



Successful Silage





TOP**FODDER**

Successful Silage

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NSW DEPARTMENT OF
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Foreword



*Ian Macdonald, MLC,
NSW Minister for
Primary Industries*

Silage has an important and expanding role in Australia's dairy, beef and sheep industries, and provides producers with a valuable tool for growing the farm business. Apart from providing an opportunity to improve productivity and profitability, silage can also be used as a long-term feed reserve to cope with drought, floods and bushfires.

Until now, the adoption of silage technology in Australia has been held back by the lack of a comprehensive extension package specifically designed for our conditions and industries. Many of the recent developments in silage are recorded in research papers and locked in the heads of a few, very experienced people.

To address this gap, NSW Department of Primary Industries and Dairy Australia with support from Meat and Livestock Australia, initiated a project to develop an extension package on silage.

Over the past three years, a team led by NSW Department of Primary Industries and including representatives from the Department of Primary Industries Victoria,

Queensland Department of Primary Industries, and Department of Primary Industries, Water and Environment Tasmania, have written this manual. Dr Alan Kaiser and his silage team at NSW Department of Primary Industries, Wagga Wagga Agricultural Institute have taken the lead role in this project.

This manual draws together information from around the world on all aspects of silage relevant to the Australian grazing industries. It has been written for a broad audience – farmers, silage contractors, advisers and consultants, agribusiness and students – with a specific interest in silage. It is intended as a reference manual when information is needed on some specific issue concerning the production or feeding of silage.

This manual has been a major undertaking and has required a considerable commitment from the writing and editing team. It is a valuable contribution that will be of lasting benefit to Australia's grazing industries.

I am delighted to introduce the first of our TopFodder products – *Successful Silage* – the definitive technical manual on all things silage for the Australian dairy industry.

Silage is an important strategy used by dairy farmers to fill seasonal feed gaps, to manage pastures, and to provide high quality, low cost forage for cows. Even though this has been common practice, market research shows that only a minority of Australian dairy farmers produce silage to acceptable levels of quality with minimal losses, and that there is large scope for improved returns on most farmers' silage making investment. There have also been a number of recent innovations in areas such as silage additives, plastics and machinery.

The TopFodder Silage program has been developed, with core funding from Dairy Australia and NSW Department of Primary Industries, as well as from the dairy Regional Development Programs and Meat and Livestock Australia, to take knowledge on modern silage practices out to motivated dairy farmers, and their advisers.

This will be done in a number of ways, including a farmer workshop series to be rolled out in all States. At the outset of this program, two meetings of stakeholders identified that a comprehensive reference manual was an essential prerequisite to underpin the delivery of silage technology to industry.

The authors and editorial team, led by Dr Alan Kaiser at the Wagga Wagga Agricultural Institute, are to be congratulated on the high standard of this reference manual, and on the comprehensive coverage of subjects and user-friendly indexing.

The following quote from a Gippsland dairy farmer who 'test-read' this manual, says it all – "I have been making large tonnages of silage for 20 years, and learnt much from this. An *excellent* manual, well done."

I commend *Successful Silage* to all thinking dairy farmers and providers of silage services to the dairy industry. In my opinion, this authoritative reference manual will become an essential tool of trade to develop profitable silage systems on Australian dairy farms in the future.



Pat Rowley
HON D. PHIL., CMG
Chair, Dairy Australia

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Primary Industries



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DEPARTMENT of
PRIMARY INDUSTRIES,
WATER and ENVIRONMENT



Department of
Primary Industries



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How to use this manual

This manual is aimed at a very broad audience – farmers/producers, contractors, advisers, consultants and agribusinesses with a specific interest in silage. Our aim has been to cover “everything you ever needed to know about silage” – from the practical to the scientific. Not all the information is relevant to all readers, and not everyone will want the level of detail on a given subject.

There are a number of ways in which you can go about finding information. If you are looking for information on a specific topic, it can be found by checking the:

- Chapter topics (see Contents, page 3).
- The Quick Find Index (see pages 7-22) will direct you to the chapters and sections that relate to a particular topic.

How the information is organised

- Each chapter has been written as a separate entity, containing a Table of Contents for easy referencing. Following the Table of Contents is a Key Issues section and an Introduction, which summarise the main points of that chapter. A quick glance through these will give readers an overview of each chapter.
- The hierarchy of headings used allows the reader to go into as much detail as required. For example, Section 11.2 of Chapter 11 covers the various costs of forage conservation in several sub-sections, including 11.2.3 ‘Contracting costs’. These sub-sections may also be divided under further sub-headings, e.g. Section 11.2.3 is divided into sections discussing the pros and cons of contracting, contract rates and what to include in the contract agreement.
- Although each chapter is written as a separate entity, there is considerable cross-referencing between them so that readers interested in more detail on a particular topic can follow the cross-referencing directions to the relevant chapter and section. To make it easier to locate specific sections, the section numbers appear in the corner of the colour band at the top of the right-hand pages.
- In the interest of readability, references have not been cited in the text. However, when actual data is presented in tables or figures, the source has been acknowledged. Details can be found in the reference list (see pages 25-30).
- The Glossary in this section (see pages 31-32, immediately before the Chapter 1 divider), contains definitions of terms that may not be familiar to you.

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< – Less than.

≤ – Less than or equal to.

> – Greater than.

≥ – Greater than or equal to.

ADF – Acid Detergent Fibre consists of cellulose, which is partially digested by ruminants, and lignin, which is virtually indigestible.

ADIN – Acid Detergent Insoluble Nitrogen is the small proportion of nitrogen that is bound (either naturally or due to heat damage) in the ADF fraction and is unavailable to the animal.

accessibility to silage – How easily the silage can be reached or approached, and removed and eaten by the animal.

additives – Include a range of chemical, feed and biological products that are added to forages at the time of ensiling. Additives have a range of uses: to increase silage fermentation quality, reduce losses and/or improve aerobic stability.

aerobic – With air, specifically oxygen.

aerobic spoilage – The loss of DM and nutrients that occurs during prolonged exposure to air during feedout and also during storage if the silage is inadequately sealed or the seal is damaged. Heating is the first sign of aerobic spoilage.

aerobic stability – The time taken for the silage to begin heating after opening and exposure to air.

anaerobic – Without air, specifically oxygen.

ash – Part of a sample remaining after heating for several hours in a muffle furnace at extremely high temperatures (usually 550-600°C); is the inorganic matter or minerals present in the sample.

bacterial growth – The increase in the number of bacteria or the size of the population.

bacteriophages – Viruses that attack bacteria.

buffering capacity (BC) – The ability of a forage to resist changes in pH.

bypass protein – Dietary protein that remains undegraded by micro-organisms after passing through the rumen. Also known as undegraded dietary protein (UDP).

chop length – *Theoretical* length of chop (TLC) or nominal chop length is the chop length nominated for a particular machinery setting.

The *actual* chop length produced by the machine can be 2-3 times longer due to factors such as blade sharpness and speed, and equipment power.

closure, period of – The time between when stock are excluded from a pasture or crop and when the forage is cut or the stock re-introduced.

conditioning – An operation performed, usually at mowing, by specifically designed machines to damage the cut forage so that the rate of moisture loss during wilting is increased.

colony forming units (cfu) – A unit of measure relating to population size of micro-organisms.

crude protein (CP) content – Calculated as N x 6.25; is a measure of total protein.

digestibility – The proportion of a feed that is digested by an animal. The undigested portion is excreted in the faeces. A forage's digestibility is directly related to its ME level.

DM (dry matter) content – The proportion remaining after all moisture (water) has been removed, e.g. 30% DM comprises 30% DM and 70% moisture.

DM loss – The quantity of forage lost (on a DM basis), not a change in DM content.

DMD – Dry matter digestibility.

DOMD – Digestible organic matter in the DM (known as 'D value' in the UK/European literature).

DSE (Dry Sheep Equivalent) – One DSE is the maintenance energy requirement for a Merino wether with a standard weight of 50 kg; DSE/ha is an estimate of the stock carrying capacity for a paddock or whole farm.

effective fibre – That component of the forage fibre that is of sufficient particle size to stimulate rumination and saliva production. It is an important consideration in dairy cow diets for maintaining milk fat synthesis.

effluent (silage) – Surplus moisture released by low DM silages. It contains valuable nutrients including WSCs, silage fermentation products and minerals.

ensilability – Likelihood of achieving a good silage fermentation without wilting or a silage additive.

epiphytic population – Natural population of bacteria present on the forage.

FCM – Fat-corrected milk (usually 4%).

feed efficiency (or feed conversion efficiency – FCE) – The efficiency with which an animal can convert feed to animal product. Often expressed as, e.g. kg feed/kg liveweight gain or liveweight gain/t of feed.

feedout rate – The speed at which silage is removed from the feeding face. For example, removing 15-40 cm/day from the silage face, or the number of days to remove one layer of bales from a bale stack.

fodder – A general term describing feeds (fresh, dried and processed) fed to ruminant livestock.

forage – Edible parts of plants, other than separated grain, that can provide feed for grazing animals or that can be harvested for feeding.

free amino acids – Those amino acids that have been released during the degradation of forage protein, e.g. during silage fermentation or in the rumen; can be further degraded to other compounds, e.g. ammonia-N.

GR site – Measurement of tissue depth over the 12th rib, 110 mm from the midline in sheep; is an estimate of carcass fat cover.

harvest window – The period in which the crop/pasture is at the desired growth stage for harvest.

harvesting forage – The picking up and processing of the mown or unmown (direct cut) material for delivery to the storage site.

heat damage – The result of excessive heating caused by aerobic respiration at the time of ensiling or at feedout; heat damage at ensiling reduces digestibility and increases the proportion of bound protein N (which is unavailable to the animal); heat damage at feedout reduces palatability, silage DM intake and silage ME.

intake – Unless otherwise specified refers to the amount of DM consumed, expressed as kg/day or g/day and meaning kg/head/day or g/head/day.

in vitro – When biological processes are simulated in the laboratory (test tube).

inoculation factor (IF) – The ratio of the number of LAB applied in an inoculant, compared to the natural population already present in the crop.

LAB – Lactic acid bacteria.

ME – Metabolisable energy (MJ/kg DM); that component of the feed energy available to the animal for heat production, maintenance and production. The ME levels of a forage are usually calculated from the forage digestibility, which is more easily measured in animals or by laboratory tests. Digestibility and ME are essentially interchangeable when assessing the energy status of a feed.

milk production – Expressed as both kg/cow and litres/cow. Litres of milk x 1.03 will give an approximation of kg/cow. The exact conversion factor will vary with the solids-not-fat (SNF) and milk fat levels of each milk sample.

MJ – Megajoule, a measure of energy, expressed as MJ/kg DM.

moisture content – The water content of any substance (including forage or silage). All substances are composed of moisture (water) and DM, e.g. a silage with a moisture level of 60% will contain 40% DM.

NDF – Neutral Detergent Fibre is an estimate of the total cell wall content of the forage; it is the hemicellulose + fibre remaining in the ADF fraction.

non-protein nitrogen (NPN) – N compounds in a feed that are not true protein; urea and anhydrous ammonia are commonly used NPN supplements or additives.

OMD – Organic matter digestibility.

P8 site – Used to estimate carcass fat cover in cattle; is the point of intersection of a line drawn from the centre of where the ligament forming the channel rim joins the pin bone, parallel with the sawn chine, and a line centred on the crest of the third sacral vertebrae at 90° to the sawn chine.

parent forage – The fresh forage from which the silage is made.

pH – Measure of acidity or alkalinity of a solution, with a pH level of 7.0 being neutral. Levels <7.0 are in the acidic range while levels >7.0 are in the alkaline range.

protein nitrogen – The proportion of forage or feed nitrogen present as protein. Lupins and cottonseed meal are examples of commonly used supplements.

proteolysis – Breakdown of proteins and products of that degradation process.

quality, silage quality – Used as a generic term that encompasses all the attributes of a silage that influence its nutritive value for animals.

quality loss – The loss of individual nutrients present in the initial forage. Most commonly applied to changes in digestibility, energy or the nitrogen fraction during the ensiling process, and the loss of WSCs during wilting.

respiration – The breakdown of WSCs by plant enzymes to produce carbon dioxide, water and energy (as heat).

rumen degradable protein (RDP) – The component of dietary protein degraded in the rumen.

secondary fermentation – Takes place after the initial fermentation, when growth of clostridial bacteria occurs in the silage.

silage – The fermented product resulting from the anaerobic fermentation of sugars (WSCs) in forage.

silage fermentation – The fermentation of plant sugars and other compounds by micro-organisms in the silage.

silage fermentation quality – A qualitative term describing the extent to which the silage has been preserved by the desired lactic acid fermentation. Where this has been achieved, lactic acid is the dominant fermentation product and there has been minimal breakdown/degradation of protein.

silo – Structure in which silage is stored, including pits, bunkers and stacks.

substrate – The initial compound used in a chemical reaction.

swath – The mown material left behind by a mower or mower-conditioner.

tedded swath – Mown forage that has been spread by a tedder or material being respread.

tedding – Describes the spreading of mown material after mowing.

TLC – Theoretical length of chop.

TMR (total mixed ration) – A formulated feed mix that supplies all the nutrients an animal requires.

undegraded dietary protein (UDP) – See bypass protein.

volatile fatty acids (VFAs) – Produced during the ensiling process; include acetic acid, propionic, and butyric acid. Their relative levels can be used to assess the silage fermentation quality.

WSCs – Water soluble carbohydrates are plant sugars, mainly glucose, fructose, sucrose and fructans, which are soluble in cold water.

wilting – The process where moisture evaporates from the mown forage to increase DM content to the desired level for harvesting.

windrow – The mown material that has been raked in preparation for harvest.