Chapter D8. Landforming and soil management

PURPOSE OF THIS CHAPTER

To explain how to use landforming to manage soils

CHAPTER CONTENTS

- advantages and disadvantages of landforming
- pre- and post-landforming management

ASSOCIATED CHAPTERS

- D7 'Cultivation and soil structure'
- D9 'Irrigation scheduling'

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***Dispersion** is a process in which aggregates in the soil break down into their component particles when they are wet by irrigation water or rainfall.*

*The main cause of dispersion is high amounts of sodium bound to clay particles. A soil with high amounts of sodium bound to its clay particles is said to be **sodic**.*

*The amount of sodium bound to clay particles is measured in terms of the **exchangeable sodium percentage. (See Chapter D3.)** The higher the exchangeable sodium percentage, the more dispersive a soil tends to be. In general, a soil with an exchangeable sodium percentage (ESP) above 6 is considered to be sodic, and dispersion is more likely when ESP values are higher than 6.*

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See Chapter D4 for a simple test for soil dispersion.

LANDFORMING AND SOIL MANAGEMENT

Landforming includes such activities as laser grading, landplaning, and activities that involves moving soil from one area of a paddock to another. The aim of landforming is usually to produce an even surface of a set grade to make irrigation more efficient.

DISADVANTAGES OF LANDFORMING

Landforming can have some undesirable effects that may reduce productivity in the short term. These are:

- Damage to the soil structure. Since landforming methods are particularly aggressive, soil structure can be severely damaged, resulting in poor crop emergence and poor water penetration. Structural damage is made worse when soil is landformed at incorrect moisture content.
- Exposure of subsoils in cut areas. Topsoils contain the bulk of plant nutrients. Once they are removed, so too are the nutrients that plants need for good growth. Additionally, the exposed subsoils are generally more dispersive than the topsoils because they are higher in sodium (that is, more sodic). Sodic soils are poorly structured and hard to cultivate, and will generally form a crust after water is applied.

The short-term losses associated with landforming can be minimised if a combination of management practices is used.

SOIL PROPERTIES AND LANDFORMING

The different soil groups described in this SOILpak have distinct properties with implications for landforming, especially the red brown and transitional red brown earths. The effect on sands and the deeper alluvial soils is not as significant.

Red brown and transitional red brown earths

These soils are characterised by a loamy topsoil overlying a clay subsoil. The critical factor for landforming is the depth of this loamy topsoil. In red brown earths this depth is generally between 15 and 40 cm, but 15 to 20 cm is most common. Transitional red brown earths have a topsoil 5 to 10 cm deep. This means that the subsoils are often exposed when landforming is being done on transitional red brown earths. The subsoils of red brown earths and transitional red brown earths have a medium-to-heavy clay texture. The exchangeable sodium percentage is usually high. Therefore, they are poorly structured and dispersive. The topsoils of both red brown and transitional red brown earths are of a loamy texture. Therefore, they can be damaged severely if cultivated when too dry. Structural damage is evident during cultivation on these soils when dust is produced. The critical factor when cutting these soils is the depth of topsoil. The minimum depth for good infiltration (and therefore good water storage) is about 20 cm of loamy topsoil. It is desirable to have as much depth as possible remaining after landforming. For this reason the most successful solution to poor yields in cut areas is topsoiling. This is the process by which topsoil is replaced on cut areas. As can be seen in the example in Table D8–1, the topsoil is a store of plant nutrients. It also helps with water storage.

Table D8–1. Red-brown-earth soil properties

	Depth	pH	Organic carbon %	Exchangeable sodium %	Available phosphorus (Colwell)	Nitrogen ppm
Topsoil	10 cm	5.4	1.9	4.5	24	74
Subsoil	20 cm	7.2	0.6	11.6	9	20

Table D8–1 is an example of a transitional red brown earth and its properties that need consideration before landforming. It is obvious that the subsoil that may be exposed during landforming may be severely lacking in properties that will promote plant growth. Nitrogen and phosphorus are low, and plant growth is likely to be poor.

The exchangeable sodium percentage is high, so dispersion is likely. This will cause problems such as crusting and poor water penetration. Most subsoils are likely to be relatively poor environments for plant establishment and growth, and therefore exposure of subsoils should be avoided. If subsoils are exposed, then they should be ameliorated with gypsum and/or fertiliser. Experience shows that poultry manure has had excellent results on these areas. Poultry manure contains a range of essential nutrients and some organic matter, both of which are in short supply in exposed subsoils.

PRE-LANDFORMING MANAGEMENT

A number of strategies should be considered before landforming to reduce the cost of the operation itself, as well as the effects of the landforming on production (Figure D8–1).

- Try to stay with the natural slope as much as possible. This will reduce the volume of cut and fill. If you are working on very flat country, beds may be an option to improve drainage.
- Shorten the bay length. This reduces the amount of cut and fill and also reduces the distance that soil must be moved. This will help to reduce the cost of landforming. However, more supply and drainage channels are needed with shorter bays.

Figure D8–1.

Grader constructing a permanent grade bank. Note that the blade is set horizontal to make a flat-bottomed channel. Cost is about $500 per kilometre. (Ben Rose)

- Split grades can be used to match the layout to the natural slope and soil type.
- On soils that have shallow topsoils (for example transitional red brown earths), the subsoils will be exposed during most landforming cuts. One technique to overcome this problem is to invert the topsoil with a mouldboard plough before landforming. This means that some topsoil is likely to remain on the cut areas.

MANAGEMENT DURING LANDFORMING

Landforming at the wrong moisture content can damage the soil structure. When clay soils are worked too wet (above the plastic limit) compaction is very likely.

When loam soils are worked too dry, 'bulldust' (fine dust) is produced. This is an indication of severe structural damage and should be avoided. Sometimes there are good reasons for landforming to be done when soil conditions are not exactly right. Nevertheless, you should make every effort to landform at the right moisture content in order to avoid serious and costly structural deterioration (Figure D8–2).

Exposed subsoils on red brown earths are generally poor environments for plant growth. For this reason it is best to topsoil in order to improve plant growth on cut areas. A heavily cut area should receive at least 10 cm of topsoil for best results.

Topsoiling is the process by which cut topsoil is set aside during landforming and replaced on heavily cut areas. Topsoils help the water storage of a soil and act as a store of plant nutrients. Research has shown that topsoiling produces superior yields to other types of soil amelioration (such as the addition of gypsum, phosphorus or zinc) on heavily cut sites.

Figure D8–2.

Harold Adem of ISIA Tatura demonstrating a soil-moisture-measuring technique to MIA farmers. (Bernie McMullen)

POST-LANDFORMING MANAGEMENT

Crop selection

Following landforming it is often necessary to get a paddock back into production as soon as possible to get a flow of income. You must choose a crop from which you can get a reasonable yield, given that the soil is likely to be poorly structured. A crop will help to return some structure to a degraded soil.

A winter cereal followed by a vegetable crop is a suitable rotation after landforming.

Plant growth and irrigation will help to settle a soil after landforming. Quite often slight depressions and rises may be evident after this settling period, and further landforming will be necessary. It is therefore important to grow an annual crop during this 'settling down' period so that a 'touch-up' landforming can be done afterwards. For this reason do not sow a pasture as the first crop after landforming.

Hill beds in the autumn to allow a winter crop to be planted and/or soil to settle before planting summer vegetables in the spring.

Ground preparation after landforming

After landforming fill areas tend to compact, while cut areas set hard or run together. Consider the following points:

- It is important to cultivate ground at an appropriate moisture content.
- Chisel plough or offset disc only as required to form a seedbed. A chisel plough often penetrates easier than other implements. Ripping to 20 cm may be beneficial if there is a ploughpan or you need to make seedbed preparation easier.

Soil nutrition in landformed areas

Nitrogen

Since most available nitrogen in soils is located in the topsoil, crop growth on cut areas is quite often reduced by nitrogen deficiencies. Nitrogen levels in subsoils are very low, so almost all crop nitrogen needs must be met by fertiliser. Yield responses can be expected at 100 kg N/ha for winter cereals. Because there is a risk of poor establishment, it is advisable to pre-drill 50 kg N/ha and apply a further 50 kg N/ha about 8 weeks after sowing if establishment is satisfactory.

Phosphorus

Phosphorus is a relatively 'immobile' nutrient in the soil. This means that water will not move the phosphorus from where it is applied. Therefore little, (if any) phosphorus applied to the topsoil moves into the subsoil. It is necessary to apply phosphorus to exposed subsoils at heavy rates. It is a good idea to get a soil test done on the area exposed in order to work out the fertiliser rates. The exception to this is where large amounts of organic fertilisers (such as chicken manure) are applied. In these situations phosphorus will move through the profile. Table D8–2 gives general guidelines for phosphorus application to cut areas.

☞ *See Chapter D3 for more information on chemical soil tests.*

Table D8–2. Phosphorus application rates

Soil P (Colwell) ppm	Phosphorus application rate (kg P/ha)
below 10 ppm	40 kg P/ha
above 15 ppm	20 kg P/ha

Improving the structure and water penetration of cut soils

Gypsum

Gypsum helps to improve the structure of exposed clay subsoils (if they are sodic to begin with). Subsoils of all soil groups are generally sodic, with the exception of self-mulching clays, which may be non-sodic in some instances, especially when cuts are not deep. Get a soil test to determine the exchangeable sodium percentage. Gypsum will help to create better structure in exposed sodic subsoils. This will greatly help establishment by reducing crusting and producing finer (smaller) aggregates for good seed–soil contact. It will also improve the internal drainage of the soil when heavy application rates are used.

Table D8–3 is a guide to gypsum application to cut areas.

Table D8–3. Gypsum application rates

Exchangeable sodium percentage (ESP) of cut area	Gypsum application rate (t/ha)
Greater than 6, less than 10	2–5t/ha
Greater than 10	5 t/ha