soil loosening) in the area where the moundplough discs operate.

The 1.5 m width of soil loosening created by the MTR will provide for easier moundplough operation. The loosened soil in the path of the moundplough discs will allow for an increased volume of soil to be moved for mound construction; an increased 'cultivation effect' and an increased opportunity to break up soil boulders (figure 9). This will be particularly beneficial to mound construction where soils are tough, e.g. clay loams, loamy clays and clay soils of the wheatbelt.

In addition, ripping directly where the moundplough discs will be operating will minimise damage to the moundplough caused by buried stumps. Less stress on the moundplough will greatly extend bearing and disk assembly life and also reduce the risk of framework fracturing (especially on rigid disk type moundploughs).

Figure 9. A well constructed mound showing best-practice 'flat and smooth top'. A wider ripping width prior to moundploughing facilitates improved mound construction and also lessens wear and tear on the moundplough.

10. Depth indicator helps minimise cost of ripping (figure 10).

Most ripping implements are not equipped with a depth indicator. The importance of ripping depth has implications for seedling survival and establishment, cost and time. For example, common practice in the wheatbelt is to rip 'as deep as possible'. This is certainly not required or desirable. Ripping to a predetermined depth increases ripping efficiency and effectiveness.

The MTR has a visible depth display. This will give the operator greater control over, and an accurate account of, ripping depth.

Figure 10. The depth indicator on the Department's multi-tyned ripper allows greater control over ripping depth. Appropriate ripping depth is important to plant survival and performance and also minimising site preparation costs.

11. Trailable ripper is more versatile than three point linkage' *(3PL)* (figure 11).

The limitation of 3PL is that many wheatbelt farmers don't have 3PL on their tractor(s). The MTR is trailable, i.e. will suit any farm tractor and can be towed from farm-to-farm with a 1 tonne utility. This eliminates the need for loading and unloading onto a tray-back vehicle between farms.

Indeed, one of the attractions of a machine type tree planter is of its ability to be towed on the highway and in the paddock.

Figure 11. A basic three-point linkage ripper showing rigid tyne construction. This type is limited in its usefulness.

AVAILABILITY

12. Best-practice and affordable ripping implement now available to wheatbelt farmers.

A tree crop culture is absent in the wheatbelt and as such there is a limited number and range of suitable ripping implements. The few ripping implements that are on farms are commonly single tyned, three point linkage and of rigid tyne construction. Farmers with such implements are naturally hesitant about loaning to other operators given the risk of damaging a rigid tyned machine.

Contractors offering a ripping service are restricted to earthmoving contractors. Options are normally grader or dozer ripping. These two options are relatively expensive and in the case of the dozer option, the ripping depth capacity is usually not necessary.

The MTR was specifically designed to:

- be available to farmers (hired from the Department of Conservation and Land Management, Narrogin),
- enable best-practice site preparation,
- enable least cost site preparation,
- facilitate the growth of a tree crop culture and
- enable groups to replicate the design features in their future equipment purchases.

13. Best-practice and affordable ripping implement now available to the Department of Conservation and Land Management (Wheatbelt Region).

In addition to providing farmers with access to a best-practice ripping implement, the Department's priority project areas will have access to this implement. For example:

- natural diversity Recovery Catchments, e.g. Toolibin Lake and Lake Bryde.
- areas of special conservation interest (Target Landscapes), e.g. Dongolocking, Wallatin Creek and Tarin Rock.

Others, such as threatened species recovery project staff and revegetation development researchers will also have access to the MTR.

Without a best-practice implement accessible to the Department's projects, traditional methods are usually employed. This can be counterproductive in two ways. Firstly, practices employed by a leading conservation agency are often copied and considered 'the best way to do the job'. Secondly, limitations to seedling survival and growth caused by poor site preparation perpetuates the myth that substantial losses (e.g. greater than five percent) and / or poor growth rates are normal.

Additional benefits of the Department's MTR.

Designed to meet minimum highway transport laws while minimising features that may cause difficulties in field operations.

The MTR is classed as a trailable 'Agricultural Implement'. This means that it does not require licensing and is exempt from the necessity to incorporate a braking system. The exclusion of brakes on the MTR was considered a necessity given the likely damaging impacts from ripping up rocks and roots and of the soil grit, especially on the wheel based braking components. The choice of wheels also accounted for the potentially harsh working conditions. Heavy-duty truck tyres and rims were used.

Given the "Agricultural Implement' status of the MTR, there are road transport conditions that must be met. These include:

- transport during daylight hours only. Note: the MTR is fitted with a portable rear lighting system.
- the MTR must be towed with a light truck, e.g. one tonne utility, or a heavier vehicle, i.e. not to be towed with a family vehicle.
- as the MTR is not fitted with brakes, due caution must be observed at all times, e.g. the recommended maximum speed of towing is 80 km/h.

Specifications of the MTR include:

- mass - 1300 kg.
- overall width - 1930 mm.
- overall length - 3950 mm.
- full ripping width - 1.5 m
- 25 cm under tyne clearance when in transport position
- tyres – 12 ply, 8.25 - 16

Direct seeding

Can be used for direct seeding preparation.

Brush matting

This is the practice of laying cut stems / branches (containing ripe fruit) on the soil surface. This technique has two aims - to spread seed and to reduce erosion. This can be a useful technique where local native seed is in abundant supply. The most suitable species for brush matting are those that retain seed capsules on the plant but which shed seed when the branch dries, e.g. *Melaleuca* spp., *Eucalyptus* spp., (*Allo*) *casuarina* spp., *Hakea* spp.

The MTR is ideal for surface preparation. It will rip through agricultural hard pans with minimal disturbance to the surface, i.e. the minor roughening of the surface that does occur is ideal preparation for brush matting, creating niches for seed to lodge and germinate.

Landscape units where the MTR is not suited.

Acknowledgment is made that there are two landscape units in the wheatbelt that will require the use of a dozer ripper. The first is breakaway areas typically vegetated with mallet tree species (*Eucalyptus astringens* (brown mallet), *Eucalyptus argyphea* (silver mallet), and *Eucalyptus gardneri* (blue mallet). The soil is very high in clay content and the gradients steep.

The second landscape unit is laterite outcrop areas. These areas typically support low heath or shrubs such as *Dryandra* spp. Revegetating these areas is extremely difficult owing to the lack of sand, loam and clay particles available to plant into. Dozer ripping these areas can be a legitimate practice to roughen the surface and facilitate natural regeneration. Careful site assessment is required on the benefit and cost of ripping these areas.

References Cited

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Road Safety Council and WA Police (1999). *Towed Agricultural Implements*. Transport, Perth.