



Note Number: AG1244

Published: July 2006

Updated: August 2008

Forage Cereals: Harvest and storage:- Harvesting whole-crop cereal silage

Cereal crops can be ensiled (fermented) either as a cut and wilted crop or as a direct cut crop. It is often referred to as “Whole-crop cereal” silage (WCS).

This Agnote covers the actual harvesting of cereals sown from autumn to spring for silage. Topics covered are:

- Influence of species and cultivars on suitability for ensiling
- Harvesting
- Additives for forage cereal silage
- Storage

Introduction

The ensiling of forage cereal crops for silage in this Agnote is called whole-crop silage (WCS) and, in other literature, may be referred to as green chop silage, fermented whole-crop or small grains silage. The dry matter (DM) range recommended for WCS is 33% - 50% DM, depending on stage of growth and type of equipment used for harvesting.

Cereal crops which have been affected by frost or unfavourable weather conditions resulting in unsatisfactory grain yields can also be ensiled.

Influence of species and cultivars on suitability for ensiling

Cereals suitable for ensiling are oats, barley, wheat, triticale and rye-corn. When these crops are harvested in the grain formation stages of growth, wheat and triticale appear to be the most suited to WCS. Barley tends to dry down very quickly, limiting the window of opportunity for harvesting. Barley also tends to have lower dry matter yields and be of lower nutritional value despite having a higher grain:straw ratio.

Recently, interest in using cereal crops for grazing and ensiling has grown, resulting in the breeding of cultivars with an emphasis on forage production within each species.

Within each species, the various cultivars (old and new) have different growth characteristics, egs. early vs late maturity, fast vs slow winter growth, requirement for vernalisation vs no vernalisation. The grain to straw ratio of overseas (UK, Europe) varieties tends to be much higher compared to current Australian varieties.

Forage cereal suitability will also vary greatly according to climatic and local district conditions such as soil type and

drainage. Because new and improved cultivars are being developed it is not possible for this Agnote to provide the full list of available species and cultivars and where they are best suited.

For further information, seek advice from your local agronomists and seed company representatives for the most suitable species and cultivars in your area.

When to cut for silage The timing of harvest should take into consideration the following:

- end use of the silage ie. for animal production vs maintenance rations
- weather conditions at harvest
- soil types and soil moisture conditions at harvest
- if double cropping, when the following crop needs to be sown
- availability of suitable harvesting machinery

Harvesting at the correct DM content is important to ensure optimal yield, minimal loss of nutritive value and a desirable fermentation process.

Stage of growth recommended for ensiling

Cereals can be harvested at the flag leaf/boot to early ear emergence stages or the soft dough stage.

The stage of growth at which to cut forage cereals for silage requires much thought and is covered in much more detail in another Agnote in the Forage Cereal series. See Agriculture Note AG1243: Forage Cereals: Harvest and Storage: - When to cut for whole-crop cereal silage.

DM levels recommended for ensiling

If cutting at the flag leaf/boot stage, the recommended DM level is in the ranges of 33 – 40% DM for forage harvested material and 38 – 50% DM for baled silage. The recommended DM ranges for cutting at the soft dough

stage are 35 - 42% DM for forage harvested material and 38 - 45% DM for baled silage.

Cereal plants contain large stems, leaves ranging from green (alive) to yellowing (dying) and grain heads in various stages of formation in the latter stages of growth. This makes the estimation of the DM content at which to begin harvesting difficult.

It is essential that a representative sample be obtained for estimating the DM content of the crop. To obtain a representative sample and to determine the dry matter contents recommended for cutting of forage cereals for silage see Agriculture Note AG1238: Dry matter content of conserved forages: Representative sampling and AG1239: Dry matter content of conserved forages: Measurement of dry matter content.

Effect of climate on drying rates

Climatic conditions approaching harvest greatly influence the rate of DM increase during the later growth stages. Research in NZ has shown triticale DM to increase by approximately 1% per day and barley approximately 1.5 – 2% per day.

However, under very hot dry conditions, these drying rates will increase substantially and vice versa in overcast conditions. Crops in Ireland normally dry at about 1 – 2% per day but may dry at 7% per day after an extended wet period followed by dry weather conditions.

Recent work in SW Victoria measured drying rates of 0.7% to 1.3%/day and should be used as a guide only until future Victorian research provides more localised information suited to Australian species and cultivars.

Mowing

The stage of growth of the crop at harvest will determine whether it is mown and wilted before harvesting or direct cut and ensiled as a “standing” crop. However the height of cutting can have some implications on the stored product.

Mowing height

Cutting height is usually 7 – 10 cm above ground level. Cutting higher will result in a slight increase in nutritive value but reduced yields accordingly. Australian and New Zealand research has shown that cutting 10 cm higher on a 15 t DM/ha crop will reduce yield by approximately 1 t DM/ha and increase ME by 0.2 MJ/Kg DM.

If mown and wilted the higher cutting height will also tend to keep the mown swath higher off the ground thereby allowing more airflow under the crop and a slightly faster wilting rate. It will also reduce the risk of soil contamination from other equipment operations such as raking.

However cutting at greater heights will leave behind increased levels of stubble which creates a problem of removal in the future and preparation for the next forage.

Flag leaf/boot to early ear emergence stage

Harvesting at this vegetative stage (18 – 22% DM) will require the crop to be wilted to reach the desired DM content before harvesting, and particularly so for cereal/legume mixtures.

Mowing with a roller type mower conditioner (See Figure 1) is recommended to crimp/crack the stems which will encourage quicker wilting. Wilting rate will be increased by 20 – 40% compared to mowing only. The amount of increase will depend on crop yield, weather conditions, effectiveness of conditioning, width and ‘fluffiness’ of conditioned windrows, etc.

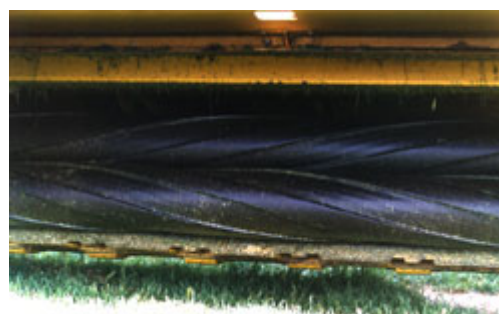


Figure 1. Roller type mower conditioner

Tyned typed mower conditioners will also increase the rate of wilting through mainly an abrading (bruising) action on the leaves and stems plus some crimping (See Figure 2).



Figure 2. Tyned type mower conditioner

A “brush” type mower conditioner will abrade the waxy layers on most surfaces of the plant thereby increasing the wilting rate.

The aggressiveness of conditioning can be altered on all machines via equipment settings. Drier material, especially if the stems are hollow, are more effectively conditioned by the roller type machines.

Super conditioners, often used for export oaten hay, have a much more aggressive crimping and abrading (bruising) action and result in faster drying than even roller conditioners.

Conditioner-only machines will also achieve the desired effects, but will require the extra pass as soon as possible after mowing.

The conditioned stems will also allow a more reliable and easier ‘picking up’ by harvester and baler pick-ups and subsequent feeding into the respective cutting or roller mechanisms.

Unfortunately high yielding crops will be relatively slow to wilt even if conditioned. In all cases, leaving the windrow as wide and thin as possible (ie. less dense), and in a “fluffy” state, will increase the wilting rate substantially.

Tedders (See Figure 3), which spread the mown crop after mowing, will also increase wilting rate, but may not be so effective on high yielding crops and may fatigue the equipment. If a tedder is used in a heavy crop, retedding half to one day later may be necessary to even out the wilting throughout the windrow. Be wary of creating clumps with repeated teddings in heavy crops.



Figure 3. Tedder spreading a pasture crop

Another disadvantage of using a tedder in cereal crops, apart from the extra pass required to do this job, is that the tedder must be set up to avoid the tynes picking up soil while operating. Be aware that the leaves may dry much quicker than the stems if a tedder is used in crops at the later growth stages (grain formation).

However, a tedder is very beneficial to respread a crop that has been weather affected.

Soft dough stage

The DM content of wheat, barley and triticale at the soft dough stage of growth will be in the desired DM range as a standing crop range. They can be either direct harvested with forage harvesters fitted with specifically designed cutting fronts or pre-mown and immediately picked up by the forage harvester.

Forage harvesters

Whole-crop cereals should ideally, be harvested using a precision chopping forage harvester to ensure a short chop length (20 – 50 mm actual length). This ensures the material can be well compacted in the stack or pit so minimising the amount of air trapped thereby resulting in reduced losses (nutritive value and DM). Losses are due to continued plant and microbial respiration during the early phases of fermentation.

Most other forage harvesting machines such as self-loading wagons cut the material to varying lengths, often over 200 mm, making adequate compaction very difficult.

The drier the crop DM content at harvest, the shorter the chop length required. Chopping the material short also ensures a thorough mixing of the high nutritive heads with the much lower nutritive stems and leaves.

Increased density also reduces the rate of aerobic spoilage at stack opening, a common although not an insurmountable problem with cereal silages. Less wastage also occurs as animals cannot easily select the heads and leave the stem material when fed.

Forage cereals being direct harvested at the later growth stage is increasingly being carried out with forage harvesters that have a cutterbar instead of the typical rotary disc mowers to reduce grain loss. Grain loss from the gaps in the housing of the chopping and feeding mechanisms can be minimised by fitting blanking plates.

Grain loss may be slightly higher in pre-mown crops due to the rotary disc action of the mower and, particularly if raked

before harvesting, DM yield and nutritive value will also be slightly lower.

If the crop is harvested after the soft dough stage, the grain will be hardening as it matures. Forage harvesters, which are fitted with specific rollers for cracking grain, often referred to as “primary processing”, will be essential.

Balers

Harvesting whole-crop using balers is not recommended as dense compaction is often not achieved and vermin damage to the bales in storage can be a serious problem. If whole-crop cereals are to be harvested with round and square balers the material needs to be wilted to slightly higher DM contents to ensure a lactic acid fermentation occurs.

Balers with chopping mechanisms are highly recommended to aid compaction. The fermentation process and animal intakes of WCS will also benefit substantially from the chopping.

Once past the ideal stage for harvesting, cereal stems become more lignified (stiffer) and the stems are hollow i.e. contain more air internally. These drier stems will allow increased air to be trapped within and between the stems in the bale. In this situation a chopping baler, with all knives in operation, is highly recommended. An alternative is to bale at the moister end of the DM range recommended for baling. Baling with some dew on the material will also be useful if DM levels are above those recommended.

Baling at a slower forward speed will also allow most balers to produce a denser bale. Baling material that is too dry, or not tightly compacted, results in large volumes of air being trapped in the bale thus reducing nutritive value and increased risk of puncturing by the stalks.

Anecdotal feedback from some machinery operators indicate that if a mower only is used for the later growth stages of the crop, particularly when baling, the baler should travel in the opposite direction to the mower. The heads of the crop are picked up first which results in much less trouble in the “picking up” and “feeding in” of the forage into the machine. However one piece of research has indicated that friction from the rolling mechanisms in some balers induces heavier grain loss than that from forage harvesters. More research is needed to determine losses at all stages of WCS harvesting and storage.

Applying netwrap instead of twine will also reduce the amount of air trapped between the plastic and the bale as the twine, especially in slightly loose bales, will “pull” into the bale. This allows air to travel around the twine once plastic is applied, possibly becoming mouldy, particularly if holed. Applying netwrap will also minimise straw stalks protruding from the bales which can puncture the stretchwrap plastic seal, allowing air to enter.

Silage additives for forage cereals

Several silage additives (mostly inoculants) are available which can improve the fermentation process. A new class of additives, which will reduce aerobic spoilage, is also becoming more common in Australia. Most additives will improve the fermentation and reduce in losses in WCS. Recent work in NZ showed that inoculant used over a wide range of DM contents (31 – 58%) in whole-crop wheat silage resulted in a better fermentation (increased lactic acid, increased acidity) and greatly reduced losses.

A common problem in WCS is the onset of spoilage and subsequent heating after opening the stack. There are now products specifically designed to minimise aerobic deterioration by moulds and yeasts in forage cereals. Some inoculants contain a strain of bacteria called *Lactobacillus buchneri* 40788 which results in silages with increased acetic acid which can inhibit mould and yeast growth. However there are also other products which inhibit aerobic deterioration as well as assist the fermentation process itself at the harvest end. All additives are applied during harvest and most require thorough mixing with the forage to be effective. The products are available as liquid and/or granular form and usually applied behind the pick up or into the forage harvester chute. Many inoculants will become ineffective if mixed with treated town water or water becomes too warm before application. Carefully follow the manufacturer's instructions and suggested application rates to ensure the effectiveness of the products.

Note: New products are continually being developed to inhibit aerobic deterioration so investigate their progress or availability before harvesting.

Weather affected forage cereal crops

Forage cereals can be affected by frost, drought, wind (lodging) and shortages of rain at critical grain filling stages resulting in crops which may not be harvested economically as a grain crop, but may be ensiled.

A feed analysis of any weather affected crop is recommended to ascertain its quality for ration formulations.

Several weather affected crops and their management are discussed below.

Lodging

Lodging occurs when portions of the crop "fall over" due to strong wind, and occasionally in very high yielding crops and/or varieties with weak stems.

The lodged plants will then begin to deteriorate in nutritive value, and the grain may even begin to sprout if advanced enough in its formation (hard dough stage).

If possible, harvest the crop within days before its nutritive value deteriorates too much and mould and deleterious bacteria build-up occurs. Travelling in the opposite direction to the lodged plants will ensure less difficulty in the harvest operation and minimal losses.

Crops lodged for some period of time can be a problem. If the harvester travels in the opposite direction to which the plants are lodged, its nutritive value will be decreased due to harvesting the decaying plants. This decaying plant material will also adversely affect the fermentation process.

Drought stressed crops

Drought stressed cereal crops can often be successfully harvested as silage as a salvage operation. Management of these crops for silage is the same as for the usual ensiling operations.

Crops, most likely, will not be at the optimum growth stage for cutting and may necessitate an early decision to cut before the crop quality deteriorates. Be wary that the material may be

drier than ideal, necessitating very short chop, dense compaction and sealed airtight.

Given the crop is experiencing drought conditions, haymaking may be the best option for these crops.

Frost affected crops

Frosts occurring at the pre-heading to flowering stage of wheats, and presumably most cereals, can affect the plant's ability to continue through to a successful grain formation. This has implications for quality of forage cereals harvested after this stage. Frosts generally do not affect most cereals too severely up to this stage so that a frosted affected crop should still be of high quality and could be ensiled successfully, if harvested and stored correctly.

Storage of whole-crop cereal silage

The storage of whole-crop cereal silage is covered in full detail in another Agnote in the Forage Cereals series. See Agriculture Note AG1245 Forage Cereals: Harvest and Storage: - Storage of whole-crop cereal silage.

Further information

The list below refers to the major topics in the Forage Cereal series. There are several related subtopics under each major topic. Most Agnotes will be available by mid-late 2006.

Forage Cereals: Species and cultivars selection

Forage Cereals: Growing

Forage Cereals: Establishment

Forage Cereals: Harvest and Storage

Forage Cereals: Feeding

References

De Ruiter, J.M, and Hanson,R. (2004) Whole crop cereal silage- production and use in dairy, beef, sheep and deer farming. Christchurch, NZ: NZ Institute for Crop and Food Research Ltd.

Kaiser, A.G., Piltz, J.W., Burns, H.M. & Griffiths, N.E. (2004) Successful Silage, Edition 2.Dairy Australia and NSW Department of Primary industries, NSW DPI, Orange.

Acknowledgments

I acknowledge the technical contributions by Joe Jacobs of DPI, Victoria, and Julian Hill, University of Melbourne. We acknowledge the contribution to this Agnote by Project 3030, which is jointly funded by Dairy Australia, the Victorian Department of Primary Industries and the University of Melbourne.



This Agnote was developed by Frank Mickan, Ellinbank 2006. and reviewed August 2008.

ISSN 1329-8062

Published and Authorised by: Department of Primary Industries
1 Spring Street
Melbourne, Victoria

This publication is copyright. No part may be reproduced by any process except in accordance with the provisions of the *Copyright Act 1968*.

This document was provided as a PDF document from the DPI website

For more information about DPI visit the website at www.dpi.vic.gov.au or call the Customer Service Centre on 136 186

The advice provided in this publication is intended as a source of information only. Always read the label before using any of the products mentioned. The State of Victoria and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this publication