HOVELLS CREEK LANDCARE GROUP

CATCHMENT PLAN 1997

THIS REPORT WAS PRODUCED BY

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INTRODUCTION

The Catchment Plan details the resources in "Hovells Creek", assesses the options for their use, and recommends the most appropriate use and management of them. It deals particularly with all issues of land degradation in "Hovells Creek" and recommends the management needs and priorities for their prevention and treatment.

The plan is not about maximising production from "Hovells Creek". Instead, it provides a balance between the measures which will increase, or at least maintain, the short term production of the farms within the landcare group, and those which have the greatest impact on land degradation problems and the long term sustainable use of the land. The treatment and prevention of land degradation problems should be a basic consideration in all farm management decisions. If you look after your base asset, than the farm will look after you.

Most Australian farms are under utilised and too often farmers have bought more land before fully utilising what they already have. The plans looks and sets out how to fully utilise the properties within the catchment.

Financial assistance may be available for various aspects of the work.

You will find that the Catchment Plan will be an important base upon which other aspects of farm management are developed, including:

- planning farm operations, such as crop rotations, cropping and grazing programs and recording paddock histories
- developing new enterprises, tree planting programs and nature conservation
- as an inventory map and development plan for discussions with advisers, bank managers and valuers

The plan should not be hung in direct sunlight as the heat from the laminating will cause rapid fading.

David McConnon of Lachlan Rural Consultancy has been registered as a farm consultant authorised to approve land management plans for the purpose of section 75D of the Income Tax Assessment Act 1936.

This means that fencing to subdivide land classes as shown on land management plans approved by Lachlan Rural Consultancy will have a 100% tax deduction in the year of construction. This benefit is available to all primary producers and other businesses earning income from rural land.

Primary producers and businesses can also claim an outright deduction for the following capital expenditure (provided the expenditure is primarily to prevent or mitigate land degradation) :

- the eradication or extermination of animal or vegetable pests
- the destruction of weed or plant growth detrimental to the land
- measures for preventing or combatting land degradation such as graded banks, gully control structures, tree planting, gully stabilisation, salinity control and regeneration or retention of native vegetation
- the erection of fences to exclude stock or vermin from areas affected by degradation to control that problem
- the erection of fences which separate different land classes
- the construction of levee banks or similar improvements
- the construction of surface or sub surface drainage works for the purpose of controlling salinity or waterlogging.

SYNOPSIS

"Hovells Creek" is in a poor condition with the major problems being water logging, gully erosion, salinity, lack of permanent perennial pasture production, acidification of soil types, tree decline, nutrient decline, and weed infestation, which, with improvement, would enable better pasture growth and livestock grazing systems.

Land management, in particular the amount of plant cover and the number of workings, will have as much effect on the rate of soil erosion as earthworks. In "Hovells Creek" sheet and rill erosion has occurred in previous years when ground cover has been inadequate and soil control measures have not been undertaken. These include few graded banks and poorly located dams with little volume. Pasture management should ensure there is a ground cover of 70% or more to further minimise erosion. When pasture improving in the future, the adoption of minimum or direct drilling techniques may allow additional earthworks to be avoided.

Where previous earthworks have been designed they must be maintained. Minimal erosion should occur if the flowlines are fenced out and grassed up according to the plan and other pin pointed areas are followed through with the recommendations.

The soil structure is average due to soil type and the lack of deep rooted perennial pastures. The use of perennial pastures; Phalaris, Cocksfoot and Lucerne, in long rotations will be the easiest and cheapest method of building up organic matter and hence soil structure.

The Hovells Creek flowline which flows through the catchment is still actively eroding in places. The higher catchment recommendations generally need to be carried out first, as these will reduce some of the undesirable effects that occur lower in the catchment. The main problem of erosion in Hovells Creek is the deepening of the creek, the vertical walls now associated with the deepening of the creek and the detrimental nature of silting along the creek. The majority of the waterways within the catchment are not fenced out or do not have perennial pastures established. Thus the water cannot be fully controlled before entering the Hovells Creek flowline.

Grassed flowlines, improved dams and graded earthwork systems will slow the velocity down and therefore the damage from water. The granite country of the catchment has many natural springs so paddocks run water through most of the winter. This spring nature of the catchment thus causes two problems; land classes of IV wet or VI wet, and stock/human management restrictions. The spring nature of the area also changes the control measures from expensive earthworks to the establishment of permanent perennial pastures. In order to successfully establish pastures, the soil acidity within the catchment needs to be improved by the application of lime. The replacement of a native pasture paddock with a permanent perennial pasture will reduce paddock runoff by 17 times .This action not only provides an alternative to expensive earthwork structures, but also improves stock production.

Where there are Pin Rushes and Tussock Sedge growing, these areas are areas to watch for any saline indicator grasses. The catchment is indicating that the water table has risen, and it is usually these areas that have a tendency to progressively get more saline.

There is some salinity evident in "Hovells Creek Catchment". The saline areas have been marked on the catchment aerial photograph as class VI s. A summary of the management of a saline area is as follows:

* Areas of a saline nature, especially scalding, are recommended that they are fenced out with an electric fence. An electric fence is preferred to a permanent fence as the saline area can increase in size leaving a useless permanent fence. In the situation of a saline area, it has to be managed separately from other areas for two reasons;

(1) So that stock are prevented from milling around the saline area day in/day out. This activity allows the problem to be aggravated and increase the baring of soil which increases the risk of erosion.

(2) So that the saline areas can be sown down to salt resistant pastures such as Puccinelia, Strawberry Clover, Tall Fescue, and Tall Wheat Grass mixed with Phalaris.

Saline areas are due to the water table being close to the surface. Therefore the saline areas, once sown down to salt resistant pastures (and let seed for the first year with no grazing), can be of great benefit as they are lush areas when others are dry. These grasses must be continually kept at a water using state. Do not let vigorous old stands get established as they use less water, defeating the purpose to why they should be fenced out and grazed with separate management.

The do nothing option on these areas will eventually lead to scalding and an area that is not aesthetically pleasing, and much harder and more expensive to revegetate.

Hovells Creek is presently testing at 1.2 dS/m.

The acidity problem is variable within the "Hovells Creek Catchment". Sometimes the better production paddocks that have had a good history of clover and super, can test the most acidic. These paddocks which are testing lower can be improved relatively easily with soil ameliorants such as Lime or Dolomite. The use of perennial pastures will slow down the acidification process. A program of soil testing each paddock every 5 years should be implemented immediately. With this report, we have given spot pH soil tests for top and sub soils as a guide only.

The soils in the district are predominantly of a Granite nature and therefore quite old. The soil age and the predominance of native annual grasses means the soils are generally increasing in acidity causing aluminium toxicity. The majority of soil erosion occurring on the properties is where the slope increases to above 4%, the soils are yellow podzolic, solodic and lithosol type, and the ground is bare. These soils create bad rills and due to the heavy downpours and the nature of these volatile soil types, a greater need for preventative erosion strategies ie perennial pasture production, mitre drains, graded banks, improved dam sizes, need to be installed within the catchment.

Nutrient loss is the biggest loss to agriculture in respect to the land degradation issues. Nutrients are lost by; product removal, being leached out of the root zone, or by being removed by water or wind erosion. Adding to this situation is the fact that many farmers have over the last few years cut their fertiliser programs back to the bare minimum or none at all.

In a grain crop, the following nutrients are removed per hectare per tonne of grain: 21 kg of N, 4.5 kg of P, 5 kg of K, and 1.5 kg of S. For beef, the following is removed per tonne of animal: 27 kg of N, 8 kg of P and 2 kg of K. For each live lamb to leave then: 0.8 of N, 0.2 of P, and 0.1 of K and for each fleece of wool then: 0.7 of N, 0.025 of P and 0.03 of K.

While stock do return more nutrients then they use, the nutrients are generally concentrated around yards, camps, watering points and gates. What these figure give are very rough minimum nutrient requirements for pasture and cropping. For example if you run 10 DSE for wool then at a minimum you need to return 7 kg of N, 0.25 kg of P and 0.3 kg of K per ha. The figures are going to alter remarkably with paddock fertiliser history, soil type, erosion, pasture composition and placement of fertilisers.

For example, research has shown that where a paddock has received 350 kg of P (ie. 4 tonne of Super Phosphate), then live weight and wool production was maintained for the following ten years on a perennial pasture. With annual pastures, it is best to apply 12 kg of P per ha per year than to apply 2 to 3 kg per ha over the whole property.

The ideal pasture is going to have a 20 to 30 percent legume component that will provide more than the required N. However to maintain that legume component then the P, K, S and trace elements need to be added each year.

All solutions point to a permanent pasture establishment program, using minimal tillage or direct drill techniques. Natural pasture paddocks do have a role with summer feed value and suitability to the region, however paddocks that are accessible with a tractor and sowing implement, are recommended to be sown to permanent perennial pasture. The use of perennial pasture in rotation will lead to a reduction in acidity, soil erosion, soil structure decline, increased stocking rates and may prevent a salinity problem from taking over large tracts of land. Cropping in the catchment should only be used to help clean paddocks of weeds or on the lower land classes. There is a problem with both corkscrew and silver grass in the catchment. Infested paddocks may need a two year cropping program to rid the paddock of the infestation. Silver grass (Rats tail Fescue) is a problem as it produces a toxin that kills surrounding grasses slowly allowing the innutritious plant to slowly take over.

The establishment of perennial pastures is not the only pasture improvement necessary. It is also important to understand and improve upon the native pasture composition of the catchment. Papers that are relevant have been enclosed in the appendix.

A tree program is highly recommended. Benefits and economic returns are well documented by C.S.I.R.O. and other research institutes. In fact recent work completed by Rod Bird at Hamilton in Victoria has shown that farms can increase profitability by planting up to 10% of their properties to trees, and under certain circumstances trees are returning a positive income when up to 20% of the property is reafforested.

"Hovells Creek Catchment" has some areas ideal for regeneration. Tree regeneration naturally occurs immediately after drought or following fire as the ground is bare (therefore little weed competition), the soil temperature needs to be rising, and soil moisture needs to be present. The whole area does not need to be fenced out. Using electric fencing, small areas can be fenced out until regeneration is above grazing height. Fencing 20 metres on the windward side of trees is best recommended. This leaves some shade and protection still from the existing standing trees whose seed is required for regeneration. Regeneration of trees can occur amongst any healthy stand of trees where trees are of the one age and are utilised as shelter and shade by stock.

Those areas on the map that have been marked as three row windbreaks for wind and shade belts, need a decision to be made 12 months in advance on the amount of direct seeding and/or tubestock which is to be planted. This is to allow deep ripping and weed control to commence. It is best to start small and grow larger numbers each year, as expertise and finances allow. It is also better to prepare more area than you envisage as to plant trees in unprepared areas is, in most seasons, a disaster.

"Hovells Creek Catchment" is not all that well situated for water in respect to dam water supply, when the next major drought occurs. There are dams which need to be improved by depth and size. When new dams are to be built, they must be built to supply water to last over 18 months without any runoff. A drought strategy has been prepared. Refer drought strategy section later in the report. The sowing of Lucerne, or a Lucerne, Phalaris, Cocksfoot, Clover mix and the planting of the recommended trees on the western and southern boundaries of each property, will protect stock from the cold and also hot summer winds. This will help in stock protection and also land degradation in time of drought, preventing top soil from being blown away with the heavy stocking.

Lucerne forms the basis of the fire prevention/protection strategy, as well as being a deep rooted perennial pasture. It is important to follow the regulations set down by the local government for fire prevention. Lucerne is recommended to be sown in those paddocks close to the house(s) of each property.

Paddocks that are class IV or VI should be put down to permanent perennial pastures . This covers the majority of the catchment. A mixture of Phalaris, Cocksfoot, Lucerne and Clover is recommended. These pastures in some cases would have to be spread with a ground spreader or aerially sown after the paddock has been well grazed. Minimal tillage or direct drilling would be the recommended sowing technique. Trialing of other perennial pastures such as Serradella and Consol Lovegrass (on the lighter soils) is suggested.

The flowline areas should be maintained with permanent perennial pasture to prevent scouring of banks and flowline areas. All flowlines should be sown with a mixture of Phalaris, Cocksfoot and Strawberry Clover. In the appendix is a paper from the Grasslands conference on the control of Tussock Sedge, which dominates the wet areas within the catchment. It stresses that if these wet areas are removed of Tussock Sedge, they must be immediately planted to permanent perennial pastures.

On major flowlines or fragile areas, which are sown to Phalaris and Strawberry Clover, these areas should be crashed grazed or slashed so that the grass height is maintained between 5 and 20 centimetres in height. Set stocking and vehicles should be avoided at all costs as they will cause rill or gully erosion. Sheep tracking can be very hazardous, either causing a gully to begin or aggravating an existing gully. Areas in "Hovells Creek Catchment" which should be temporarily fenced or monitored are marked out on the recommendation overlay of the catchment plan. When sheep are tracking down a gully or hillside that is starting to wash, place an iron post in the sheep track with a piece of plastic attached every 3 metres. This will help get sheep off the track. In conjunction there needs to be grass seed spread to help grass up the sheep track and prevent further washing.

Pasture establishment needs to be enhanced by grazing management, to decrease chemical reliance and promote desirable species. This could easily be done using an electric wire to crash graze an area when an undesirable plant is at its weakest stage i.e. flowering. Conversely, paddocks should be rested or understocked when desirable plants are flowering. Not all paddocks need to be Phalaris based as it would be beneficial on smaller paddocks with better soils to establish a Lucerne/Sub Clover based pasture for grazing only.

In setting priorities of each individual property, the decision can only be set by the owner with financial constraints being the obvious restriction. However, the better soils (Yellow Box & Kurrajong Communities) and lower land classes (Class I, II and III) should be "treated" first.

The Hovells Creek Catchment priorities for recommendations are as follows;

1. An increasing problem in the catchment is that of waterlogging. The waterlogged areas hinder pasture development and encourage the growth of tussock sedge. However it is the lack of pasture improvement in the past, which has caused these waterlogged areas to form and spread. This encroachment of the tussock sedge has developed as another weed infestation problem of the catchment. The tussock sedge smothers potential growth areas which are suitable for perennial pastures. The other concern is that these wet areas have the potential to turn into salt areas if the water table continues to rise or the tussock sedge is removed and perennial pastures are not planted in return. Refer appendix on Tussock Sedge.

2. Another problem in the catchment is gully erosion and erosion of Hovells Creek. The erosion of the creek and flowlines is a direct result of the increased velocity of runoff water, caused from the clearing of trees, the removal of native perennial pastures, and poor pasture management.

3. Salinity has started to encroach the catchment in some of the wet areas. Salt recommendations have been given earlier in the report. Their is a salinity section later in the report. The salt areas are small enough to start working upon by planting salt tolerant pasture species in the salt areas. A permanent perennial pasture program on the immediate higher areas surrounding the salt is necessary, and should be carried out in conjunction with treating the salt area. It is important that each member of the group be aware of salt indicator plants e.g Annual Beard Grass, Sea Barley Grass, Cabungi, Spiny Rush.

The saline nature of the water is important to monitor as this informs you of the underground quality of water tables and streams. Stock can drink saline water up until 14 dS/m but lactating animals shouldn't drink higher than 4.7 dS/m. When mixing chemicals be aware of the saline nature of the water as most chemicals contain salt and mixing it with saline water could dilute the mixture. This could cause the effect of the sprays to be less effective wasting both time and money.

4. The soil acidity is a concern in the catchment. The soils being of a granite nature are badly leached. The soil acidity causes aluminium and manganese toxicity or zinc deficiency. Therefore pasture growth and improvement with perennial pastures cannot be addressed until soil acidity with liming or other soil ameliorants have been used. Remember when purchasing lime, use lime less than 250 microns.

5. Lack of perennial pastures is a major problem. This results in poor water efficiency and increased runoff. The poor water efficiency and increased runoff is a significant contributor to the erosion that is occurring throughout the catchment. The majority of pasture establishment in the catchment should be by direct drilling. Direct drilling is the preferred establishment technique due to the nature of the soil type and the ability to maintain a ground cover.

Superphosphate history of each property varies significantly throughout the catchment. Some properties have a good history, while others have a very poor history. The critical factors are whether there are desirable plants present to use the phosphorous, and the level of soil acidity. The catchment in general has few desirable plants and quite acidic soils which lock up any available phosphorous, and therefore super phosphate application is of low value. Money should be spent in total paddock programs; using soil ameliorants to reduce soil acidity, then establish perennial pasture, then apply super phosphate.

6. The paddocks in some areas of the catchment are too large and the management of the paddocks has allowed weed infestations and selective grazing. Large paddock sizes also make it more expensive when pasture improvement has to occur in the paddocks. With smaller paddocks taken out for pasture establishment, it has little affect on stocking rate and is a less expensive exercise. Livestock will always preferentially graze, thus there will be areas that become weed infested and/or good pasture allowed to become rank. Keeping these areas to an absolute minimum should be the goal.

7. Some dams in the catchment are poorly located, and some of the banks were built as absorption banks rather then graded banks. Several dams have been built with no capacity and little catch. There are few banks which lead to dams to improve catch. As a result, there is still a lot of excess water shedding off higher in the catchment which could be controlled. Many of the dams were built with little freeboard, thus a lot of dams in the catchment have had the bank walls eroded. A lot of the banks require repair, due to little maintenance over the years. Stock have created problems such as tracking over the banks, causing them to become ineffective.

8. Some of the flowlines have been used for rubbish. Rubbish in flowlines causes turbulence and therefore increases the velocity and damage in these areas. No rubbish should be placed into a flowline. A separate garbage pit should be dug.

9. Tracks, especially those leading down from the granite hills, require maintenance. Many of these tracks are washing badly and need to have a little maintenance on them with a shovel or the blade of the tractor. Little repairs now save time and money then if left to incur increasing damage that in the end may require earthworks and dozers. Mitre drains on the tracks coming down from the hills are required to take the water off the tracks.

10. Weed infestation is another major problem with the occurrence of Tussock Sedge, St John's Wort, Paterson's Curse, Saffron, Capeweed, Variegated Thistle, Stemless Thistle, Star Thistle, and Silver Grass in the catchment. These can spread along the flowlines, by animals, by vehicles, and by wind, so all members should be aware of there appearance and there control. For Tussock Sedge, use Roundup at rates of 1.6 to 1.8 L/ha with a wetting agent . Apply Roundup when pastures species are dormant so that little bare ground is created. Spray from late spring through summer up to the seasonal break. See full paper in the appendix on control measures of Tussock Sedge. The other weed in the catchment to keep under control is Paterson's Curse. Selective chemical spraying may be required in conjunction with heavier stocking to control this weed in the catchment.

11. Tree decline. There is a big variance within the catchment with some properties having reasonable stands of timber, while others are bare and exposed. Many of the mature trees left as individuals or small clusters in paddocks are all of the one age. These areas require to be regenerated as in another 20-30 years there will be no trees at all for stock shelter or shade. Tree types found within the catchment can be found latter in the report under trees. Areas of regeneration have been marked on the recommendation layer of the catchment report. Agreements and funding may be sought from two areas. Firstly, National Parks and Wildlife with three categories for farmers; the Wild Life Refuge scheme, Conservation Refuge, and the Remnant Vegetation agreements. The other area of assistance is with the Save the Bush program through National Landcare.

12. Kangaroos/Rabbits are a problem in the catchment causing damage to pasture, crops and fences. Furthermore, these animal compete with stock for feed and water. In marginal years, this can make a significant difference to a properties stocking capability.

MANAGEMENT CONSIDERATIONS FOR INDIVIDUAL PROPERTY MANAGEMENT

If clovers are to be spread with super it is important to take into consideration the following;

1. Make sure the clovers are suited to the area

2. Make sure anti ant theft is added to the seed

3. Inoculate, pesticide treat, and lime pellet the seed

4. Have the paddock well grazed so that light is reaching the ground.

Varieties suggested to look at are;

1.0 kg/ha Goulburn Subclover
1.0 kg/ha Seaton Park Subclover
1.0 kg/ha Strawberry Clover
0.5 kg/ha Balansa Clover

For wet areas use a combination of Strawberry clover and Balansa clover.

This will improve the protein content of the pasture. The paddock should be well grazed prior to the spreading of pasture seed. This will allow good weed control and allow sunlight down upon the seed bed. Fertiliser is best spread in February/March.

DIRECT DRILLING AS AN OPTION

The best time for pasture improvement utilising direct drilling techniques are in April/May, though depending upon the timing of the autumn break it could be as early as the end of March in this area.

Preparation 12 months in advance to pasture sowing.

Apply herbicide when the weeds are actively growing and in a small rosette stage. Clover damage will be minimal if they have at least 2-3 leaves. Autumn spray application 6-8 weeks after autumn break is ideal time for spraying. For spring treatments, usually a second "spray graze", keep the paddock well grazed during the winter. Apply the herbicide before the clover flowers. Two techniques can be applied to the spring prior to sowing.

SPRAY GRAZE TECHNIQUE

SPRAY

Spray with sub lethal rates of MCPA or 2,4-D Amine to give effective control of certain broadleaf weeds if correct methods are followed.

GRAZING AFTER SPRAYING

Wait 7-10 days after spraying. The paddock should then be stocked, preferably with sheep, at 8-10 times the normal stocking pressure to graze the weeds close to the ground. Graze between 2-6 weeks depending on length of pasture. Do not overgraze, to protect your clover content. Sheep are the preferred option in spray- graze, however cattle are useful in the grazing of large thistles.

Remember, if weeds are not heavily grazed at an increased stocking rate, then weeds will return after three weeks as the spray alone will not kill them.

PASTURE TOPPING

Pasture topping with Roundup (or Gramoxone) is most important for weed control in the preparation for sowing pastures.

WINTER PREPARATION 12 MONTHS PRIOR TO SOWING

Graze the paddock over winter and keep well grazed ie 12.5 mm tall using sheep or 25mm using cattle. Graze heavily through spring until the soil begins to dry out and the days are warm and hot (sometime between late September and early November). Once stock are removed, all grasses will rapidly come to head. This is important for success in spraying so grasses come to head at the same time.

TIMING IS CRITICAL

Apply Roundup at early head emergence (50% heads emerged). Gramoxone must be applied after complete head emergence until the oldest heads begin to hay off. The two herbicides provide a 2-3 week window for effective spraying. In some situations even head occurrence will vary. Use heavier rates of Roundup CT (up to 1L/ha) at full head emergence of the earliest flowering plants. This will effectively control seeding of the entire sward.

SPRAY

Due to the low application rates of herbicide, an extra wetting agent must be added at 200-300 mls/100L of spray. Use rates of 240-360mls/ha Roundup CT or 500mls/ha Gramoxone W. A pesticide can be added to the herbicide to reduce the number of eggs laid over the summer to lower earth mite control. Note; Gramoxone is effective in preventing saffron thistle from setting seed if applied at flowering. Similarly, Roundup CT applied at flowering time controls the seeding of capeweed.

GRAZE

Graze immediately after with Gramoxone W as feed declines soon after spraying. With Roundup CT, it is preferable to graze 21 days after spraying as the palatability reaches it peak at this time.

Although pasture topping decreases total spring pasture yield by about 15%, livestock actually eat more of the available feed.

PLEASE REFER TO AN AGRONOMIST OR LACHLAN RURAL CONSULTANCY FOR UP TO DATE CHEMICAL RECOMMENDATIONS.

PADDOCK SIZE AND GRAZING MANAGEMENT

Some of the paddocks in the catchment are presently too big in size for potential grazing efficiency. Stock preferentially graze, therefore there are some parts of paddocks they prefer to graze more frequent than others. This may be due to; grass species, aspect (grazing in the morning sun), and shelter (wind protection) in winter etc. With preferential grazing, maximum stocking rates are not achieved and weed control is very difficult, as stock have a choice as to what species they wish to select from. With smaller paddocks, stock have a smaller area to graze and therefore preferential grazing is minimised or halted completely.

This allows all the grass to be eaten and therefore no native or perennial grasses are allowed to become tall and rank, thus unpalatable to stock. If pastures are kept in a continual growing state, they are usually higher in protein and more palatable to stock. Smaller paddock sizes for pasture improvement programs is preferred, as such a big area of land is not taken out of the grazing system whilst a new paddock is improved.

Stock having to eat the majority of a paddock out play a greater role in weed control as they are forced to use weeds as roughage/ food source. This creates a lesser reliance on chemical control which is very expensive.

Windchill factor is one of the second biggest killers of young lambs after Dystocia. It is important when lambing to record the number of lambs dead, so to be able to compare lambs dropped to lamb survival rates. Remember an extra 10% in lamb survival rates means an improvement by 5% to the overall bottom line. Small improvements in windbreaks, pasture improvement and watering points can improve lambing and calving paddocks.

This sheet can be used as an example.

Paddock Name	ha	No Ewes	Stock Type	Live Lambs	Dead Lambs	Act Lamb %	Poss Lamb %	Wean %	Ewe Loss
Middle Lane	17	160	4 Tooth	156	34	97%	119%	87%	9

LUCERNE MANAGEMENT

A full soil test is recommended for any paddock that is planned to be planted to lucerne.

Once Lucerne is established, a way of checking whether Lucerne nitrification is being affected by acidification is to look at the plant's nodules. If the nodules (when cut open) are pink, they are fixing Nitrogen. If they are white or green, they are not fixating Nitrogen. When sowing Lucerne, the seed must be inoculated, lime pelleted and pesticide treated to ensure success of production. A check list if plants are not nitrogen fixing is as follows:

(1) Inoculation of seed
(2) Acid soils
(3) Salinity

Lucerne requires strategic management in grazing, as set stocking kills lucerne quickly. Rotationally graze lucerne (ideally graze paddocks over 2-3 weeks), then rest until early flower, given good soil moisture. Remember to replenish root reserves, allow lucerne to flower when ever possible.

Once a stand becomes to old and thin, it should be placed into a cropping regime to place it back into pasture. A recommended crop rotation is: Canola, Wheat, Lupins, Wheat, Oats, Lucerne. The cropping phase should be a minimum two years to prevent Lucerne Flea and other diseases being passed from old Lucerne roots to the new Lucerne crop.

The Lucerne varieties that are recommended are Pioneer L69 for hay production or Aurora Lucerne for dual purposes. Lucerne is a high water using plant with an extensive tap root. Lucerne must be managed differently to other pastures as it cannot withstand extended spells of set stocking. If planning to establish a paddock down to lucerne, a program has to be undertaken to clean the paddock up by chemical weed control or through cropping .

PHALARIS PASTURE MANAGEMENT

A phalaris pasture mix will provide a good vegetative cover year round and should help bind the raw edges of flowlines. This will help prevent any further erosion along flowlines.

Phalaris should be well managed as to achieve maximum grazing and soil stability. Phalaris should be allowed to set seed in the first year and one year out of every five from planting onwards. Phalaris should not be allowed to go tall and rank as it becomes innutritious and unpalatable to stock. It should be maintained at a grazing height of 6-20 cm. To avoid this the paddock should be grazed heavily immediately after seed set of Phalaris, to allow light to reach the soil and germinate other pasture species especially clovers. Once the paddock is heavily grazed, it needs a minimum 20% clover content. To regenerate the pasture once phalaris is established, it needs to be fertilized at 125 kg/ha to 200 kg/ha of Mo fortified Single Super in February/March with 3.5kg/ha mix of Seaton Park, Goulburn, and Balansa Clover. Don't let Phalaris get tall and rank as it produces a toxin which kills the clover.

Another ideal way to get Phalaris down once it becomes tall and rank would be to spread lupins out at 250 kg/ha. Wethers are preferred and would need to be introduced to lupins first. To eat this paddock down sufficiently, increase the stocking rate to crash graze. Good management will prevent phalaris from becoming innutritious and rank.

If Phalaris needs to be thickened up at some stage, it can be achieved by locking it up in August and allowed to go to seed. The paddock should then be reassessed to see if the Phalaris has thickened. If not, plans should be undertaken to direct drill Clover, Cocksfoot, Fescue and Phalaris back into it.

LAND CAPABILITY CLASSIFICATION

The entire area of each property has been classified into a series of land classes which are called land capability classes. There can be up to eight land capability classes, numbered with Roman Numerals I to VIII and separated by a green line on the first overlay. In the case of "Hovells Creek Catchment" five of the eight classes have been identified.

The classes with lower numbers (I, II and III) are the more productive lands, whilst the higher numbers (VII and VIII) have either a much reduced or zero agricultural value or have very high risks of soil erosion or other forms of land degradation if they are not managed properly. Production returns are usually increased by concentrating improvements on the better classes of land. The less productive or high risk lands should be left in their natural state and managed according to their particular limitations.

Land capability is determined by taking into account climate, soil types, slope, soil erosion hazards, rock outcrop, and where present, land degradation features such as salinity, waterlogging, mass movement, soil acidity, etc.

The land capability class identifies the maximum potential use of the land, i.e. its maximum capability but not necessarily its existing use. It also identifies the management practices needed to ensure that land degradation does not affect the long term productivity of the land, or cause problems to immediate neighbours or downstream landholders.

In "Hovells Creek Catchment" the five classes of land are:

Class II

Consists of better quality cultivation land. Soil erosion levels are low and erosion can be controlled by good farming systems which include:

* suitable crop rotations
* maintaining soil structure by not growing more than five consecutive crops for a period of between 3-5 years, depending upon soil types
* improving soil organic matter levels by retaining as much stubble as possible
* adding lime to soils which are slightly acidic
* contour cultivation, reduced tillage practices, use of tyned implements
* no overgrazing.

Class III

This is sloping land suitable for cultivation on a regular basis with pasture rotation. Because of the erosion risk structural earthworks are needed along with good farming systems (as with the Class II) to maintain soil structure , soil fertility and reduce the erosion risk.

Class IV

This is land suitable for grazing with occasional cultivation for pasture improvement, and is of low to moderate soil erosion hazard and includes land where the existing and potential erosion can be controlled by land management practices such as, establishment of improved pastures, stock control, application of fertiliser and maintenance of soil structure and fertility.

Class IV land includes:

- slopes between 8-25%
- soil limitations such as shallow depth, heavy texture, low water holding capacity, high soil erodability, poor soil drainage, and low nutrient status

- areas subject to frequent flooding
- rock or stone that will not restrict cultivation for pasture establishment
- semi-permanent seeps and soaks that are not saline

Cultivation to improve pasture quality should only be done using machinery which will cause minimum soil disturbance. Grazing strategies should continue to aim at improving the quality of pastures and reducing weeds and unpalatable vegetation. Rabbit numbers also need to be kept in check. Natural tree regeneration programs and the establishment of planted individual trees or treelots are recommended for areas shown on the plan by the shaded areas.

Class VI

This country is land that is very fragile and should not be set stocked but crashed grazed.

This class comprises those areas which can be used for light grazing but which should not be cultivated under any circumstance because of limitations, such as:

- salinity
- wetness
- rockiness
- shallow soils
- steep slopes
- house or buildings

Stocking rates should be varied to maintain a good ground cover at all times. Stock should be withdrawn when pastures are evenly eaten down and prior to bare areas becoming evident. Existing trees should be retained, with stock and grass cover being managed to enable the regrowth to establish.

Class VII

This is an area that should not be cultivated in any circumstance, and left to it's natural timber and pasture. It is of low agricultural value and posses a high soil erosion risk if cleared.

SOILS

Three main soil types have been identified in "Hovells Creek Catchment". Typical descriptions for each of the soils are:

Yellow Podzolics

These soils are borderline between duplex and gradational. The A Horizon is a clay loam or a loam while the B horizon is a sandy clay or a medium clay. The boundary between the A and B horizon is gradual in colour but diffuse in texture. They are a relatively fertile soil. Physically the soils are friable to about 1 metre depth. However the friable B horizon is readily dispersible if water is concentrated. These soils are found in drainage lines and along the creek.

Solodic

Solodic soils occur at a wide range of locations in the semi-arid to humid rainfall areas. They have formed on a wide range of parent materials, including siliceous to intermediate igneous rocks (especially granite and rhyolite), sedimentary and metamorphic rocks, and on alluvium and colluvium. These soils are rarely associated with more basic rocks, such as basalt. Solodic soils typically occupy the mid to lower slopes of hilly lands, especially in the tablelands and on coastal plains. Solodic soils are characterised by strong texture contrast profiles with light-textured surface soils overlying tough, hard and dense B horizons. The boundary between the A and B horizons is very abrupt. There is also a characteristic bleached A2 horizon.

Lithosol

Lithosols are essentially stony or gravelly soils lacking horizon development other than an A1 due to organic matter accumulation and structure development in the surface. Normally they are shallow sands, loams and clay loams and usually contain a large proportion of coarse textured material in the form of fragmented rock , which may show some degree of weathering. Stoniness and the lack of pedological differentiation are the essential features.

Lithosols are found mainly where natural erosion has been active enough to maintain a thin layer of soil cover; that is principally on the crests and more steeply sloped parts of the hillier and mountainous areas.

Soil Tests

It is suggested that:

- soil tests should include a test for aluminium to determine more accurately the effects on increasing soil acidity
- test results should indicate the depth at which the soil samples were taken
- some samples should be taken at greater depths to find out if problems occur throughout the soil profile. It is normally the practice to collect soil samples within the plant root zone of the soil.

What a soil test should read:

	OPTIMUM RANGE		
pH Water	6	7	
pH CaCl	5.3	6.3	
Salinity	0	0.4	
Cation exchange	5	30	
Calcium	> 2.00		65% TO 80%
Magnesium	> 0.50 PASTURE	> 1.50 CROP	10% TO 15%
Potassium	> 0.25		1% TO 5%
Sodium	0	0	> 5% SODIC SOIL
Aluminium	0	0	0% TO 1%
Extractable Aluminium	0.00 ppm	0.00 ppm	
Extractable Manganese	0.00 ppm	0.00 ppm	
Soil Phosphorus	15.00 ppm	30.00 ppm Bray Phosphate	
Calcium Magnesium ratio	1	3.5	
Soil Sulphur	> 5		

Lime requirement/ha
(Desired level - Present level) divided by soil type where clay = 0.3, clay loam = 0.4, loam = 0.5 and sandy soil = 0.6
e.g. Your soil pH is 4.5, you wish top raise the pH to 6.0 on a sandy loam soil, therefore -
6.0 - 4.5 / 0.5 = 3 tonnes per ha Lime or Dolomite.

CONDUCTIVITY	SALT RATING	ACTION REQUIRED
< 0.15	LOW	NIL
0.15 - 0.40	SATISFACTORY	NIL OR LEACH SOLUBLE SALTS
0.40 - 0.80	MEDIUM HARMFUL TO SENSITIVE PLANTS	USE TOLERANT CROPS, LEACH SOLUBLE SALTS
0.80 - 2.00	HIGH HARMFUL TO ALL BUT TOLERANT PLANTS	USE TOLERANT PLANTS, DRAIN SITE, CONSULTATION REQUIRED
> 2.00	VERY HIGH - SCALDS	CONSULTATION REQUIRED

Cation Exchange is the measurement of the soils ability to hold nutrients to the clay or organic matter fraction. The range is usually 3 to 10 on lighter soils and can be greater on heavier, especially Basalt, Andesite and Limestone Soils.

CLIMATE

"Hovells Creek Catchment" is in the zone that has a median annual rainfall of 603 mm. The annual total is quite variable with 50% of years having rainfalls from 485 mm to 774 mm.

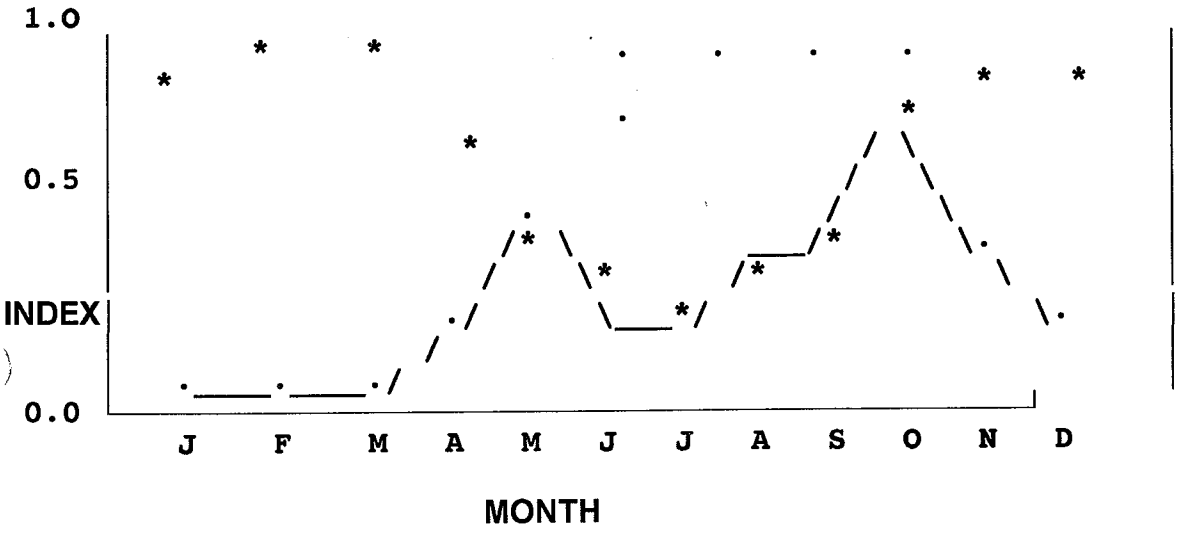
June to August are the wettest month of the year with rainfall of about 50 mm. This decreases to around 30 mm per month in February. The seasonal pattern of a peak in June and a depression in February is typical. Winter rainfall is considerably more reliable than the summer rainfall.

Soil moisture content is very high and reliable throughout the period from June to October, with April, May and November also having relatively high moisture levels. In the summer months the probability of adequate soil water for plant growth is much reduced. Runoff on a catchment basis is highest during August when it will be expected to occur once in every two years.

The pattern of seasonal plant growth, resulting from the interaction of temperature and soil moisture is shown in Figure 1. The autumn peak is more sustained because of better moisture conditions, and the winter depression intensified because of lower temperatures.

FIG.1 CLIMATIC INDICES FOR "Hovells Creek Catchment"

*** TEMPERATURE . MOISTURE - GROWTH**



Reference: Rainfall in NSW Soil Conservation Service Technical Handbook No. 3

LAND DEGRADATION PROBLEMS AND MANAGEMENT RECOMMENDATIONS

There are at least nine factors associated with land degradation.

Soil erosion: The primary method of avoiding soil erosion is to maintain a stable vegetative cover on the land surface. This can be mainly achieved by sound land husbandry-avoidance of overgrazing/ over cultivation, and adoption of a conservation farming philosophy etc. As well, soil conservation structures to control water erosion, and windbreaks to control wind erosion, are widely accepted techniques.

Soil salinity: To lower levels of ground water with its associated harmful salts, reforestation of recharge areas has proven benefits. Diversion dams, absorption or interceptor structures, water table pump-down, and controlled irrigation can all be used. Eventually it might be necessary to transport recovered salts away from the reclaimed agricultural areas, a disposal problem which generally has not yet been firmly addressed.

Soil structure decline: One of the best ways to maintain good soil structure is to achieve a high level of soil organic matter. This can be done by maintaining vigorous pastures, by retaining stubble and by incorporation of green manure crops of organic wastes. Wise cultivation, avoidance of overgrazing, and use of gypsum or other soil conditioners are also other approaches.

Soil nutrient decline: The obvious way to overcome loss of nutrients by product removal, leaching, or erosion, is to replace them by using fertilisers, organic or 'inorganic'. However, prevention of product removal, leaching and erosion obviously addresses the primary causes of nutrient loss.

Soil acidity: The obvious approach to correct soil acidity is to raise the pH. This can be done by adding ameliorants such as lime. Withdrawing nitrate from the soil profile by using deep rooting plants, and reduction in the removal of cations in agricultural produce, should also decrease soil acidity.

Soil biological degradation: Soil biological degradation can encourage soil degradation. To encourage soil biological activity, organic matter in various forms can be added. Unfavourable conditions for biological activity can be altered by attending to such factors as acidity, salinity, and chemical pollution. Fertiliser addition may increase biological activity. Organisms such as mycorrhiza, rhizobia, and earthworms can be introduced.

Rural tree decline: The obvious way to stop the decline in the population of trees is to stop cutting them down. By planting trees, encouraging natural regeneration, and overcoming dieback, rural tree decline can be reversed.

Soil chemical pollution: The cessation of chemical additions to soils will obviously prevent further chemical pollution. This may involve physical or ecological pest control, and may require acceptance of lower yields, and a change in consumer attitudes regarding produce of high cosmetic appearance.

Pests: Plants and animal which, unintentionally as far as human land managers are concerned, adversely affect the land can theoretically be destroyed by ecological, physical, or chemical (naturally occurring or human synthesised) methods.

SOIL EROSION

Gullies

Gullies occur in a number of situations:

- where drainage has concentrated and slopes increase
- along stock and vehicle tracks

Land Management Recommendations

- fill and shape the gullied areas and protect with diversion banks
- sow the filled-in areas with a pasture mix consisting of Phalaris, Cocksfoot and Clovers and restrict stocking until pastures are well established
- fence gullies with large external catchments that are uneconomical to fill or shape and plant trees out of the main flow of water

Sheet and Rill Erosion

Occur on all cultivated areas, with the highest risk during summer fallow periods.

Land Management Recommendations

- cultivate lands using narrow and deep tyne implements to reduce the risks of sheet and rill erosion; disc implements should be avoided
- retain crop stubble cover and burn only late in the season if necessary
- maintain/rebuild all contour banks and outlets

SOIL ACIDITY

Soils become acidified by:

- the use of acidifying nitrogen and elemental sulphur fertilisers
- the use of legume dominant pastures, which fix high levels of nitrogen in excess of pasture requirements
- the nitrification of soil organic compounds and their subsequent leaching from the root zone
- the removal of alkaline products and waste products, eg manure
- increased soil organic matter levels

Induced acidity greatly affects the chemistry of the soil. The relative levels of soil nutrients and their availability to plants vary with soil pH. Problem acid soils are often characterised by a pH of <5. The effects of acid soils include reduced pasture and crop growth. This results in decreased ground cover and an increased susceptibility to soil erosion.

Elements released due to acidification are often detrimental to plant growth. For example, levels of aluminium and manganese can increase when soil pH falls below certain levels in some soils.

Notes

- The method of determining pH must be known in order to interpret results because different methods of determining pH give different pH values. Calcium chloride (1:2, soil:0.01 m $CaCl_2$) tests are usually 0.5 to 0.8 pH units lower than water pH readings. Unless otherwise specified, Lachlan Rural Consultancy uses water pH readings.
- If an acid soil problem is indicated then an analysis is required for the exchangeable cations of calcium, magnesium, potassium, sodium, aluminium and manganese in the surface soil (0-15 cm or to the depth of the seed bed, and subsoil 15 - 50 cm).
- Lime requirement testing by serial filtration or other methods should be undertaken.

Management Recommendations

Recommended treatments include:

Selection of Acid-tolerant Species

This is essential where soil acidity occurs throughout the profile. Plant species and varieties which are tolerant of aluminium and manganese should be used. For example, the tolerance to aluminium is generally greater for oats than barley, whilst the oats variety 'Cargeen' is greater than for 'Coolabah'.

Inoculation and lime pelleting are recommended when sowing some temperate legumes into soils which have a history of soil acidity.

Liming - quantities of lime or dolomite should be chosen depending upon soil test results. Where legumes are grown molybdenum is often deficient.

Three aspects of lime quality are important:

- Small particle size - 70% of the sample should pass through a 50 mesh screen. Particles coarser than 20 mesh are virtually useless. Finer particles react more quickly with soil.
- High neutralising value (NV) - higher neutralising values have a greater capacity to neutralise the soil.
- Source; neutralising values vary between liming materials.

The following practices should be used in applying lime:

- work it into the soil before seeding
- allow time for reaction; fine lime will take 6 to 8 weeks to react
- consider a cropping phase in pasture paddocks
- apply before first crop in a pasture/crop rotation
- use a traditional seedbed for the first crop in a direct drill program, or alternatively, lime may be broadcast

Lime has a low solubility. Lime applied to the surface will move down the soil profile slowly, so it may take several years before the full benefit is realised.

Although lime has a relatively long residual effect:

- Soil will continue to be acid if subject to the same conditions.
- On most light to medium textured soils, the benefits of applying lime at the correct rate may last for ten years or more. However, this depends upon the soil type, the amount of lime applied and the rate of acidification.

Some dangers occur with using lime. They are:

- nutrient imbalance and deficiencies can occur with over liming
- excess lime can induce magnesium, zinc and boron deficiencies
- problems are most likely to occur on light soils that are lime to pH >6.0
- using too much lime is wasteful as all soluble aluminium is neutralised at a pH of about 5.5

Changes in the Management of Farming Systems

To reduce the rate of acidification, including modifications to fallow practices, use deep-rooted perennial species, ammonia-based fertilisers, and increase grass levels in legume-based pastures.

DESIRABLE pH RANGE

BARLEY	6.5 TO 7.5
COTTON	5.5 TO 6.5
MAIZE	5.5 TO 7.0
OATS	5.5 TO 7.0
CANOLA	6.0 TO 6.5
RICE	5.0 TO 6.5
SORGHUM	5.5 TO 7.0
SOYBEANS	5.5 TO 7.0
SUNFLOWERS	5.5 TO 7.0
RED CLOVER	6.0 TO 7.0
SUB CLOVER	5.0 TO 5.5
WHITE CLOVER	6.0 TO 7.0
COWPEAS	5.5 TO 7.5
VETCHES	5.5 TO 7.5
GRASSES (MOST)	5.5 TO 7.5
LUCERNE	6.5 TO 7.5

(Blair,1979,Plant Nutrition,U.N.E.)

VERY SENSITIVE PLANTS

BARREL MEDIC
CANOLA
LUCERNE

SENSITIVE PLANTS

SENSITIVE WHEATS
SENSITIVE PHALARIS
BARLEY

TOLERANT PLANTS

TOLERANT WHEATS
TOLERANT PHALARIS
SUB CLOVER
COCKSFOOT
PERENNIAL RYE

VERY TOLERANT PLANTS

LUPINS
TRITICALE
OATS
CEREAL RYE

EARTHWORKS

Earthworks, banks, waterways and gully control structures are an excellent insurance policy. While the figures shown in the universal soil loss equation are given as an average annual soil loss, in reality, erosion does not occur as uniformly as this. The majority of the erosion will probably occur from one or only a few major rainfall events, then no major soil loss occurs for months even years. Soil loss from one storm has been measured at over 500 tonnes per hectare. It is estimated that structural earthworks can reduce soil erosion by forty to sixty percent and since you have to cultivate on the contour then earthworks contribute even higher to the reduction of soil loss. Further soil loss is reduced by management practices such as the number of cultivations, the type of cultivation, the crop rotation and the management of stubble or plant cover.

Graded banks are designed to collect and divert runoff from a paddock and safely convey it to a stable water disposal system. The success of a graded bank system is dependent on the maintenance of the system. This is covered in the appendix.

It is recommended that the minimum size for all dams and gully control structures be 1500 cubic metres, as anything smaller will evaporate over the summer. The maximum size is dependant on the site and finances. It is important that the dam size and location be discussed fully with the District Soil Conservationist or Lachlan Rural Consultancy before construction commences.

SOIL STRUCTURE DECLINE

This is evident throughout the catchment, and varies greatly depending on the tillage and stocking history of paddocks. Tillage aims to prepare a soil for a crop. It fulfils one or more of the following functions; weed control, moisture storage through fallowing, stubble management or seedbed preparation. Tillage effects on soil, particularly soil structure, can be dramatic and complex. For explanation of factors affecting soil structure decline and additional information see appendix.

Land Management Recommendations

- avoid using disc implements, use only tyne equipment
- incorporate in the cropping program a pasture phase of at least five to seven years duration
- incorporate crop residues
- recommended rotation is a break crop, such as rapeseed, cereal, legume, cereal with pasture undersown
- stubble should be treated immediately after harvest aiming to keep maximum amount of residue on top of the soil. Treatment is with either slashing or 'Coolamon' harrows and the use of stock.

SALINITY

Saline soils are bare and often they are waterlogged. Their salt content is too high for normal vegetation to survive, and when it dies the soil is left bare and the salt accumulates at the surface. This causes it to seal and shed more water than normal creating water erosion.

All soils contain some salts but saline soils have accumulated quantities which deleteriously affect plant growth. By definition, non saline soil have less than 0.1 per cent salt by weight, and saline soils have greater than this amount.

Experience has shown that the dominant salt type in NSW is sodium chloride, with varying amounts of calcium and magnesium chlorides and sulphates, and sodium sulphate.

All soils and their parent rock material have soluble salts produced as a result of weathering of their mineral constituents. Sediments laid down in a marine environment, with salt water in the pore spaces is not uncommon in Australia.

Soluble salts by their nature, move in soils with the flow of water. They accumulate where soil water accumulates. Water in soils move laterally or vertically and soluble salts are washed down through soils to where the permanent water table exists or soil water movement ceases. Water tables move laterally to the lowest section of the landscape, emptying into creeks and rivers where there is ample water to prevent salt accumulation.

Water table induced salting occurs where the water table is caused to rise to the surface before reaching the river or creek at the lowest point of the catchment. When water tables rise close to the surface, water moves upward due to capillary action, particularly when evaporative conditions occur. Salts in water thus crystallise at the surface as water vaporises.

The net result is that salt accumulates at the surface and throughout the soil profile above the water table because more water moves upward than downwards or across the slope as runoff from rain.

The underlying cause of the development of such saline soils is the widespread clearing of trees since European settlement. The almost complete removal of trees and their replacement by grass has drastically altered the water balance in the soil. The replacement of deep rooting trees by shallow rooting grasses has meant that water percolating beyond the rooting depth of grasses is no longer withdrawn by plants. In consequence, there has been a general increase in the height of water tables, which has brought them closer the soil surface and induced salting of the surface soils in many areas. Only widespread reafforestation will bring about any reduction in the spread of saline soils. Early control measures initiated will prevent further degradation of valuable farming land.

To prevent further spreading of a saline discharge area, control measures in the recharge area of the catchment are essential. Without addressing recharge area control measures it is unlikely that discharge areas will be reclaimed.

The most salt tolerant pasture plants for saline areas are two perennial species - Puccinellia (*Puccinellia ciliata*) a winter growing grass, and Tall Wheat Grass (*Agroyron elongalum*) which is capable of making good growth throughout most of the year. Both grasses establish well and should be planted together - growth is slow in the first year but is rapid in subsequent years.

Both grasses are planted in autumn at a shallow depth of 5 - 10 mm. Sowing rates of 3 kg/ha Puccinellia and 5 kg/ha Tall Wheat Grass are recommended. The moderately tolerant species that can be planted in combination are; phalaris, lucerne, couch grass, strawberry clover and wimmera ryegrass.

In general, annual dressings of 200 kg/ha of di-Ammonium Phosphate (DAP) are recommended.

The above only treats the problem. It does not resolve the problem or even prevent the area of salinity affected land from increasing. The correction of the problem is long term, i.e. slow, complicated and at this stage unsubstantiated by pure research. The problem is a water logging problem, knowing this then it is logical that the saline areas can be reclaimed by lowering the water table. This can be done naturally or mechanically. At this stage, mechanically lowering the water table is uneconomical.

To lower the water table naturally will require:

1. to stop the excess rainfall from reaching the water table
2. to use more water than is annually available from rainfall

SALINITY RATING **these are shown in red on the photo below the pH readings**

0 TO 0.15 dS/m	very low	sensitive crops
0.15 TO 0.30 dS/m	low	moderately sensitive crop
0.30 TO 0.70 dS/m	medium	moderately tolerant crops
0.70 TO 1.20 dS/m	high	tolerant crops
1.20 TO 1.90 dS/m	very high	very tolerant crops

WATER SALINITY LEVELS **these are shown in blue at water points on the map**

	dS/m
Desirable limits for humans	0.8
Grape, Potato yield reduced by 10%	1.7
Lucerne yield reduced by 10%	2.2
Absolute limit for humans	2.5
Limit for mixing herbicides	4.7
Limit for poultry	5.8
Limit for pigs	7.5
Limit for dairy cattle, ewes, lambs	10.0
Limit for horses	11.6
Limit for beef cattle	16.6
Limit for adult sheep on dry feed	23.0
Sea Water	55.0
Dead Sea	550.0

Water salinity greater than 1 dS/m begins to cause problems for plants.

PLANT TOLERANCES TO SALINITY

	Soil salinity EC se at	
	90% yield	50% yield
Cowpeas	2.0	4.8
White Clover	2.0	6.2
Snail Medic	2.3	5.4
Potato	2.5	5.9
Strawberry Clover	2.5	6.4
Grapes	2.6	6.8
Tomato	2.8	5.0
Lovegrass	3.2	7.9
Lucerne	3.4	8.9
Rice	3.3	7.1
Oats	5.5	7.5
Soybeans	5.5	7.5
Fescue	5.8	13.3
Sunflower	5.9	7.5
Trefoil	6.0	10.0
Kikuyu	6.3	19.7
Barley	7.4	13.0
Wheat	7.4	13.0
Sorghum	7.4	9.9
Couch Grass	8.5	14.7
Cotton	9.6	17.3
Tall Wheat Grass	9.9	19.4
Rhodes Grass	10.1	22.6

NUTRIENT LOSS

A study done by the select committee on land degradation found that nutrient loss was by far the greatest loss to farmers with the annual cost to Australian farmers in excess of 250 million dollars. Nutrients are lost by product removal, becoming unavailable to plants by being leached out of the root zone or by being removed by water or wind erosion. Most farmers have over the last few years cut their fertiliser programs back to the bare minimum or none at all. On basalt soils the use of Sulfur to create a chemical reaction to produce P has become a common practice however the amount of P is still finite and should only be a practice used as a last resort.

As farmers are the long term stewards of the land, then their philosophy should be to pass the farm on in better condition then what they started with. This means that at some stage nutrients have to be replaced as they are lost. How much nutrient should be applied both practically and economically is the major problem. Some nutrients such as S are easily leached from the soil while other elements move very slowly through the soil but are easily tied up by soil conditions such as low pH.

Each farmer should be looking at replacing what he takes out on a regular basis. This can be done by using legumes to produce nitrogen for the grasses, using natural or synthetic fertilisers, use of effluent, and green manure crops. By working out the amount of nutrients lost by product removal then a base figure is derived. This figure will need to be boosted by pasture or crop type, seasonal conditions and soil conditions. The following tables are guides to a minimum fertiliser program :

CROP	YIELD tonne/ha	PART	NITROGEN	PHOSPHORUS	POTASSIUM	SULPHUR
			Kilogram per hectare			
Wheat	2	grain	42	9	10	2.5
	2.8	stubble	17	2	24	4
	3.5	grain	73	17	17	4
	4.8	stubble	29	3	30	7
Oats	1.8	grain	28	5	7	3
	3	stubble	14	3	36	6
	3	grain	47	8	11	5
	5.4	stubble	24	6	64	11
Barley	2.5	grain	44	9	10	4
	2.6	stubble	17	3	31	5
	4.2	grain	73	15	16	6
	4.6	stubble	30	4	54	9
Canola	1.3	seed	34	8	10	25
	1.5	stubble	55	12	40	
Pasture Hay	5		130	16	110	
Lucerne Hay	15		364	36	276	36
Beef	1250 kg/ha		34	9	2.5	
Sheep	60 kg/ha		7	0 .25	3	

LAND MANAGEMENT

CONSERVATION FARMING

Herbicides are an important resource to control plant growth. Grazing has a big influence on the cost and effectiveness of many of the chemical and spray techniques used.

Frequent grazing is used to restrict plant development and root system growth. This may mean below optimum animal intake is necessary to get the best cropping preparation. A good understanding of animal needs is essential to minimise production loss.

The use of sprays to provide a rapid kill of plant material in place of repeated tillage allows grazing to be extended. This may significantly lift stocking rates or animal productivity by relieving a period of feed shortage in the annual feed cycle.

NUTRITIONAL REQUIREMENTS OF LIVESTOCK

DRY SHEEP

Merino wethers or non breeding ewes which have reached mature size have the lowest nutritional requirements of all classes of stock. They can tolerate short term (up to two weeks) nutritional stress with little affect on wool production and so are most suited for use when heavy grazing is required. They do however still respond to ideal nutrition for maximum production.

WEANERS AND YOUNG SHEEP

Young sheep frequently exhibit a phenomenon known as compensatory gain whereby weaners which have received a set back will grow faster than those which did not, if given the opportunity before they pass mature age. They will never be better than the ones which did not have a set back but they will not be as far behind as they are immediately after the stress. This characteristic means that if pressed for suitable stock to graze an area for cropping or pasture purposes, weaner or yearling sheep will suffer only a small loss in productivity providing they have conditions which are ideal before they reach maturity.

BREEDING EWES

Breeding ewes, particularly if it is a highly fertile flock, have very specific and critical nutritional needs which must be understood well if maximum productivity is to be achieved. The consequences of restricting nutrition at critical times can be dramatic as well as costly. The actual time of year in which these requirements occur will vary with the date of joining and can be manipulated to a certain degree. However, as cycling is stimulated by decreasing day length, the highest reproduction rates usually come from an autumn joining.

CATTLE

Cattle require consistent levels of plentiful high quality feed. The use of cattle to manipulate plant material is consequently limited to the low intensity grazing requirement periods.

INTEGRATING LIVESTOCK INTO REDUCED TILLAGE SYSTEMS

Dry or young sheep can be utilised at any time for even the hard grazing required with some techniques. There will be a small production loss but it will not likely be outweighed by the savings of the new methods. Breeding ewes can be utilised if their feed requirements are matched up with the grazing requirements of the techniques being used.

The most likely match comes with an autumn ewe joining and winter cropping programme.

Joining is in February-March when ewes are high in body weight after gaining weight from grazing freshly harvested crop stubble or summer pasture. After joining, when nutrition is not as critical, these ewes can be used for autumn grazing in preparation for herbicide application and sowing.

The pre-lamb build up and lambing can be undertaken on a range of grazing crops and pastures. Finally the natural spring flush ensures ewes have an abundant milk supply for their lambs. Weaning can be carried out at the end of spring with weaners having sufficient wool to be shorn to prevent losses caused by grass seed.

A beef breeding enterprise with a late winter calving may combine partially with a reduced tillage winter cropping program.

Joining occurs from October to December with cows attaining a condition score 3/4 by the middle of joining in November. By calving through July, August, September, abundant good quality nutrition can be provided for breeders prior to, during and after calving. This is particularly important in late August-September when breeding cows need good nutrition to provide milk for a calf and gain in condition for joining. Calves can be weaned in late-April, allowing cows a few months to build-up in condition for the next calving.

The specific chemical used in a spraying program affects the grazing requirements. Roundup (R) is translocated from the leaves of actively growing plants into the root system and is able to control plants in advanced stages of growth without the need for heavy grazing. This herbicide ideally requires an average weed height of 6 to 8 cm to provide sufficient leaf area for the chemical to be absorbed. Therefore hard grazing just prior to spraying is not recommended. If heavy grazing has occurred it is necessary to allow sufficient regrowth before spraying.

Contact herbicides SpraySeed (R) or Gramoxone (R), are also used in reduced tillage systems. For contact herbicides to be effective it is essential that paddocks are continually and well grazed to minimise root development. Crash-grazing just before spraying is not a recommended practice when using SpraySeed (R) or Gramoxone (R).

It is harder to kill a plant that has been allowed to grow unchecked and then grazed, than one continually grazed. A good grazing program will minimise weed root development.

BETWEEN CROPS - PASTURE PHASE

FEED QUALITY

Pastures vary greatly in their quality and palatability. Nutritional needs of animals vary also. As long as energy requirements are met the main variable is in protein intake requirements.

Pastures with some legume content are most likely to provide the higher levels of protein required by young growing stock.

Palatability and digestibility of all plants falls as they mature. Sheep find short green plants, less than 10cm high, most palatable while cattle prefer green material up to 30cm high.

Plant digestibility falls as the proportion of lignin and cell wall increases in relation to total dry matter. This occurs naturally when leaf area declines as a proportion of the whole plant and well before haying off or seeding.

Perennial species usually provide more high quality feed for a longer time than rapidly maturing annuals.

GRAZING MANAGEMENT

Grazing management has an influence on the plant performance and the health of the pasture. Some species respond to intermittent heavy grazing, lucerne being the best known of these.

Other species such as Phalaris need continual grazing during the main growing period of the year to prevent the plants becoming old and rank.

Pasture medics need resting at flowering and seed set as they produce their seed at a height where animals graze. Sub clovers should be grazed during flowering to increase seed size and subsequent viability and induce seed burying.

Heavy grazing of medic, sub clover and serradella pastures after seed set can remove dry matter and assist seed coat breakdown in preparation for germination in the next season.

Heavy grazing of mixed sward pastures at times when one species is seeding or has recently germinated can change pasture composition dramatically.

THE ROLE OF ALTERNATIVE CROPS IN CONSERVATION FARMING

A number of alternate crops are available which are readily integrated into the conservation farming system. These include :

OILSEEDS	**LEGUMES**	**PASTURES**
Canola	Lupins	Sub-clover
Linseed	Field Peas	Lucerne
	Chick Peas	Medics

Alternative crops are included in the rotation for a number of important reasons. Reasons for their adoption into the cropping program include :

- DISEASE CONTROL
- WEED CONTROL
- SOIL FERTILITY
- IMPROVE CROPPING PROFITABILITY
- DISEASE CONTROL

Three factors are essential for a disease outbreak:

- A susceptible host
- A virulent pathogen
- Suitable environmental conditions

Intervention can affect the incidence and severity of disease by influencing these components. Conditions which favour optimum crop growth also in general favour the development of diseases. The inclusion of alternate crops in the rotation breaks the disease cycle because they do not host the same diseases which affect winter cereals.

However some conservation farming practices can increase the disease potential. Retaining stubble increases the amount of pathogen surviving from year to year ; eg. speckled leaf blotch and yellow leaf spot.

Speckled leaf blotch is wind borne over long distances while yellow leaf spot will spread only a metre

or so from its point of origin. The practical solution in the short term, if infected stubble is a potential problem, is to retain the stubble for as long as possible and dispose of it by burning just prior to sowing. The long term answer is in the growing of resistant varieties.

The inclusion of rapeseed in the rotation as the first crop following the pasture phase has been shown to impart tremendous benefits to the following wheat crops. Most of the increased yield which has been observed has been due to the rapeseed controlling the diseases which would normally pass from the pasture grasses onto the cereal crop.

Controlling grasses during the winter period of the pasture year prior to cropping, and stopping seed set of grasses in the spring reduces the grass population in the following wheat crop. The incidence of root disease in the crop is also reduced.

WEED CONTROL

Weeds affect crop yields both directly through competition for space, light, nutrients and moisture and indirectly by causing delayed planting.

In conservation farming there has been a greater use of expensive post-emergent herbicides to control ryegrass and wild oats in wheat and barley crops established by these methods. This has led to the development of new weed problems such as Barley grass, Brome grass, Paradoza grass and Silver grass emerging for which there is no selective in-crop herbicide available.

However by including alternate broadleaf crops such as rapeseed, lupins, etc. in the rotation, these problem weeds can be largely overcome. Alternate crops to wheat allow an extended ranged herbicides to be used. In general weeds do best in crops with similar growth requirements such as ryegrass in wheat and wild radish in rapeseed. Control of these can often be achieved by a change of crop.

Farmers in the eastern wheat belt have achieved good control of ryegrass by growing rape after pasture. It is sown with a high rate of Trifuluralin and the minimum cultivation needed for incorporation. Not only does this suppress grass weeds and wireweed, so reducing chemical costs in the following cereal crops, but the small amount of cultivation loosens soil compacted by grazing, encourages weeds to germinate (necessary for control) and mixes nutrients through the soil which may otherwise be less available.

Repeated use of a single herbicide can lead to the development of herbicide resistance in weeds eg. resistance of ryegrass to Paraquat was discovered in WA and in SA resistance was recorded in ryegrass to Diclofop Methyl. By using alternate crops in the rotation and using a range of chemicals to control weeds, the change of resistance developing is much reduced.

SOIL FERTILITY

The aim of a cropping rotation is to achieve a balanced system where the legume phase (crops or pastures) replenishes the nitrogen and organic matter exploited by the cereal cropping phase.

In a pasture ley system, a legume pasture can add between 40 and 80 kg of N per year to the top 15 cm of soil. This is equivalent to some 176 kg / ha of Nitram valued at $51.85 per ha.

Lupins have been estimated to fix 50 to 100 kg of N/ha/year. The actual amount of N fixed varies with soil type, temperature, amount and distribution of rainfall and the success of the crop. In a continuous cropping system, a 30% increase in grain yield has been recorded when wheat follows lupins compared to wheat following wheat. Field peas are thought to contribute slightly less N than lupins. Research is continuing to determine the N input derived from some of the newer legume crops under NSW conditions. Organic nitrogen accumulated by leguminous crops is released over a longer period and

is less prone to leaching than mineral or bag nitrogen.

ROTATION SYSTEMS

There is no ideal systems of rotation for every individual farm in NSW. Many factors will influence each situation and will depend upon such things as :

- PRODUCT PRICES
- SOIL TYPES
- SOIL FERTILITY
- WEED SPECIES PRESENT AND DENSITY
- ANNUAL RAINFALL AND DISTRIBUTION
- AVAILABLE MACHINERY AND EQUIPMENT
- CASH FLOW
- LIVESTOCK CONSIDERATIONS
- DISEASE RISK

PASTURE ESTABLISHMENT AND RECOMMENDATIONS

Good productive pastures are essential to livestock performance. Good pastures don't happen by accident; they need careful planning.

A natural pasture carrying 1.5 dry sheep equivalents (DSE) can be increased to 5 DSE by a sound pasture improvement program and good management.

Legume dominant pastures have a beneficial effect on future cropping programs through improved soil fertility and structure.

In some situations, consider retaining better quality natural perennial grasses. The benefits are:

- Erosion prevention
- Excellent persistence
- Competitive ability in controlling some weeds
- An alternative feed supply if stock health problems develop on improved areas.

Natural pasture is generally frost sensitive, and of low nutritive value.

Sub clover dominant pastures contribute greatly to improved soil fertility and moisture holding ability and are an integral part of any cereal farming rotation.

In suitable cropping areas, consider the paddock's:

- crop yield potential
- erodibility
- access for machinery

Cropping paddocks, with less than 70 percent arable country, are best sown to suitable permanent species such as lucerne, phalaris or cocksfoot and not used in regular cereal rotations.

In non-cropping paddocks, improve the highest productive potential areas first.

Other factors influencing planning and the selection of a pasture mix are:

- Production potential of the area, as well as acidity, drainage and depth.
- Growing season - the quantity and effectiveness of rainfall and the effect of temperature on plant growth.
- Timing of requirements.
- The type of stock being carried.
- Whether long or short term pasture is required.

Establishing pasture without a cover crop is desirable and should be practised especially if lucerne, phalaris or cocksfoot is sown. Absence of a cover crop improves results and increases carrying capacity the following year. For economic reasons, cover crops are usually sown with pastures, even though they reduce the chance of good establishment.

A rapid growing cover crop can reduce the erosion risk during the pasture establishment period. Cover crop stubble may provide some protection for young seedling during hot, windy conditions after harvest. But generally, cover crops compete for light, nutrients and moisture at the expense of individual pasture plants.

Sowing cereal through every second run of a combine allows pasture to compete better with the crop. Lower cereal crop seeding rates allow weeds to be more competitive. Excellent crop yields are possible with lower crop densities so long as weed control is adequate.

Linseed is the least competitive cover crop.

Wheat sown early April is the preferred cereal cover crop, but seeding rates should be reduced to no more than 20 kg/ha.

Barley sown in April - May at 20 kg/ha is a suitable cover crop.

Direct drilling into natural pasture can produce good results.

Competition from weeds and existing pasture plants has to be reduced significantly. Heavy grazing before sowing may reduce competition for sub clover, white clover, annual ryegrass and vetch sowing, but a herbicide is essential to establish perennial species like phalaris and lucerne.

As seasonal conditions influence sowing time, aim for April - May sowing when conditions are milder and follow-up rain more likely.

Aim to use direct drilling where country is erosion prone or too rough to cultivate but still manageable by ground rigs in preference to aerial seeding as, by having some soil covering the seed, the risk of failure is greatly reduced.

Use adequate fertiliser when direct drilling, as available mineralised nutrient is very limited, and seedlings need a good boost to become competitive with the existing sward.

For annual species, like sub clover and annual ryegrass, aerial seeding works well. Seed must get to the ground surface to germinate. Heavy grazing well before sowing is essential to bare the ground and reduce competition after sowing.

However, when sowing perennial species like phalaris and lucerne, herbicides are necessary. Seek specific advice as the technique is risky and expensive, and detailed forward planning is required. Surface sowing of perennials on the better soils of non-arable country can be successful.

Perennial pastures are expensive to establish and therefore **absolute** weed and pest control, **accurate** seed placement and **adequate** soil moisture at sowing is essential for good results. The best soil cover is about 5mm or twice the seed diameter. If sown too deep then the shoot runs out of energy before emerging. If sown too shallow then the seed may dry out or ants or birds may pilfer the seed. Do not overwork the soil as this causes surface crusting and poor germination will result.

There have been very good results from direct drilling perennial pastures, as long as the **3 A's** mentioned above are adhered too. The best machine to use for establishing pasture are those that have tyned implements with an inverted T boot that is independent or ground following.

To successfully establish perennial pastures then the following steps need to be observed:

1. Existing vegetation must be killed or suppressed by heavy grazing, cultivation, herbicides or a combination of the above.

2. Use adequate seed quantity to provide competitive pasture with few weeds.

3. Use only recommended varieties by the department of agriculture as these are independently trailed for production, persistence and animal health problems.

4. Sow when conditions are best for germination and survival. Temperate perennials can be sown from autumn to early spring, temperate annuals can be sown April to early May.

5. Provide adequate sulfur, phosphorus and molybdenum at sowing time. This is best applied by banding fertiliser near the seed. This promotes quick early growth, provides efficient use of fertiliser and promotes sown species rather than weeds.

6. Inoculate legume seed with the correct strain of rhizobia

7. Use efficient sowing technique that ensures accurate seed placement.

8. Minimise competition from cover crops and weeds with grazing and/or herbicide.

9. Control pests and graze carefully, graze only when plants cannot be pulled out. Graze heavily for short periods to remove weeds. Allow pastures to set seed before set stocking. Lucerne should be grazed after flowering for short periods followed by long rests.

The following is a summary of pastures. The information has been summarised from NSW Dept of Agriculture Agfacts and commercial literature. The figures after each variety name is the minimum annual rainfall.

Medics

Winter/spring-growing annuals regenerating each year from seed. Best suited to neutral to alkaline soils in lower rainfall sections of the wheatbelt and further west (except murex medic).

Barrel medic

Parraggio 400. Replacement for Jemalong. Tolerant of spotted alfalfa and blue-green aphid.

Sephe 400. Replacement for Jemalong. Very tolerant of spotted alfalfa aphid, tolerant of blue-green aphid. Has performed better than Paraggio in poorer drained areas.

Murex medic (Medicago murex)

Zodiac (P). 500. Suited to soil pH (CaCl2) 4.5. and above. Below pH 6.0 use Group A inoculant. Compared to subclovers of similar maturity, murex has higher hard seed levels, stays greener for longer, particularly in dry springs, and has a slower breakdown of dry residues over summer.

Subterranean Clover (Trifolium subterranean)

Winter/spring-growing annual suited to moderately acid to neutral soils. Basic legume for southern NSW. Varieties are listed from late to early maturity. All recommended sub clover varieties have low oestrogenic levels and are unlikely to cause clover disease. Mixtures of varieties can be used. Using the variety most suitable for a particular rainfall district will set seed reliably and ensure persistence of the clover component. Using a slightly longer season variety will allow advantage to be taken of extended seasons.

Woogenellup. 525. Susceptible to clover scorch disease. Very susceptible to root rot. Low hard seed levels. Vigorous seedling.

Junee 500. Resistant to clover scorch. Tolerant of root rot. Moderate levels of hard seed.

Trikkalal 525. Suited to water logged soils. Very tolerant of root rot. Tolerant of clover scorch. Low level of hard seed.

Riverina. Suited to water logged soils. Very tolerant of root rot. Tolerant of clover scorch. Low level of hard seed. New Release 1995.

Seaton Park. 475. More persistent but less spring production than Woogenellup. Moderate level of hard seed. Susceptible to clover scorch and root rot.

Daliak. 425. Resistant to clover scorch, tolerant of root rot but very susceptible to blue-green aphid. Moderate to high levels of hard seed.

Dalkeith. 400. Persistent, high levels of hard seed. Susceptible to clover scorch. Tolerant of root rot and blue-green aphid.

Nungarin. 375. For drier fringe of sub clover belt. High levels of hard seed. Good persistence. Useful in mixtures of sub clovers.

Goulburn. 525. a replacement for Woogenellup.

Denmark. 675. a replacement for Karriadale and Mt Barker. Ideal for hay production due to disease and pest resistance.

Lucerne (medicago sativa)

Drought resistant, warm season perennial. Suited to a wide range of well drained neutral to alkaline soils. Must be rotationally grazed or cut for good persistence. Select best variety on the basis of late autumn/winter growth and pest and disease resistance. The use of varieties susceptible to aphids is strongly discouraged as this leads to unreliable production, the build-up of aphid numbers and an increase in the risk of insecticide resistance.

<u>Semi winter-dormant varieties</u>

Pioneer 581. Validor WL. Southern special. Nova. WL 318.
Similar growth pattern to Hunter River variety. More persistent than highly winter-active varieties when not rotationally grazed.

Winter-active varieties

Trifecta. Aurora. Hunterfield. Good seedling vigour and late autumn/winter growth. More persistent than highly winter-active varieties when not rotational grazed.

Yellow Serradella (Ornithopus compressus)

Winter/spring-growing, self-regenerating annual suited to deep sandy soils of low pH. Seed must be hot water treated prior to sowing. Sowing rate: dryland alone 5-10 kg/ha seed pods; mixtures 2-5 kg/ha seed pods.

Avila (G). 450. Replacement for Pitman. Similar maturity.
Slender serradella (Ornithopus pinnatus). As for Yellow Serradella but better adapted to less well drained soils.

Jeballa. 450. Better adapted to waterlogging than Yellow Serradella. Useful in mixtures.

Woolly pod vetch (Vicia villosa)

Winter/spring-growing, self-regenerating annual suited to well-drained soils. Moderately tolerant to soil aluminium. Can be a weed in winter cereals (susceptible to 2,4-D). Useful pioneer species. Sowing rate: dryland alone 6-10 kg/ha; mixtures 4-6 kg/ha.

Namoi. Susceptible to heavy grazing pressure although more persistent with cattle. Low bloat risk. Useful in mixtures with oats.

Balansa Clover (Trifolium balansae)

Winter/spring-growing, self regenerating annual adapted to soils of pH (CaCl2) 4.5-7.0. Tolerant of waterlogging. Slow early growth but good late winter and spring production. Produces good quality hay. Resistant to clover scorch and root rot. High levels of hard seed. Sowing rate: dryland alone, 2 kg/ha; mixtures, 1 kg/ha;.

Paradana (P). 550. Seedlings very susceptible to red-legged earth mite.

Rose clover (Trifolium balansae)

Winter/spring-growing annual. Adapted to a wide range of soil types. Sensitive to heavy grazing pressure. Sowing rate: dryland mixtures 0.5-4.0 kg/ha. Hykon. 425. Early maturing.

Annual Ryegrass (Lolium rigidum)

Self-regenerating annual. Vigorous early growth. Weed of winter crops. Potential threat to animal health should annual Ryegrass toxicity occur in NSW. Sowing rate: dryland alone, 3-15 kg/ha; mixtures, 3-6 kg/ha; irrigation alone.

Wimmera. 500. Inexpensive seed.

Phalaris (Phalaris aquatica)

Produces late autumn to spring. Highly persistent perennial suited to fertile soils. Most sensitive of temperate grasses to acid soil problems. Suits high altitude in drier situations. Tolerates wet soils, flooding and moderate salting. All varieties can cause phalaris poisoning, although there is a reduced risk of staggers with Sirosa and Sirolan. Sowing rate: dryland alone, 0.75-3 kg/ha; mixtures, 0.75-2 kg ha;

Australian. 550. Slow establishment, relatively prostrate growth. Aggressive once established on fertile soils. Most persistent cultivar.

Uneta. 550. Similar to Australian but improved seed yields.

Sirosa. 525. Good seedling vigour and winter growth. Heavy grazing in spring may affect persistence.

Sirolan. 525. Good seedling vigour and drought resistance. Heavy grazing in spring may affect persistence. More summer-dormant than other varieties.

Holdfast. 500. Strong seedling vigour. More tolerant of acid soils compared to Sirosa. Low levels of alkaloids but like all new varieties will require resting.

Maru. 525. Low alkaloid content, good seedling vigour. Summer dormant but good response in Autumn Winter and Spring.

Cocksfoot (Dactylis glomerata)

Perennial suited to low fertility soils. Tolerant of soil acidity. Moderately persistent. Suits high altitudes in drier situations. Sowing rate: alone, 2-3 kg/ha; mixtures, 1-2 kg/ha.

Currie. 600. Autumn/winter/spring growth with summer response. More tolerant of heavy grazing than other varieties.

Grasslands Apanui. 850. Pronounced summer/autumn growth. Poor persistence under heavy stocking.

Tall Wheat Grass (Agropyron elongatum)

Spring/autumn-producing perennial suited to salty, poorly drained soils. Sowing rate: dryland alone, 10-15 kg/ha; mixtures, 3-10 kg/ha.

Tyrrell. Tall growing. Slow to establish. Useful pioneer species for salty areas.

Puccinellia (Puccinellia ciliata)

Perennial. More salt-tolerant but less vigorous and productive than tall wheat grass. Sowing rate: dryland and irrigated alone, 3 kg/ha; mixtures, 1-3 kg/ha.

Menemen. 400. Low-growing. Winter-producing. Sensitive to heavy grazing. Useful pioneer species for poorly drained salty areas.

Perennial veldt grass (Ehrharta calycina)

Autumn/spring/summer-producing perennial suited to light sandy soils and erosion control. Sowing rate: alone, 1-3 kg/ha; mixtures, 0.5 kg/ha.

Mission. 550. Sensitive to heavy grazing.

Consol Lovegrass (Eragrostis curvula)

Consol lovegrass was developed by the NSW Soil Conservation Service as a soil binder and grass for soils of light texture and acidic soils, it is not suited to heavy clays. It is best suited to areas of 400 to 625 mm rainfall. Consol does not require high level of phosphorous but does respond to high nitrogen either from fertilisers or companion plants such as Serradella or Sub clover. It is a summer Autumn growing plant.

Fescue

Fescue is suited to areas of rainfall greater than 620 mm or to areas that have rising watertable problems. It does not persist if not in wet areas or summer rainfall. Has high production during summer and good production in spring and autumn. Feed quality is better than phalaris and cocksfoot.

PASTURE RECOMMENDATIONS

Pasture types basically comes down to the landholders preferences and experience. The following recommendations are broad but are a starting base for sustainable pastures.

Class VI and Rougher Class IV Country

These areas are to be permanently planted to perennial pastures with phalaris being the base. A good mix will be Australian and Sirosa Phalaris at 1 kg each per ha, Currie and Wana Cocksfoot at 0.5 kg each per ha, a 5 kg per hectare mix of Goulburn, Dalkeith, Seaton Park, Junee, Trikkala and Woogenellup sub clover. A 0.5 kg per ha of Aurora lucerne can also be planted.

Class III and Better Class IV Country

These areas are cropped in rotation with a pasture ley, Class IV country is cropped once or twice in ten years, the class III country is cropped four to six years in ten. The pasture mix could be Currie and Wana Cocksfoot at 2 kg per ha, Aurora lucerne 2 kg per ha and a mix of sub clovers at 3 to 5 kg per ha.

Class II Country

This country is best suited to lucerne pasture in rotation with a cropping phase. A suggested rotation would be Lucerne pasture minimum five years followed by Canola, Wheat, Lupins, Wheat, Oats or Barley.

Wet Country not Saline

This country opens many opportunities for the open minded farmer, a mix of Fescue and Paspalum ? why not some kikuyu ? If nothing else the wet areas should be planted down to phalaris Sirolan or Sirosa at 2kg per ha, Strawberry Clover 1 kg per ha, Balansa Clover 0.5 kg per ha, Haifa White Clover 0.5 kg per ha.

Saline Areas

Generally the seed needs to be broadcast onto sprayed areas as any machinery will cause at the very least tracking. Puccinellia 2 kg per ha, Tall wheat grass 5 kg per ha, Strawberry Clover 1kg per ha and Australian Phalaris 2 kg per ha. Mulch the bare area with straw by feeding out bales in this area.

When using Balansa clover in mix, plant grasses and subclovers first year and add Balansa with fertiliser when grasses have established otherwise the Balansa could smother establishing grasses.

Do not skimp on fertiliser at planting time. Look to supply the germinating pasture with 15 kg of N, 15 kg of P plus S and Mo.

All pasture seed should be lime pelleted, inoculated, and pesticide treated.

STOCKING RATE

Different species and different classes of animals within the same species, have different feed levels.

Table 1 shows the feed requirements for various classes of sheep and beef cattle.
It is worth highlighting that feed requirement is related to the animal's body weight, pregnancy and lactation status and whether or not the animal is gaining (or losing) weight.

For example, a 50 kg wether maintaining weight requires 1.1 D.S.E. per day compared with a similar 40 kg wether which requires 0.9 D.S.E. If the 50 kg wether is to gain 100 g/day then its feed requirement increases to 1.8 D.S.E. i.e. double the requirement of the 40 kg wether maintaining its weight. A practical implication of this is that you can graze 200 40 kg wethers which are maintaining weight on the same area on which 100 50 kg wethers gain 100 gm/day.

Animals which are losing weight need, or at least eat less food - their energy and other requirements for basic body functions being supplemented by mobilising energy etc stored as fat reserves. One kg of body fat mobilised results in 28 megajoules of energy (approx 4 D.S.E.). So a 50 kg sheep losing 100 gm/day would be obtaining 0.4 D.S.E. of its requirements from its body and the remaining 0.7 D.S.E. from ingested food.

Pregnancy and lactation increase daily feed requirements by 2-3 fold and help explain the situation which seems to mystify some apparently experienced farmers i.e. why non-lactating cows continue to maintain or gain weight whilst lactating cows may die of starvation!

The obvious take home message is that stock should be grouped according to feed requirements and then fed appropriately.

Calculating Stocking Rates.

- Record the number of stock in each class at times of likely feed shortage periods.
- Note whether stock should be maintaining, gaining or losing weight.
- Calculate feed requirements in D.S.E.'s for each class of stock and multiply this by the number of stock in each class.
- Add up the feed requirement for each class of stock to give a total. Refer to example.

In the example the '100 cow' beef herd requires 1703.5 D.S.E. per day (12265 megajoules (MJ) of metabolised energy (ME).

Once the stocking rate/feeding requirements are calculated you can estimate whether your land can carry the stock. (Local Department of Agriculture staff will be able to give you a guide to the carrying capacity of your land).

Pasture in winter may grow at 5 kg dry matter per hectare depending on pasture composition, soil type, drainage, fertility, temperature and rainfall. 5 kg equates to approx 55 MJ of ME.

So if there is no carryover feed from the autumn and no supplementary feed being offered, the 100 breeder cattle herd will need approximately 223 hectares of pasture. In practice the area needed to be grazed will normally be less than this because there is generally some carryover feed from the autumn flush.

In addition, in this example, the mature cows could be allowed to lose weight (0.5 kg/day) with little impact on fertility or calf growth - providing they remain above condition score 2. A controlled live weight loss of 0.5 kg/day/cow over 80 cows would result in a saving of 80 x 14 MJ = 1120 MJ or 156 D.S.E. per day, which would release approximately 20 hectares of pasture.

After the Calculation

If, after calculating the feed requirements of your flock/herd at critical times of the year you identify a feed gap, then you have two options - either decrease the feed requirements or increase the available feed.

Decrease feed requirements

- Cull the freeloaders - e.g. non-pregnant cows should be culled at weaning and any cows which lose a calf should be culled as soon as possible.

- Allow stock to put on condition in the periods of surplus with the intention of allowing them to lose weight slowly and controlled in periods of feed shortage. Be careful with this strategy - avoid extremes of over fatness or thinness.

- Run stock in groups with similar feed requirements so that the classes most sensitive to underfeeding (in this example the yearling heifers and first calvers) can be preferentially fed - at the expense of less sensitive groups such as mature cows if necessary.

Also remember that it is more efficient to feed a dry cow and her weaner calf than it is to feed a cow/calf unit.

- Change time of calving/lambing or stock turnoff. Spring calving/lambing equivalents. But don't change your time of calving or lambing without determining your ability to feed stock in late summer/early autumn and the market for your end product.

- Are you using large-framed, high live weight cows? Is it appropriate to switch to a medium-framed breed/strains and use a larger or heavier muscled terminal sire to get more kilograms of calf per cow mated?

Increase feed availability

- Will your pastures respond to fertilisers?

- Is irrigation water available to either extend the summer growing period of permanent pastures or to ensure an autumn break and growing period for annual pastures?

- Are winter active pasture species such as Sirosa phalaris or Haifa white clover suitable for your area? What about fodder crops such as maize or sorghum for the summer or oats for the winter?

- Can you drain paddocks which are prone to waterlogging in wet winters?

Example Estimating July Feed Requirements: (for 100 cow Beef Herd which calves in April/May and is being mated late July).

Assumptions:

- Mature lactating cows (500 kg) are fed to maintain weight, 100% calves at foot
- 2 year old first calf heifers (400 kg) are fed to gain 0.25 kg/day, 100% calves at foot
- yearling heifers (300 kg) are fed to gain 0.5 kg/day
- Bulls (800 kg) are fed to maintain weight

Class of stock	No.	D.S.E.	TOTAL D.S.E.
Mature cows with calves	80	15	1200
2 y.o. 1st calf with calves	20	14	280
Yearling Heifers	25	7.5	187.5
Bulls	4	9	36
TOTAL	**129**		**1703.5**

Table 1. Dry sheep equivalents for different classes of livestock on a daily feed requirement basis*.

Class of stock	Dry sheep equivalents (D.S.E.) (AT SPECIFIED LIVEWEIGHTS)	
Sheep		
Weaned lambs	**15kg**	**25kg**
gaining 100 g/day	1	1.3
gaining 200 g/day	1.6	1.9
Mature sheep		
Dry ewes, wethers	**40kg**	**50kg**
store**	0.9	1.1
gaining 50g/day	1.1.	1.4
gaining 100g/day	1.5	1.8
pregnant ewes (singles) ***	1.1.	1.3
pregnant ewes (twins) ***	1.3	1.5
ewes with lambs at foot	2.4	3.1
Beef		
Weaned calves	**200kg**	**250kg**
gaining 0.25 kg/day	4	5
gaining 0.75 day	7	8
Yearlings		
gaining 0.25 kg/day	6	7
gaining 0.75 kg/day	9	10
Mature Cattle		
dry cows, steers		
store	6	7
gaining 0.25 kg/day	7	9
Bullocks gaining 0.75 kg/day	11	13
pregnant cows last 3 months	8	9
cows with 0-3 month calves	13	15
cows with 4-6 month calves	15	17

*Assuming that a dry sheep weighing 45 kg requires 7.2 MJ of metabolisable energy each day.
**Pregnant ewes classed as 'dry' until last six weeks of pregnancy
***Average requirement during last 6 weeks of pregnancy. Daily weight gain in grams per day.

TREE RECOMMENDATION

Trees are important in the management of properties as:

- windbreaks for stock, crop and pastures
- shelter for reduction of stock stress
- wet and saline area treatments
- bird habitats to improve natural controls over insect populations
- visual appeal.

Land Management Recommendations:

- promote natural tree regeneration in the areas marked on the plan overlay as shaded and not fenced; use electric fencing to keep sheep away until the trees have grown beyond the grazing height of sheep

- establish new tree lots by:
  - fencing out defined areas
  - deep ripping at least 12 months prior to planting
  - planting tube stock
  - providing early protection from rabbits, kangaroos and drying weather
  - weed control to reduce competition pressures.

- fence tree lots using a quality fence which may be removed once the trees have grown beyond grazing heights

TREELOT - PLANTED - RECOMMENDATIONS

Native trees growing in the catchment are; Eucalyptus melliodora (Yellow Box), Eucalyptus dealbata (Tumbledown Gum), Eucalyptus micocarpa (Grey Box), Eucalyptus albens (White Box), Callitris endlicheri (Black Cypress Pine), Callitris columellaris (White Cypress Pine), Eucalyptus blakelyi (Blakely's Red Gum), Brachyshiton populneus (Kurrajong), Eucalyptus bridgesiana (Apple box), Eucalyptus polyanthemos (Red Box), Eucalyptus goniocalyx (Bundy Box), Casuarina stricta (Drooping She Oak), Casuarina cunninghamiana (River She Oak), Acacia ssp (Wattles), Eucalyptus sideroxylon (Mugga Ironbark), Eucalyptus macrorhyncha (Red Stringybark), Eucalyptus globoidea (White Stringybark). Besides the above, the following native trees are recommended for a three row windbreak, they are all drought resistant and frost resistant.

In "Hovells Creek Catchment" the minimum size windbreak should be three rows. There should be at least three different varieties per row to minimise damage by insects and natural conditions. Of these at least fifty percent should be indigenous to the property. The rest can be selected from the list below or of your own choice.

Trees should be planted in rows three metres apart, the row closest to the fence should be at least two metres off the fence. The middle and lee rows should have a tree spacing of five metres while the shrubs, the windward side, will have a spacing of three metres. A three row windbreak will need to be ten metres from fence to fence.

Preparation should commence the spring before by deep ripping and being kept weed free by chemical or mechanical means. Planting can commence from autumn to late spring. It is recommended that a residual herbicide is used to prevent weeds in the first twelve months. This is best applied before planting in strips 2 metres wide. The ground should be scarified a fortnight before planting and a residual applied at this stage. Residual soil should be removed at planting.

All the following trees are drought and frost tolerant and will require little maintenance after planting.

Fodder Trees - Australian Species - Windward Row		
	Acacia aneura	Mulga
	Atriplex nummularia	Old Man Saltbush
	Geijera parviflora	Wilga
	Acacia pendula	Myall or Boree
Small Trees - Australian Species - Windward Row		
	Callistemon rigidus	Stiff Bottlebrush
	Acacia decurrens	Green Wattle
	Callistemon paludosus	River bottlebrush
	Acacia floribunda	Gossamer Wattle
	Acacia pravissima	Ovens Wattle
	Melaleuca incana	Weeping Grey
	Melaleuca Armillaris	Honey Myrtle
Medium Sized Trees - Australian Species - Middle Row		
	Casuarina cunninghamiana	River She Oak
	Eucalyptus cladocalyx	Dwarf Sugar Gum
	Eucalyptus leucoxylon	Yellow Gum
	Eucalyptus stricklandii	Strickland's Gum
	Melaleuca bracteata	White Cloud Tree
	Grevillea robusta	Silky Oak
	Brachychiton populneus	Kurrajong
	Acacia melanoxylon	Blackwood
	Eucalyptus mannifera	Spotted Gum
Large Trees - Australian Species - Lee Row		
	Eucalyptus camaldulensis	Silverton Red Gum
	Eucalyptus melliodora	Yellow Box
	Eucalyptus sideroxylon	Mugga Ironbark
	Eucalyptus polyanthemos	Red Box
	Eucalyptus viminalis	Ribbon Gum

AGROFORESTRY

Agroforestry is the deliberate integration of trees and shrubs in farming systems in order to achieve benefits in the maintenance of soil and vegetation health and in farm productivity.

Two sorts of functions of trees can be distinguished:

Service roles - these relate to the beneficial interaction between trees on one hand and soil, crops and livestock on the other.

Production roles - these relate to harvestable products of trees.

The most common form of agroforestry in Australia and New Zealand is the grazing of sheep cattle and deer under thinly planted, improved pastures of radiata pine. Both resources having an economic return to the farmer. The stock in the short term and the timber over a twenty to thirty year period. Other forms of agroforestry is the use of fodder trees (such as Kurrajongs, Carob beans, Honey Locusts, Tagasaste, Willows, Casuarinas, Salt Bush) in a pasture situation either as a drought reserve or as a supplementary feed for certain seasons. Carob bean also has a market in it's own right for human consumption in what is currently an import market for Australia.

Another form is stock grazing on pasture established on orchard or vineyards. An exciting cottage industry is the Quandong fruit for restaurants and tourist trade. To control the couch or kikuyu host grass, free range domestic fowl is used.

The planting of high value timber species on cropping and grazing country is common in parts of Victoria and New Zealand. By adding species such as (soil and climate being suitable) silky oaks, mountain ash, walnut, red cedar, amongst a range of local species can mean that a windbreak or woodlot now has a multi purpose role with an excellent economic return in twenty five to forty years.

All properties should be aiming at fifteen percent tree cover to help mitigate the effects of soil and water degradation. Initial research has shown that the negative effects of trees are negated by the positive effects at this level of tree cover.

In other words total farm production is not decreased by these plantings but property values, erosion control, stock and crop survival are all enhanced plus the benefit of a long term economic return to the farm.

Australia imports one point six billion dollars of forest products per year. However, according to Curly Humphreys of the A.N.M mills at Albury there is an oversupply of pulpwoods which will be exacerbated with the introduction of recycled newspapers in the nineties. Therefore market research is vital before any plantings are carried out.

Most forms of tree production would be possible within an agroforestry system. Tree products form the basis of many and varied industries.

Wood Products	peeler logs for veneer
	saw logs
	chip for particle board and pulp
	round timber posts for poles
	firewood or fuel
Whole Tree Products	Christmas trees
	Developed stock for sale

Tree Seed Products	fruit
	nuts
	seeds for sale
	pods

Miscellaneous Products	honey
	chemicals and essential oils
	fodder
	flowers

Economic production of any of these products demands strict conditions. These are:

- quality sites suited to the tree species
- improved genetic stock for guaranteed yields
- a thoughtfully-planned planting design
- specific management practices for tending and harvesting, and finally
- a market for the goods which is within an economical transporting distance

The profit returned from any tree product is, therefore, dependent on production levels and returns paid at the farm gate. A thorough investigation into market trends and site quality is imperative when growing trees for economic return.

Careful tending and management of the trees can guarantee a high quality product which should demand a higher price on the market. Veneer quality timber, a result of many years of scrupulous tending, can return two or three times the price of standard sawlog material.

Tree production within an agroforestry system results in diversification of farm production.

SCIENTIFIC NAME	COMMON NAME	USE AND REMARKS
E. macrorhyncha	Red Stringybark	Rutin a flavonoid used medically to treat capillary failure
E. radiata	Narrow Peppermint	Koalas - Good street and park tree
E. dives	Broad Peppermint	Commercial Oil - Hybridises with E. radiata
E. cladocalyx	Sugar Gum	Saw logs, sleepers, round produce. Dirty planted close together
E. blakelyi	Blakely's Red Gum	Fence, firewood, good honey. Salt tolerant.
E. camaldulensis	River Red Gum	Structural timber, honey, koalas, salt tolerant.
E. globulus	Blue Gum	Tas. spp. timber where bending is required.
E. maculata	Spotted Gum	General construction, tool handles, koalas.
E. microcarpa	Grey Box	Heavy construction, excellent fuel better honey producer.
E. albens	White Box	Heavy construction, excellent fuel, good honey yielder.
E. melliodora	Yellow Box	Posts, excellent firewood, best honey, koalas.
E. sideroxylon	Red Ironbark	Red very tough wood, excellent fuel, allelopathic
E. regnans	Mountain Ash	Flooring, frames, veneer. Tallest hardwood in world.
E. polybractea	Blue Mallee	Oil production. ANU currently researching.
E. grandis	Flooded Gum	Valuable timber tree.

Grevillea robusta	Silky Oak	Plywood, furniture, Joinery.
Grevillea striata	Beefwood	Carving and turnery
Toona australis	Red Cedar	Furniture, panelling, veneer, boat building, carving
Acacia melanoxylon	Blackwood	Furniture, decorative veneer, panelling, carving, turnery, flooring, boat building
Acacia implexa	Lightwood	Turnery, handles
Acacia cambagei	Gidgee	Turnery, carving
Acacia aneura	Mulga	Turnery, fancy woodware
Casuarina cristata	Belah	Fencing, fuel, carving, turnery.
Casuarina leuhmanii	Bull Oak	Flooring, fencing, flooring, fuel, turnery, woodware
Geigera parviflora	Wilga	Carving and turnery
Flindersia maculosa	Leopard Tree	Carving and turnery

Fodder Trees	
Acacia spp.	
Casuarina spp.	
Gleditsia triacanthos	Honey Locust
Quercus spp.	Oaks
Atriplex spp.	Saltbush
Paulownia tomentosa	Paulownia
Ceratonia siliqua	Carob bean
Chamexytisus prolifer	Tagasaste
Salix babyloniea	Willow
Fruit and Nut Trees	
Carya illinoinensis	Pecans
Juglans regia	Walnuts
Phoenix dactylisera	Dates
Santalum acuminatum	Quandong
Pistachio	Pistachios

FARM ROADS

The location and form of farm roads and tracks can be of great importance to soil conservation on properties. Where poorly located or constructed, they may be subject to, or contribute to, significant soil erosion problems. They will also require greater maintenance than would have been necessary had better siting or construction methods been used.

Where the terrain is such that roads or tracks contribute to erosion problems, the safest locations, in order of preference, are:

Along ridges: these are usually the best drained areas, and problems with runoff water are minimised.

Directly across the slope on the contour: with tracks in this location it is easier to avoid diverting and concentrating runoff water. They may at times be located immediately below soil conservation banks.

Straight up and down slope: roads or tracks in this type of location minimise interference with water flows, and are easily drained. Water should be prevented from flowing down the tracks or side drains by either farming the road and using mitre drains, or by crossing the track with shallow drains or low banks with gently sloping batters.

Roads sited diagonally across slopes tend to divert and concentrate water runoff. They require more erosion control precautions than those in other locations.

Other points to be considered when locating and developing farm roads and tracks are:

- Water flowlines should be avoided where possible: tracks should never run parallel with the direction of water flow. Where flowlines must be crossed, this should be at right angles to the direction of flow to avoid diverting or concentrating the water. Precautions are necessary at any flowline crossing to avoid erosion damage.

- Adequate drainage of the road or track site should be provided, and drains be designed so as not to create a soil erosion problem. Seasonally wet areas should be avoided where possible.

- Preference should be given to stable and 'hard' soil areas, with highly erodible soils being avoided.

- When developing tracks, particularly the less used ones, surface disturbance by cut and fill should be avoided as far as possible. Where this is needed, low sloping batters should be used with a ratio not greater than 1 in the vertical to 3 in the horizontal. Topsoil should be replaced on all disturbed areas, and these seeded and fertilised to obtain rapid revegetation.

Roads and tracks have bare, hard surfaces which produce high water runoff.

FIRE PREVENTION/PROTECTION

Fire is an integral part of much of our natural vegetation. Most forest types can either recover from a fire or need fire to provide the right conditions for regeneration.

Protection from fire lies in decreasing the amount of fuel present and in reducing windspeed. The windspeed depends on the amount and extent of green foliage that presents a physical barrier to heat and flames. Fuels that are compact and close to the ground, burn more slowly than similar fuel which is loosely arranged. For example, slashed grass on the ground burns far more slowly than the same amount of grass still standing and dry.

Dry paddocks of annual pasture species can, even under grazing, carry a fire because there is a continuous ground layer of dry fuel. In areas of native vegetation where the dominant evergreen species do not undergo an annual drying (the ground level fuel consists mostly of litter in various stages of decay), there is a break between this ground layer of fuel and the next level of green material. However, under extreme fire conditions, a fire will become more intense in native vegetation than in pastured or weedy areas.

Many acacias do not burn very readily and young, vigorously growing trees will deflect heat off and over themselves. Mature trees have a lot of dead and twiggy growth around the trunk and can burn like torches.

Species that are said to be resistant in all but the most severe fires are:

Botanical name	**Common Name**	**Drought**	**Frost**	**Height**
Photinia serratifolia	Hawthorn	mod.	res.	6m
Tamarix aphylla	Athel Tree	res.	mod.	10m
Tamarix parviflora	Tamarisk	mod.	res.	5m
Myoporum montanum	Boomeralla	res.	res.	5m
Atriplex nummularia	Saltbush	res.	mod.	2m
Melia azedarach	White Cedar	mod.	res.	10m
Albizia julibrissin	Silk Tree	sus.	res.	4m
Schinus molle	Pepper Tree	res.	mod.	16m
Chamaecytisus prolifer	Tagasaste	mod.	res.	6m
Cotoneaster spp				

They will give good protection if they have green leafy material to ground level, the ground beneath them is free of dead twigs and leaves, and any lower dead branches are pruned.

Deciduous species, such as the Elms, Planes, Poplars, Oaks or Prunus, are an effective barrier, but are likely to be killed by the fire. They should be sited three to five times the mature height of the trees from the buildings to be protected.

Recommendations

An area of 3 metres be cleared of combustible material on the northern and western boundaries of the properties and around all cereal crops. This can be done by slashing, ploughing or chemical spray.

Maintain a clear and green area between windbreak trees and buildings or houses. Many people plant trees far too close to buildings and even though species suited to the purpose may be used, if poorly maintained they can become a fire hazard.

When choosing firebreak species, be careful to look at the bark of the mature tree. If it produces long ribbons of bark, as many eucalypts do, it could become a serious hazard in a fire, sending flaming pieces or torches of bark over a wide area and starting spot fires well in front of the main fire.

Although most eucalypts burn well, most recover from fire. Most acacias are killed by fire, but the heat of the fire stimulates the germination of hundreds of their seeds.

It is recommended that fire retardant trees be planted around each of the homes and sheds and a summer growing perennial e.g. lucerne be grown between the trees and the buildings.

DROUGHT STRATEGY

The drought strategy for "Hovells Creek Catchment" is:

1. Supply enough water for all stock to survive without runoff event for 18 months.

2. Sacrifice a small paddock preferably next to the major water supply where all stock can be handfed, immobilised and do the least amount of damage to the property.

The water supply in "Hovells Creek Catchment" is not adequate at present to withstand a major drought if the reliance was on dam water. This is due to the small nature of dams on the properties. However the properties rely on the spring fed nature of the granite soil type and for some properties the permanency of Hovells Creek.

Drought strategy paddocks on a property should be selected due to the shelter provided by windbreaks of future plantings, closeness to silo's/haysheds and good clean water supply, and are at present or have been recommended to be planted to perennial pastures such as a phalaris/cocksfoot mix. Other drought procedures are listed below.

Feeding of stock options are :

- do nothing
- sell all stock
- cull and sell some stock
- agist
- commence feeding.

The first two options are extremes and not advisable for long term droughts. Cull and sell some stock is the option most often taken. The priorities set in culling are:

1. sell all unthrifty stock, faulty mouthed and diseased weaners
2. aged females and wethers and steers
3. sell remaining males and weaners
4. sell breeding stock.

Feeding stock on property can take three forms; 1. supplementary feeding ie protein feeding to complement dry grass. Be careful stock do not become dependant on the grain/hay. 2. survival feeding ie the minimum requirement to keep stock alive. 3. production feeding ie prime stock during drought conditions may bring a large premium. Lot feeding of lambs or yearlings may be well worth investigating as will production feeding of breeders. Feeding of stock should commence well before stock reach their survival weight. Stock will require time to adjust to protein diets and should be introduced slowly to grain. How much feed to conserve will depend on many factors not the least being financial and type of fodder - grain type, hay type, silage. Silage is the cheapest form and also has the added advantage of cleaning paddocks of problem weeds.

Store 14 tonnes of oats per 1000 DSE per month for sheep

100 head of Cattle for two months supplementary feeding

Dry Cow	10 t of grain or 15 t of hay or 60 t of silage
Wet Cow	15 t of grain or 23 t of hay or 100 t of silage
Yearlings	8 t of grain or 12 t of hay or 55 t of silage.

ECONOMICS

FINANCIAL BUDGETING

A summary of your present financial position will indicate your farm's net worth prior to commencing any new operations/developments. This is important in any property development plan as it gives a starting point to measure the change in property net worth over time. Besides establishing your financial position, it is also necessary to estimate your present pattern of receipts and payments in a cashflow statement. Once this statement has been drawn up, your receipts and payments data may be adjusted according to the expectations and production plans for the coming year or years. Allowances for expected increases in sale and purchase prices, yield increases through improved management or enlargement of enterprises, and the expected effects of capital expenditure may all then be included to change the statement as it stands. These effects will have further impact on trading and stock firm accounts as well as any other sources of finance. **Lachlan Rural Consultancy** can do Gross Margins, Partial Budgets, Cash Flow statements and other farm management accounts.

Development Costs

Tree planting we currently contract at $3.00 per tree which includes all costs including guard, planting, tree, spray and fertilisers. A three row windbreak usually has 600 trees per kilometre so to budget you need to allow approximately $2,000.00 per kilometre plus fencing. These trees have a six month guarantee except for animal or insect attack.

A conventional fence approximately $3.80 per metre erected.
An electrical fence approximately $2.00 per metre erected.

Earthworks vary greatly due to soil type and working conditions. It is important to use reputable local operators such as the soil conservation service or drivers trained by them.

Dams and Gully Control Structures $1.20 per cubic metre.
Banks $1.00 per linear metre.
Waterway $2.00 per linear metre.
Flumes and gully shaping vary dramatically from site to site.

Pasture improvement including fertiliser, lime, seed, labour, contract machine is approximately $200.00 to 250.00 per ha.

RAA grants and low interest loans or subsidies are applicable for most of the above development costs, including earthworks done by contractors. We can help apply for any of the subsidies, grants or advances.

FENCING

RABBIT PROOF FENCE 900 MM NETTING					
QUANTITY	LENGTH	MATERIAL	UNIT COST	TOTAL COST	
10	100M	ROLLS NETTING	$167.90	$1,679.00	
200		STAR POSTS	$3.50	$700.00	
2	1500M	2.5 MM HT WIRE	$108.00	$216.00	
4	500M	HT BARB WIRE	$49.80	$199.20	
2		END STRAINERS	$50.00	$100.00	
3		IN LINE STRAINERS	$40.00	$120.00	
1		TIE WIRE	$20.00	$20.00	
				TOTAL MATERIAL COSTS	**$3,034.20**
	1000M	LABOUR PER METRE	$1.80	$1,800.00	
				TOTAL COST PER KILOMETRE	**$4,834.20**
				COST PER METRE	$4.83

HINGEJOINT					
QUANTITY	LENGTH	MATERIAL	UNIT COST	TOTAL COST	
5	200M	HINGEJOINT	$205.00	$1,025.00	
200		STAR POSTS	$3.50	$700.00	
2	500M	HT BARB	$49.80	$99.60	
2		END STRAINERS	$50.00	$100.00	
3		IN LINE STRAINER	$40.00	$120.00	
1		TIE WIRE	$20.00	$20.00	
				TOTAL MATERIAL COSTS	$2,064.60
	1000M	LABOUR PER METRE	$1.50	$1,500.00	
				TOTAL COST PER KILOMETRE	**$3,564.60**
				COST PER METRE	$3.56

5 WIRE BARB				
QUANTITY	LENGTH	MATERIAL	UNIT COST	TOTAL COST
10	500M	BARB	$49.80	$498.00

200		STAR POSTS	$3.50	$700.00	
2		END STRAINERS	$50.00	$100.00	
3		IN LINE STRAINERS	$40.00	$120.00	
1		TIE WIRE	$20.00	$20.00	
				TOTAL MATERIAL COSTS	$1,438.00
		LABOUR PER METRE	$1.50	$1,500.00	
				TOTAL COST PER KILOMETRE	**$2,938.00**
				COST PER METRE	$2.94

ELECTRIC FENCING 5 WIRE

QUANTITY	LENGTH	MATERIAL	UNIT COST	TOTAL COST	
1	SOLAR KIT PLUS ENERGISER		$507.00	$507.00	
1	BATTERY		$75.00	$75.00	
4	1500M	2.5 HT WIRE	$90.00	$360.00	
100		STAR POSTS	$3.50	$350.00	
4		STRAINERS	$65.00	$260.00	
500		PINLOCKS	$0.20	$100.00	
10		INSULATORS	$1.00	$10.00	
1		GATES	$17.50	$17.50	
10		PERMANENT STRAINERS	$5.50	$55.00	
1		EARTHING KITS	$33.00	$33.00	
				TOTAL MATERIAL COSTS	$1,185.50
	1000M	LABOUR PER METRE	$0.80	$800.00	
				TOTAL COST PER KILOMETRE	**$1,985.50**
				COST PER METRE	$1.99

PASTURE ESTABLISHMENT COSTS **PHALARIS BASED PASTURE**

	$	KG/HA	TOTAL
COCKSFOOT - CURRIE	$4.50		$0.00
COCKSFOOT - KARA	$4.70	1	$4.70
COCKSFOOT - PORTO	$4.10		$0.00
COCKSFOOT - WANA	$4.90	1	$4.90
PHALARIS - AUSTRALIAN	$5.50	1	$5.50
PHALARIS - SIROSA	$3.55		$0.00
PHALARIS - SIROLAN	$3.75		$0.00
PHALARIS - UNETA	$5.00	1	$5.00
PHALARIS - HOLDFAST	$4.00		$0.00
SUB CLOVER - WOOGENELLUP	$2.50	1	$2.50
SUB CLOVER - SEATON PARK	$2.30	1	$2.30
SUB CLOVER _ DENMARK	$4.00	1	$4.00
SUB CLOVER - GOULBURN	$3.95	1	$3.95
SUB CLOVER - JUNEE	$2.25		$0.00
SUB CLOVER - KARRIDALE	$2.50		$0.00
SUB CLOVER - TRIKKALA	$1.70		$0.00
WHITE CLOVER - HAIFA	$4.10	0.5	$2.05
WHITE CLOVER - TAHORA	$6.30		$0.00
BALANSA CLOVER	$1.70		$0.00
LUCERNE - NOVA	$4.50	0	$0.00
LUCERNE - AURORA	$4.50	0.5	$2.25
LUCERNE - TRIFECTA	$3.80		$0.00
LUCERNE - L69 PIONEER	$6.50		$0.00
LUCERNE - L52 PIONEER	$7.70		$0.00
LUCERNE - HUNTERFIELD	$3.80		$0.00
CONSOL	$50.00		$0.00
CHICORY - PUNA	$14.00		$0.00
SERRADELLA - AVILA	$6.00		$0.00
RYEGRASS - KANGAROO	$3.50		$0.00
RYEGRASS - VICTORIAN	$1.85		$0.00

KIKUYU - NOONAN	$25.00		$0.00
KIKUYU - WHITTET	$20.00		$0.00
FESCUE - DEMETER	$3.60		$0.00
FESCUE - AU TRIUMPH	$4.50		$0.00
INOCULATION + APRON	$0.50	6	$3.00
SEED COSTS			**$40.15**
FERTILIZER COSTS			
BULK MO SINGLE	$185.00	0	$0.00
STARTERPHOS + MO	$435.00	100	$43.50
FERTILIZER COSTS			**$43.50**
LIME TONNES / HA			
SUPER FINE BULK	$30.00	0	$0.00
CARTAGE	$12.00	0	$0.00
SPREADING	$8.00	0	$0.00
TOTAL LIME COSTS			**$0.00**
SPRAYS LITRES / HA			
ROUNDUP	$12.50	1	$12.50
MCPA	$3.99	0.5	$2.00
LE MAT	$45.00	0.05	$2.25
APPLICATION COSTS	$7.00		$7.00
SPRAY COSTS			**$23.75**
GROUND PREPARATION			$0.00
SOWING			$25.00
MISCELLANEOUS			$15.00
PASTURE ESTABLISHMENT COSTS			**$147.40**

PRICES ARE ACCURATE AT TIME OF PRINTING BUT FLUCTUATE DUE TO SEASONAL AND SUPPLY AND DEMAND JUNE 1994

SELF REPLACING MERINO FLOCK (1000 EWES)

* 212 Ewe Lambs Retained Plus 212 Wether Lambs

INCOME				
Wool	Number	kg	$	Total $
Shearing Ewes	960	4.5	$7.00	$30,240.00
Shearing Lambs	403	1.25	$6.00	$3,022.50
Crutchings	1378	0.13	$3.00	$537.42
Sales				$0.00
CFA Ewes	470	0	$15.00	$7,050.00
CFA rams	4		$6.00	$24.00
Ewe hoggets	103		$35.00	$3,605.00
Wether lambs	191		$35.00	$6,685.00
TOTAL INCOME				**$51,163.92**
VARIABLE COSTS				
Replacement rams	5		$300.00	$1,500.00
Shearing	1796		$3.00	$5,388.00
Crutching	1378		$1.00	$1,378.00
Drenching	2184		$0.25	$546.00
Jet	1204		$0.40	$481.60
Vaccination	2248		$0.15	$337.20
CFA Sale Commission 5%	474			$23.70
CFA Cartage	474		$0.00	$0.00
Wool Packs	27		$8.50	$229.50
Wool Cartage	32		$10.00	$320.00
Selling Costs 15%			$70.00	$10.50
TOTAL VARIABLE COSTS				**$10,214.50**
GROSS MARGIN				$40,949.42
GROSS MARGIN/DSE				$18.61

MERINO WETHERS 20 MICRON

INCOME				
Wool	Number	kg	$	Total $
Shearing	1000	4.5	$7.00	$31,500.00
Crutching	1000	0.45	$3.00	$1,350.00
CFA Wethers	182	1	$15.00	$2,730.00
TOTAL INCOME				**$35,580.00**
VARIABLE COSTS				
Replacement Wethers	0		$35.00	$0.00
Shearing	1000		$3.00	$3,000.00
Crutching	1000		$1.00	$1,000.00
Drenching	1000		$0.90	$900.00
Jet	1000		$0.20	$200.00
Pour On	1000		$0.00	$0.00
Vaccination	1000		$0.00	$0.00
CFA Sale Commission	182		$0.68	$122.85
CFA Cartage	182		$1.00	$182.00
Wool Packs	27		$8.50	$229.50
Wool Cartage	27		$10.00	$270.00
Selling Costs 15%				$4,725.00
TOTAL VARIABLE COSTS				**$10,629.35**
GROSS MARGIN				$24,950.65
GROSS MARGIN/DSE				$24.95

AGROFORESTRY COSTS AND INCOMES

YEAR	OPERATION	COST / HA	RETURN / HA	CUMULATIVE
1	DEEP RIP	$50.00		($50.00)
	WATER	$2,500.00		($2,550.00)
	SPRAY	$50.00		($2,600.00)
	PLANT	$4,000.00		($6,600.00)
	MAINTENANCE	$50.00		($6,650.00)
2	MAINTENANCE	$50.00		($6,700.00)
	SPRAY	$330.00		($7,030.00)
3	PRUNING	$300.00		($7,330.00)
4	THINNING	$1,200.00		($8,530.00)
	PRUNING	$300.00		($8,830.00)
5	PRUNING	$300.00		($9,130.00)
6	PRUNING	$300.00		($9,430.00)
7	PRUNING	$300.00		($9,730.00)
8	PRUNING	$300.00		($10,030.00)
	THINNING	$1,200.00		($11,230.00)
	FIREWOOD SALE		$224.00	($11,006.00)
9	MAINTENANCE	$300.00		($11,306.00)
10	THINNING	$1,200.00		($12,506.00)
	FIREWOOD SALE		$1,600.00	($10,906.00)
11 TO 19	MAINTENANCE	$3,000.00		($13,906.00)
20	THINNINGS	$300.00		($14,206.00)
	FIREWOOD		$390.00	($13,816.00)
30	PEELER LOGS SALE		$18,000.00	$4,184.00
35	PEELER AND SAWLOGS		$22,500.00	$26,684.00
40	SAWLOGS		$60,000.00	$86,684.00
				$86,684.00

THESE BUDGETS ARE SITE SPECIFIC

FIREWOOD

20 m * 1 km = 2 ha

	$
land already owned	$0.00
Site preparation own equipment	$150.00
Trees planted contract	$3,750.00
Weed control per year 5 years	$750.00
Fencing	$3,600.00
Felling and Loading	$5,600.00
Transportation	$1,700.00
Total cost	**$16,300.00**
Gross Income year 5, trees coppiced 1,250 trees @ 1 m3 per tree $30 tonne delivered to distributor	
930 tonnes * $30.00	$27,900.00
Gross return	$11,600.00
per hectare	$5,800.00
per hectare per year	$1,160.00

THESE BUDGETS ARE SITE SPECIFIC

LAND DEGRADATION AND TAXATION

The following information on land degradation and taxation was current as of May 1992. No changes to rulings have occurred since then but rulings can change anytime as determined by the Australian Taxation Office.

Water Conservation Under S.75B a taxpayer carrying on a business of primary production on land in Australia may claim a deduction on the construction, acquisition or installation of plant or a structural improvement primarily and principally for the purpose of conserving or conveying water for use in the business. The deduction is allowed in equal instalments over three years commencing with the year in which the expenditure is incurred. The term 'plant or structural improvement' in S.75B includes a dam, earth tank, underground tank, concrete tank, metal tank, stand for a tank, bore, well, irrigation channel or similar improvement, pipe, pump, water tower and windmill.

Soil and Land Conservation S.75D allows a deduction in the year of expenditure for capital expenses incurred by a primary producer and other businesses earning income from the use of rural land on soil and land conservation including:

- An operation primarily and principally to prevent or combat land degradation
- the eradication or extermination of animal or vegetable pests
- the destruction of weed or plant growth detrimental to the land
- measures for preventing or combatting land degradation such as graded banks, gully control structures, tree planting, gully stabilisation, salinity control and regeneration or retention of native vegetation
- the erection of fences to exclude stock or vermin from areas affected by degradation to control that problem
- the erection of fences which separate different land classes
- the construction of levee banks or similar improvements

Land Degradation The term 'land degradation' extends not only to soil erosion but also to the decline of soil fertility or structure, degradation of natural vegetation, the effects of deposits of eroded material and salinisation. RULING: Both S.75B and S.75D contain a 'primary and principal' requirement, which does not relate to the motives of a taxpayer, but to the result produced by the expenditure. Under S.75B the plant or structural improvement must be for use primarily and principally for the purpose of conserving or conveying water. The 'primary or principal' requirement recognises that capital expenditure on irrigation and water, and land conservation measures may be undertaken for more than one reason. For example, a dam may be built to hold and conserve water. It may also be built to act as a retention dam preventing excessive water runoff which could lead to soil erosion. Where expenditure is incurred for dual purposes it will be necessary to establish the primary and principal function or purpose of the expenditure.

APPENDICES

APPENDIX - UNIVERSAL SOIL LOSS EQUATION

The Universal Soil Loss Equation (USLE) is designed to predict the long time average annual soil loss in runoff from specified land units in specified cropping and management systems.

Commencing at Cowra in 1943, a series of plot trials were initiated to assess the effect of varying and management practices on surface runoff and oil loss. Data were recorded for varying periods, some in excess of thirty years, resulting in at least 4,500 plot years of record.

Measurements of rainfall energy commenced at Gunnedah and Cowra in 1976 to assess the erosivity of rainfall for use in soil loss prediction. Rosewell (1983) concluded that the energy of rain in eastern Australia is sufficiently similar to that in the United States to allow the use of at least the rainfall component of the USLE in NSW. Measurements of soil loss from unit plots maintained under continuous tilled bare fallow commenced at Inverell in 1977 and at three other sites in the early 1980's. The rainfall erosivity and unit plot data has been used to establish some values for the critical climate and soil variables. Data from the long-term plot measurements have been used to assess and validate the USLE for use in NSW.

The USLE is the most important soil loss equation available anywhere in the world today. It is both widely used and abused. It has great practical value.

It is applicable to areas such as crop land, pasture land, rangelands, forests and construction sites. It provides a means of ranking the effect of various management practices on soil loss and in so doing allows the selection of those practices that will cause least erosion.

In "Hovells Creek Catchment" the USLE compares the average annual soil loss currently occurring with the soil loss that is estimated when structural and management practices are introduced.

Example

A paddock has an average slope of 6%, slope length is a minimum 600 metres, soils are Non Calcic Brown. At present paddocks are cultivated across the slope and stubble management is traditional tillage. Soil loss from this system is 13 t/ha/yr (Figure 1).

Figure 1 **Soil Loss Estimation**

Rainfall Factor	Rainfall Zone .. 2	R = 1150
Soil Factor	Non Calcic Brown	K = 0.040
Slope Steepness	6.0% Slope Length .... 300 metres	LS = 2.11
Support Practice	Across Slope - small furrows	P = 1.000
Management Factor	Rotation: RS,WH,WH,FP,WP,PA,PA,PA,PA,PA.	
	Cultivations: 6 6 6 6 6	
	Stubble Management: Traditional Tillage	C = 0.13
Long Term Average Annual Soil Loss		A = 13t/Ha

By introducing a banking system with banks at 110 m spacing not only decreases slope length but also changes cultivation practices, ie instead of going around the paddock and across the slope the cultivation now has to be on the contour. So by the introduction of graded banks soil loss is reduced by 40% to 7.7 t/ha/yr (Figure 2) to reduce soil loss again bank spacing needs to be reduced to 45 m apart which is impracticable or the management factor can be altered. Management factors including the rotation (in this exercise set at 5 yr cropping, 5 yr pasture), cultivation (number of times the ground is worked) and stubble management (the longer the stubble cover is retained less the soil loss).

Figure 2 **Soil Loss Estimation**

Rainfall Factor	Rainfall Zone .. 2	R = 1150
Soil Factor	Non Calcic Brown	K = 0.040
Slope Steepness	6.0% Slope Length .... 110 metres	LS = 1.28
Support Practice	Across Slope - small furrows	P = 1.000
Management Factor	Rotation: RS,WH,WH,FP,WP,PA,PA,PA,PA,PA.	
	Cultivations: 6 6 6 6 6	
	Stubble Management: Traditional Tillage	C = 0.13
Long Term Average Annual Soil Loss		A = 7.7t/Ha

The easiest method is to reduce the number of cultivations, under traditional tillage the paddock is cultivated 6 times (including sowing) under reduced tillage that figure is halved to a maximum of 3. This immediately reduces the soil loss to 5.6 t/ha (Figure 3). Still too high for the soil type (ie soil formation is less than soil loss).

Figure 3 **Soil Loss Estimation**

Rainfall	FactorRainfall Zone .. 2	R = 1150
Soil Factor	Non Calcic Brown	K = 0.040
Slope Steepness	6.0% Slope Length .... 110 metres	LS = 1.28
Support Practice	Across Slope - small furrows	P = 1.000
Management Factor	Rotation: RS,WH,WH,FP,WP,PA,PA,PA,PA,PA.	
	Cultivations: 3 3 3 3 3	
	Stubble Management: Reduced Tillage	C = 0.10
Long Term Average Annual Soil Loss		A = 5.6t/Ha

The next step (assuming still that the rotation is fixed) is to introduce Direct Drill System in the cropping phase of the rotation. By doing this we can reduce soil loss to 5 t/ha/yr. The only way to reduce soil loss any further is to change the rotation so that the longest cropping phase is 3 years followed by 7 years pasture, this will reduce soil loss to 2.7 t/ha
(Figure 4).

Figure 4 **Soil Loss Estimation**

Rainfall Factor	Rainfall Zone .. 2	R = 1150
Soil Factor	Non Calcic Brown	K = 0.040
Slope Steepness	6.0% Slope Length .... 110 metres	LS = 1.28
Support Practice	Across Slope - small furrows	P = 1.000
Management Factor	Rotation: RS,WH,WP,PA,PA,PA,PA,PA,PA,PA.	
	Cultivations: 3 3 3 3 3	
	Stubble Management: Direct Drill	C = 0.10
Long Term Average Annual Soil Loss		A = 2.7t/Ha

APPENDIX - SOIL STRUCTURE DECLINE

Tillage greatly increases macroporosity, usually forming many very large pores (> 10 mm) and greatly increasing surface roughness. The actual size of the clods or aggregates produced by the tillage operation is dependent on the tillage implement, its speed, the moisture content of the soil in relation to liquid and plastic limits and the friability of the soil (the tendency to break into natural aggregates). For a seedbed, aggregates that are about 10 to 20% of the seed size are ideal. In structurally degraded soil it may be necessary for several cultivations to breakdown clods to this optimum size range.

When people talk of 'good' structure, they usually mean the soil has a large percentage of large pores or macropores (> 0.75 mm) necessary for high infiltration rates and good soil drainage. Such a soil is likely to have low soil strength as well. In soils with low aggregate stability, a surface crust may form very quickly in response to rainfall, and the high macroporosity and surface roughness be eliminated by about 100 mm of rainfall.

Tillage is a relatively violent operation on the soil. It physically breaks soil aggregates and also leads to losses of organic matter, which is a major bonding agent in the stable aggregates of many soils. Organic matter is almost the sole agent for imparting stability on large (> 250) aggregates. Tillage also destroys the continuous, large biopores developed by biological activity.

Every tillage operation reduces aggregate stability. By how much depends on the tillage implement, its speed through the soil, the moisture content and inherent stability of the soil aggregates. The loss of aggregate stability leads to the following:

- surface crust information
- collapse and settlement of macroporosity and surface roughness induced by cultivation
- low hydraulic conductivity values at the soil surface
- high soil strength at the soil surface as the soil dries out
- loss of friability of the soil when cultivated

The result is that although cultivation may increase overall infiltration as an immediate effect, the overall depth of wetting is much less and so soil water is more available for evaporation.

The redevelopment of structure in a degraded soil is largely through the reintroduction of organic matter and the development of macroporosity by biological activity (roots, worms).

This may be done using a pasture phase or by minimum tillage techniques where the organic matter from each crop is allowed to accumulate in the soil. The removal of tillage also allows the macroporosity build up by biological activity during crop growth to be maintained.

The speed of redevelopment is dependent on the amount of moisture and plant material available. As a general guide, the following time periods for the redevelopment of soil structure in light textured, weakly structured soils can be used.

- dryland pasture about 3 years
- minimum tillage - direct drilling 5 - 7 years

In soil high in clay, low sodium and with a high shrink-swell potential, structure of the surface soil can be redeveloped by self-mulching, perhaps within a matter of weeks, but certainly within one year.

Some soil physical properties can have a large effect on plant productivity through their influence on some critical crop growth factors, namely germination, emergence and root growth, water supply, nutrient supply and biological factors.

Good germination requires that the seed be covered during the sowing operation. Moisture content of the soil and tine penetration are critical in obtaining a good seed-soil contact.

Rapid crust formation in structurally degraded soils is a serious potential problem for emergence. Wheat has the advantage of growing in winter when evaporative demand is low and the surface soil usually remains moist until emergence is complete. Hard compacted layers (sodic subsoils, cultivation pans or pedological pans) can restrict root growth.

A good water supply is critical for reducing soil strength to allow root growth an access to nutrients.

Soil structural degradation, particularly crust formation, can greatly reduce the surface infiltration with subsequent effects on the effective use of rainfall.

Tillage initially increases infiltration but reduces aggregate stability and destroys continuous biological pores. When soil is structurally degraded, rainfall can quickly reduce surface infiltration on a tilled soil by crust formation.

Erosion when it leads to the loss of useable soil can reduce the available water supply. This can be particularly damaging in shallow soils or in soils having a hard compacted layer at a shallow depth. Erosion may also expose soil layers with lower infiltration.

Erosion when it leads to the loss of useable soil can reduce the nutrient supply particularly in those soils where a large proportion of their nutrients are held in the topsoil. This loss of nutrients by erosion also has an economic cost, perhaps as much as $100 per hectare. Tillage operations can affect the nutrient supply, N and P in particular. Rotations using legumes have a potential for building up nitrogen supplies.

While advantages to soil structure and erosion accrue under no tillage or minimum tillage some biological problems often arise. Under no tillage, minimum tillage some diseases and herbicide resistant weeds can build up. Some control of these can be obtained by increased tillage, but rotations using alternative crops or pasture phases are likely to be more effective at the same time maintain the soil physical advantages of no-tillage and minimum tillage systems.