

Chapter 1

Introduction

Soil erosion remains a major threat to the agricultural lands of Queensland and associated downstream areas. The loss of topsoil through erosion results in a significant loss in productivity. The subsoils that remain are likely to be incapable of supporting viable agricultural enterprises. Advanced erosion leads to rills and gullies that make paddocks unworkable. Runoff from eroding landscapes contains sediment and any nutrients, fertilisers or pesticides that were present in the soil. Downstream impacts include damage to roads and railway lines, siltation of watercourses and water storages and an overall reduction in water quality in creeks, rivers and coastal areas.

The incidence of soil erosion can be spasmodic. Studies in Queensland have shown that a few large events in each decade may be responsible for a large proportion of the total soil loss (Freebairn 2004). This issue must be kept in mind when determining targets aimed at reducing soil erosion and improving water quality. Both farmers and the community can become complacent about soil erosion during periods in which few significant erosion events occur.

1.1 Principles of erosion control

There are three important principles to consider in the control of water erosion:

- use land in accordance with its capability
- protect the soil surface by some form of cover
- control runoff before it develops into an erosive force.

Factors such as soil type and land slope determine how vulnerable a piece of land is to soil erosion and what type of erosion control measures will be required. Land with serious erosion risks may not be suitable for any form of agricultural use or may require a form of land use that is less conducive to soil erosion.

Adequate levels of surface cover play an important role in erosion control by reducing the effects of raindrops falling on bare soils. Surface cover also encourages runoff to spread rather than to concentrate. However, there is a natural tendency for runoff to concentrate as it moves down-slope. Soil conservation structural measures such as contour banks and waterways are used to manage this runoff in upland areas, while strip cropping is used on floodplains.

The role of trees in the control of soil erosion needs some consideration. Trees play a vital role in our landscapes by maintaining biodiversity, providing shade and shelter, recycling nutrients, utilising carbon dioxide and using moisture that may 'leak' into groundwater and contribute to salinity problems. They also provide stability to stream banks and prevent landslip on susceptible steep slopes. In forests, the leaf litter, shrubs, grasses and a variety of other forms of vegetation covering the soil surface, provide protection from erosion. However, if heavy grazing (or high pedestrian traffic in recreational areas) removes the surface cover below trees, erosion may result. The vulnerability of an area to erosion following clearing depends on how the land is managed.

When dealing with soil erosion, various publications refer to the need for riparian vegetation. Strips of riparian vegetation along creeks and rivers are essential for a wide range of reasons including the filtration of groundwater flows moving into the stream (Hunter and Hairsine, 2002). However they have minimal impact in filtering out sediment and nutrients from overland flows exiting eroding paddocks. While the runoff from some areas of cultivation may flow directly into a stream, this is the exception. Runoff will exit most paddocks at one or two well-defined points and flow into a drainage line. Drainage lines then enter creeks, and creeks enter rivers at well-defined points or via floodplains. Concentrated runoff from catchments does not enter creeks and rivers by flowing over their banks. Any attempts to force this to happen, usually results in a very serious gully erosion problem.

To manage water quality problems associated with erosion, it is essential to tackle the problem where it starts. High levels of surface cover are essential to keep soil where it belongs and to prevent it from becoming a water-borne pollutant. Contour banks are very effective sediment traps. When their channels are lined by crops or standing stubble, they provide a very useful filtration function, since the crop or stubble can reduce the velocity of flow by a factor of 5 compared with channels with bare soil.

Grassed waterways collect runoff from contour banks and provide another opportunity to filter out sediment as the runoff flows towards a natural watercourse. Farm dams or other detention structures such as artificial wetlands can be constructed to further increase the deposition of soil, nutrients and other pollutants from the paddock.

1.2 Past gains

Programs aimed at the control of soil erosion in Queensland commenced in the middle of the last century. By 1950, 16 000 ha of cultivated land in Queensland had become so badly eroded that it had to be withdrawn from cultivation (Ladewig and Skinner 1950). Evidence of this erosion can be observed by examining aerial photographs of upland areas on the Eastern Darling Downs taken in the 1950s.

Considerable gains have been made in the control of soil erosion in Queensland since a concerted effort to manage the problem began in the 1950s:

- Significant areas of steep land have been taken out of cultivation and returned to pasture or native vegetation. This move has largely been driven by economics, since the cultivation of shallow soils on steep slopes is not profitable for most crops.
- Surface cover levels have improved dramatically. Bare soil fallows were the norm in the 1950s and 1960s when stubble was removed by burning and excessive tillage. The use of implements that can handle stubble and the introduction of herbicides suitable for weed control in cropping lands has allowed the adoption of minimum till and zero till practices.
- There has been widespread installation of contour banks and waterways to manage runoff in upland areas and strip cropping to manage floodwaters on floodplains that are subject to erosive flooding.

1.3 Goals for the future

Most farmers have been keen to adopt soil conservation measures. Soil erosion can become a very visible problem and an obvious threat to the future viability of a property. Soil conservation measures provide direct economic benefit through increased farm productivity and reduced wear and tear on machinery. Farmers are also becoming more aware of the impact of their practices on the external environment as well as the marketing advantages provided when consumers are aware that their food is produced in an environmentally friendly manner. The adoption of soil conservation measures is a key ingredient in minimising damage to roads, waterways and drainage networks and in ensuring that the scenic amenity of rural areas is maintained. There are many benefits in ensuring that rural properties

are visually attractive to both local residents and tourists.

However, the task of controlling erosion is far from complete:

- There is scope for further improving levels of surface cover
- Many upland cultivated areas are unprotected by contour banks or existing banks are poorly maintained
- Many waterways that receive runoff from contour banks have stability problems and are in need of maintenance.
- Many floodplain areas subject to erosive flooding are yet to be protected by strip cropping practices
- Extended periods of low rainfall and runoff resulting in minimal erosion can lead to a degree of complacency in relation to the implementation and maintenance of soil conservation measures.

1.4 The Manual

The first publication to deal with the design of soil conservation measures in Queensland was the Queensland Soil Conservation Handbook. It was published in 1966 by the Department of Primary Industries, the government agency responsible for soil conservation at that time. A metric version with minor revisions was produced in 1978.

The primary purpose of this manual relates to the design of soil conservation measures and it is most appropriate to cropping lands. The manual does not describe management practices associated with stubble retention practices such as minimum and zero tillage. It is considered that there is already a considerable amount of information on this topic and there are many agronomists working in machinery and herbicide sales who are available to provide the necessary advice.

Some peripheral information that would not normally be associated with a manual is included. Much of this information is not available in any other published document and it is considered that it will assist practitioners in gaining a greater understanding of the issues relating to soil conservation in cropping lands.

There are four sections in the manual:

- Section A Planning
- Section B Runoff estimation
- Section C Channel design
- Section D Special applications.

Section A Planning

This section is mostly related to broadacre cropping and includes information on legal aspects of planning. Some chapters in other sections also have relevance to soil conservation planning eg. the chapter on horticultural applications.

Section B Runoff estimation

There are two steps associated with the design of soil conservation structures. Firstly, an estimate is required of the rate of flow that the structure will be required to accommodate. This section describes the processes related to runoff with a special emphasis on the impacts of stubble retention practices. Two methods of estimating runoff for small rural catchments are described.

Section C Channel design

The second step associated with the design of soil conservation measures involves the design of a structure that can accommodate the design runoff. This section includes some general design principles as well as chapters on contour and diversion banks and waterways.

Section D Special applications

This section includes information on issues such as vegetated strips in upland areas, controlled traffic, horticultural applications and floodplain management.

This manual does not include information on the surveying of soil conservation measures and their construction. For information on the surveying, implementation and construction of soil conservation measures the *New South Wales Soil Conservation Service Earth Movers Training Course* is recommended. It was produced in 1991 as a series of 21 booklets and is available from the New South Wales Department of Infrastructure, Planning and Natural Resources (www.dipnr.nsw.gov.au). A Queensland publication relating to this issue but now out of print is *Surveying for Soil Conservation – A Training Manual* (Dickenson and Faulkner 1988).

The focus of this manual is on erosion by water. While wind erosion is a very significant problem in the more arid grazing lands of inland Queensland, it is generally not a serious issue in cropping areas. Most soils cultivated in Queensland have a heavy texture and form relatively large aggregates that are too coarse to become airborne when strong winds are blowing. Soils with a sandy texture are susceptible to wind erosion but cultivation of such soils is generally uneconomic in the Queensland environment. These soils have very low moisture storage capacity and low fertility – their use in Queensland is limited to small areas for horticulture or vegetable growing where irrigation is available. As with the control of erosion by water, the provision of cover on the surface of the soil is the key to the control of wind erosion.

A bibliography is included which attempts to capture all of the Queensland references that are relevant to the design of soil conservation measures. It should be noted that most of the references dated prior to 1995 were prepared by staff of the Department of Primary Industries—the state agency responsible for soil conservation programs up until that time. The bibliography includes references to the land management field manuals that have been prepared for most of the cropping lands of the state. These manuals provide useful information on land resources and land management with specific references to soil conservation. In many cases they provide more specific information relating to the design of soil conservation measures than can be provided in this manual, which has a statewide context.

For ease of use, frequently used tables and charts are included in the *Appendix*. ■