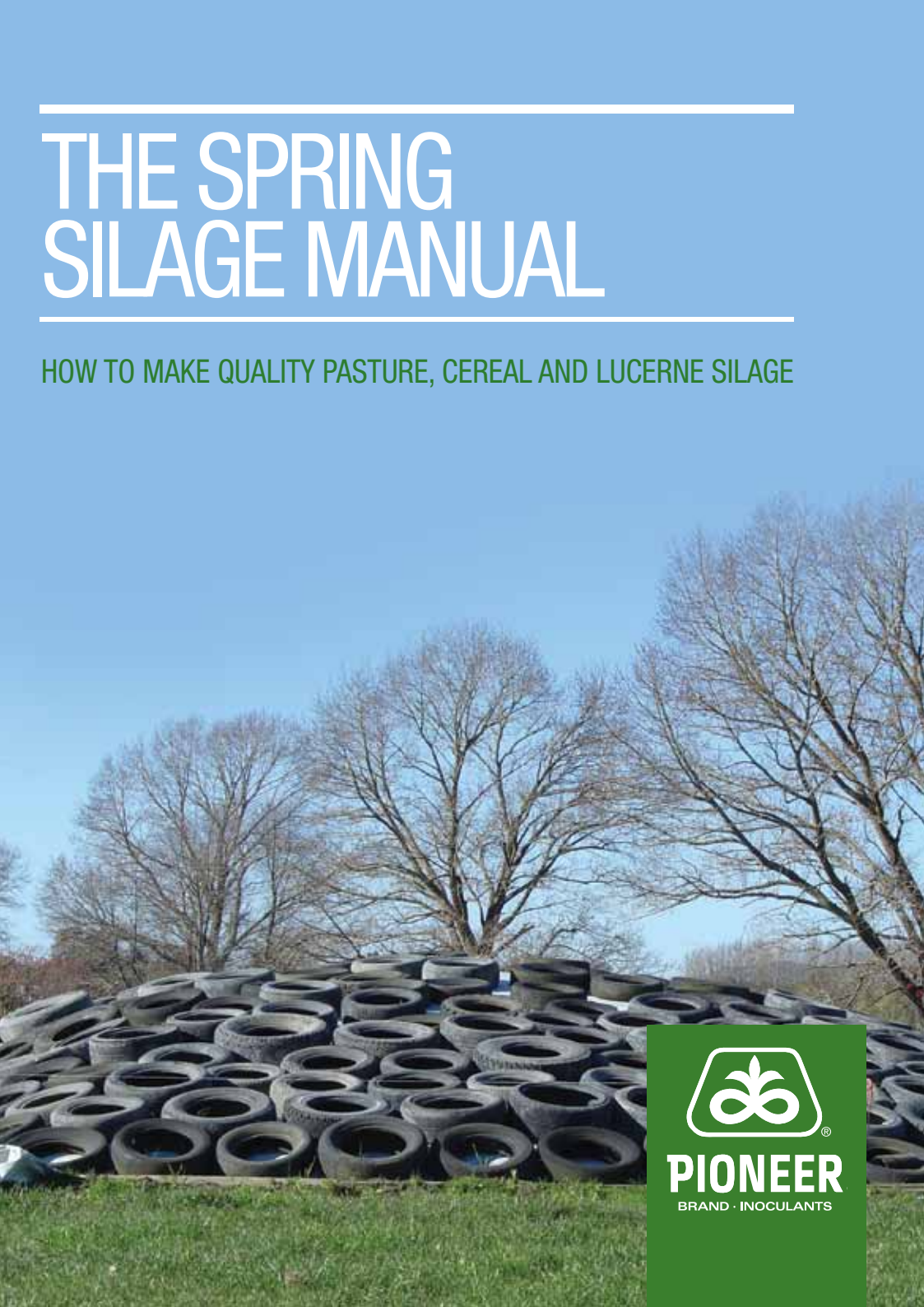
THE SPRING SILAGE MANUAL

HOW TO MAKE QUALITY PASTURE, CEREAL AND LUCERNE SILAGE



PIONEER®
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"Silage is a valuable feedstuff for livestock throughout the world. This booklet contains up-to-date information on making and storing high quality pasture, cereal and lucerne silage which can be fed when required to maximise production and profit."

Dr Jakob Kleinmans
PhD (Agr. Sc.)

Contents

Abbreviations that appear in this publication:
kg = kilogram **mm** = millimetre
kgMS = kilograms of milksolids
kgDM/m^3 = kilograms of drymatter per cubic metre
kgDM/ha = kilograms of drymatter per hectare
MJME/kgDM = megajoules of metabolisable energy per kilogram of drymatter

Making quality silage

High quality silage is made from high quality pasture or crop, which is preserved through excellent fermentation. Producing high quality silage makes good economic sense, however it requires good planning and attention to detail.

This manual provides practical steps to ensure you maximise the quality of your pasture, cereal or lucerne silage.

If you would like more information on any aspect of silage making, phone the Pioneer Advice Line toll-free on 0800 PIONEER (0800 746 633).

Pasture silage

Time of harvest

Silage is always slightly lower in quality than the material that was ensiled. Therefore, the first step in producing high quality silage is to harvest high quality pasture.

The later a paddock is closed for silage, the faster pasture quality declines due to increased seed head emergence. Data collected from Waikato and Taranaki[1] indicate that silage can be made six to seven weeks after closing without major loss in quality, when the final grazing was in the two weeks before balance date. When the paddock was closed later (two to four weeks after balance date), quality dropped within three weeks due to seed head emergence.

The general guideline for farmers throughout the country is:

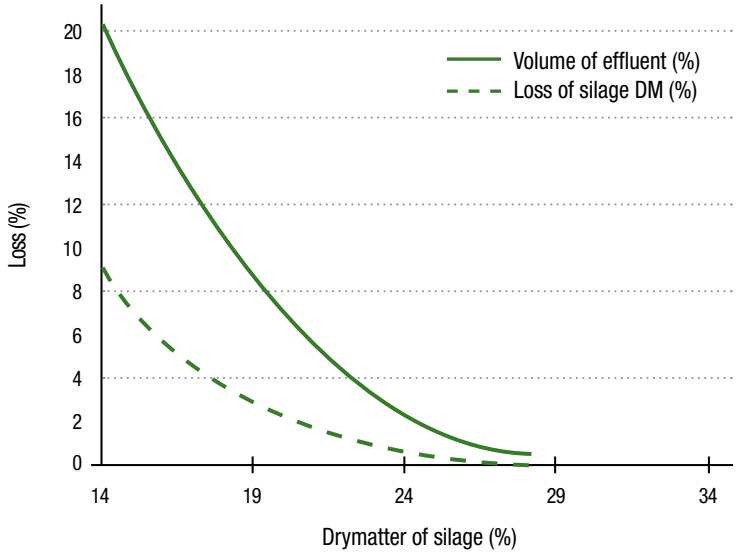
Close paddocks early and harvest silage no later than 35 - 40 days after the last grazing or when a maximum of 10% of the ryegrass seed heads have emerged.

[1]Wrenn, N.R.; Mudfore, C.R. 1996. Making quality silage. Proceedings of the Ruakura Farmers Conference 48: 50-57.

Wilting

Silage effluent (or run-off) is surplus water from the silage which carries soluble sugars and proteins as it flows out. Wilting the cut pasture will reduce or eliminate the amount of silage effluent that is produced (Figure 1) and increase the silage feed value.

Figure 1: Relationship between pasture drymatter content and drymatter and effluent losses[2]



The targets for pasture silage harvest drymatter are[3]:
Pit/stack silage: 25 - 30%
Baled silage: 30 - 35%

[2]Bastiman and Altmann, 1985. In Silage Science and Technology p 453.

[3]DairyNZ farmfact 1-46. What is high quality pasture silage?

The squeeze test

The squeeze test can be used to estimate the drymatter percentage of fresh grass. Cut the grass into 2 - 3 cm lengths, roll it into a ball about twice the size of a golf ball and squeeze it in your fist for 30 seconds. The table below gives approximate drymatter percentages.

Table 1: Estimating pasture drymatter levels[4]

	Estimated drymatter %
Juice runs out easily	18 - 20%
A little juice runs out with difficulty	20 - 25%
Your hand is damp and the sample stays in a ball when you stop squeezing	25 - 30%
Sample does not stay in a tight ball when you stop squeezing	Over 30%

[4]DairyNZ farmfact 1-47. Assessing quantities of silage.

Harvest management

When you turn pasture into silage, you always lose some weight (drymatter) and some quality.

Silage losses start when pasture is cut. Sugars and protein in the pasture are broken down by enzymes and bacteria. Losses decrease quality as well as quantity because it is the most highly digestible components of pasture which are broken down first[5].

The amount of drymatter lost during the ensiling process, and where the loss occurs, will depend on the drymatter of the pasture you ensile and the quality of your harvest management. Typical losses are shown in Table 2.

Table 2: Typical pasture silage drymatter losses[5]

Drymatter % at ensiling	Drymatter loss (%) in:				
	Field	Fermentation	Effluent	Heating	Total
20%	2%	8 - 10%	3%	0%	14%
30%	5%	6%	1%	1%	13%
40%	10%	5%	0%	3%	18%
50%	15%	7%	0%	5%	27%

Field losses occur as sugars are lost from cut grass through respiration. When pasture is drier more is likely to be lost as it is broken up or blown away. Leaving pasture in the field to dry for longer also increases the risk of rain damage.

To minimise silage losses:

- Harvest after 1 - 2 days of sunny weather to ensure good sugar levels in the pasture.
- Minimise wilting time by cutting silage in the morning of a sunny day.
- Avoid wilting for more than 24 hours.
- Make sure that the dirt is not harvested or carried into stacks on the wheels of compaction vehicles.
- Use a quality silage inoculant (see pages 17 and 18).

[5]DairyNZ farmfact 1-44. Losses when making pasture silage.

Compaction and sealing

Plant enzymes and naturally occurring aerobic (oxygen-loving) bacteria convert plant sugars and proteins into water, carbon dioxide and heat. This results in a loss in both quality and quantity of pasture to ensile.

Good silage compaction and sealing will help ensure an efficient fermentation process and reduce the risk of heating and mould growth.

Compaction targets for stacks and bunkers are shown in Table 3:

Table 3: Required densities for stacks and bunkers[6]

Drymatter percentage of pasture silage (%)	Compaction density (kg/m^3)	
	Wet silage (kg)	Drymatter (kgDM)
25	720	180
30	670	200
35	630	220
40	600	240

Stacks or bunkers

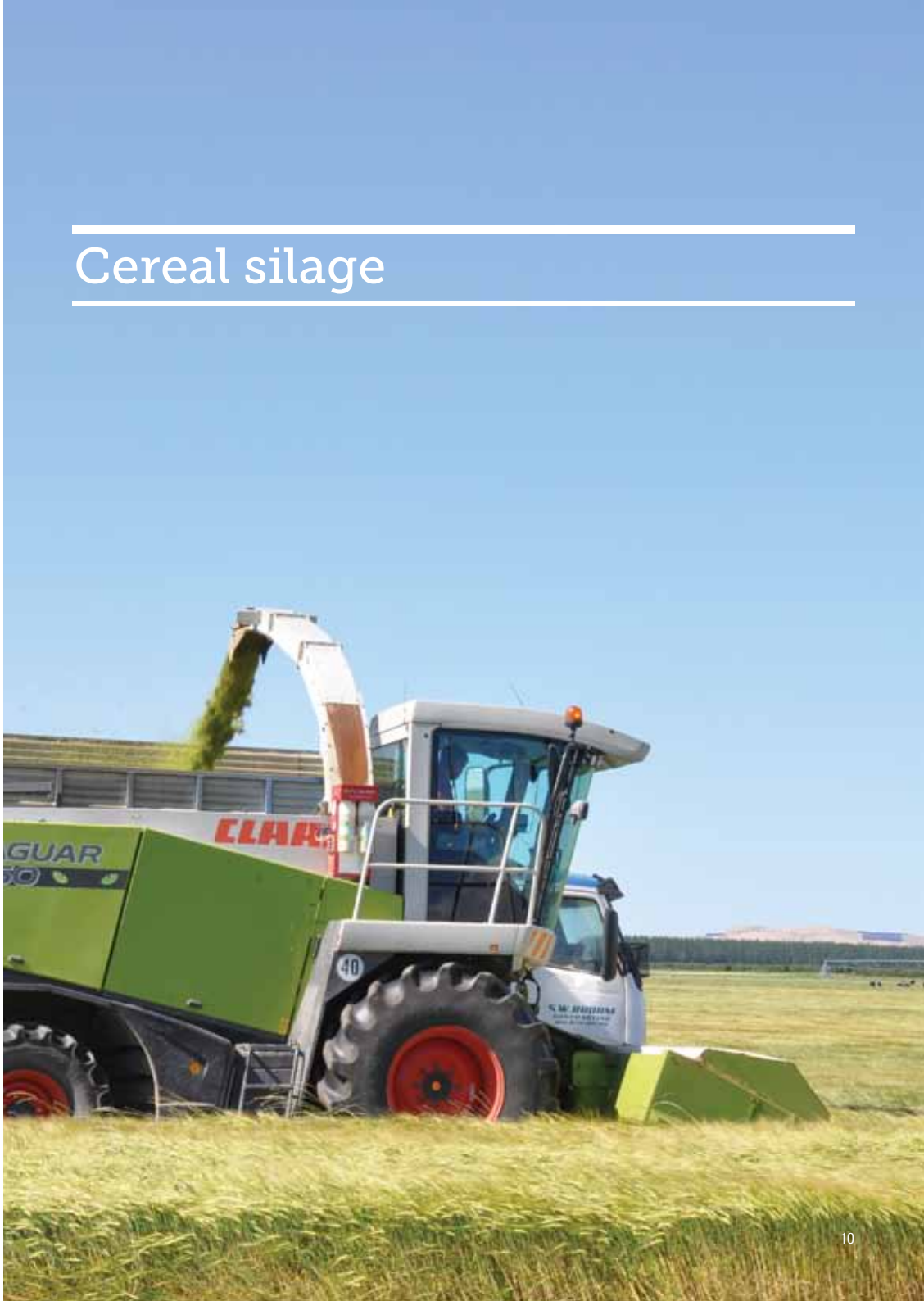
- Spread grass into 100 - 150 mm layers and compact until the surface is firm.
- Seal the stack using a high quality plastic cover and weigh it down with tyres that are touching.
- Seal the edges with sand or lime.

For bales

- Use a reputable baling contractor with well maintained machinery.
- Wrap bales as soon as possible after making silage.
- Use quality plastic and follow the manufacturer's recommendation for the number of wraps.
- Handle bales carefully to avoid puncturing the wrap.
- Stack bales no more than two high.

[6]Honig, H. 1991. Reducing losses during storage and unloading of silage. Forage toward 2000, FAL 1991, p. 116-128.

Cereal silage



Time of harvest

Whole crop cereals can be harvested at two stages of growth – at the flag leaf/boot stage to early ear emergence or at the soft dough stage[7,8].

Flag leaf/boot – early ear emergence stage

- The flag leaf is usually the widest leaf in oats, wheat and triticale and is the last leaf to appear before the head emerges. Flag leaves in barley are often the smallest.
- Booting is defined as the stage when the developing ear is expanding within the flag leaf sheath. The awn tips and ear will emerge soon after.
- Harvesting at this stage will ensure the best protein and energy without compromising the yield too much. There is a trade-off between declining quality and higher yield as the stem and ears develop. Overall quality declines from this stage but recovers toward the end of grain fill as the starch content rises.

Soft dough stage

- As cereal grains mature they pass through the clear liquid stage, then become milky, followed by the soft and hard dough stages.
- The ideal time for this later harvest is when the inside of the grain has a texture similar to cheese.
- Harvesting at this stage will ensure there is sufficient moisture for ensiling and deliver near optimum yield and near optimum energy. Protein content will be lower than at the boot stage.

Cereal crops should not be harvested at the clear liquid – early milk stage as the resulting silage often has reduced quality and possibly lower palatability for stock.

[7]de Ruiter, J.M.; Hanson, R. 2004. Whole crop cereal silage – production and use in dairy, beef, sheep and deer farming. New Zealand Institute for Crop & Food Research Limited. ISBN 0-478-10849-4. 33pp.

[8]When to cut forage cereals. Agnote 1243. Department of Primary Industries, Victoria, Australia.

Wilting

Crops must be wilted when harvested at the boot/early ear emergence stage, but they can be direct chopped at the soft dough stage. The recommended harvest drymatter contents for the respective stages are given in Table 4. The window of opportunity for optimum silage making is narrow (often less than 7 days). If the crop is too dry (>46%DM) it may be difficult to compact and can trap more air in the silage leading to spoilage. Alternatively if it is too wet the silage quality will be poor, with spoilage and possible effluent losses[9].

Table 4: Target drymatter content for ensiling cereals[10]

Species	Flag leaf – Boot stage	Soft dough stage
Oats	32 - 40%*	Not recommended
Barley, wheat and triticale	32 - 40%*	36 - 42%

* Some balers may require higher drymatter levels.

Crops that are harvested at the flag leaf/boot – early ear emergence stage will have field drymatter levels of 18 - 22% and therefore need to be wilted to promote the best fermentation characteristics.

For best results:

- Cut at approximately 7 - 10 cm in height.
- Where possible use a mower conditioner to crimp/crack the stems. This will encourage faster wilting.
- To encourage fast wilting, leave the windrow wide and thin especially if the crop is dense.

[9]de Ruiter, J.M.; Hanson, R. 2004. Whole crop cereal silage – production and use in dairy, beef, sheep and deer farming. New Zealand Institute for Crop & Food Research Limited. ISBN 0-478-10849-4. 33pp.

[10]Adapted from: Forage Cereals: Harvesting whole-crop cereal silage. Agnote 1244. Department of Primary Industries, Victoria, Australia.

Direct harvesting

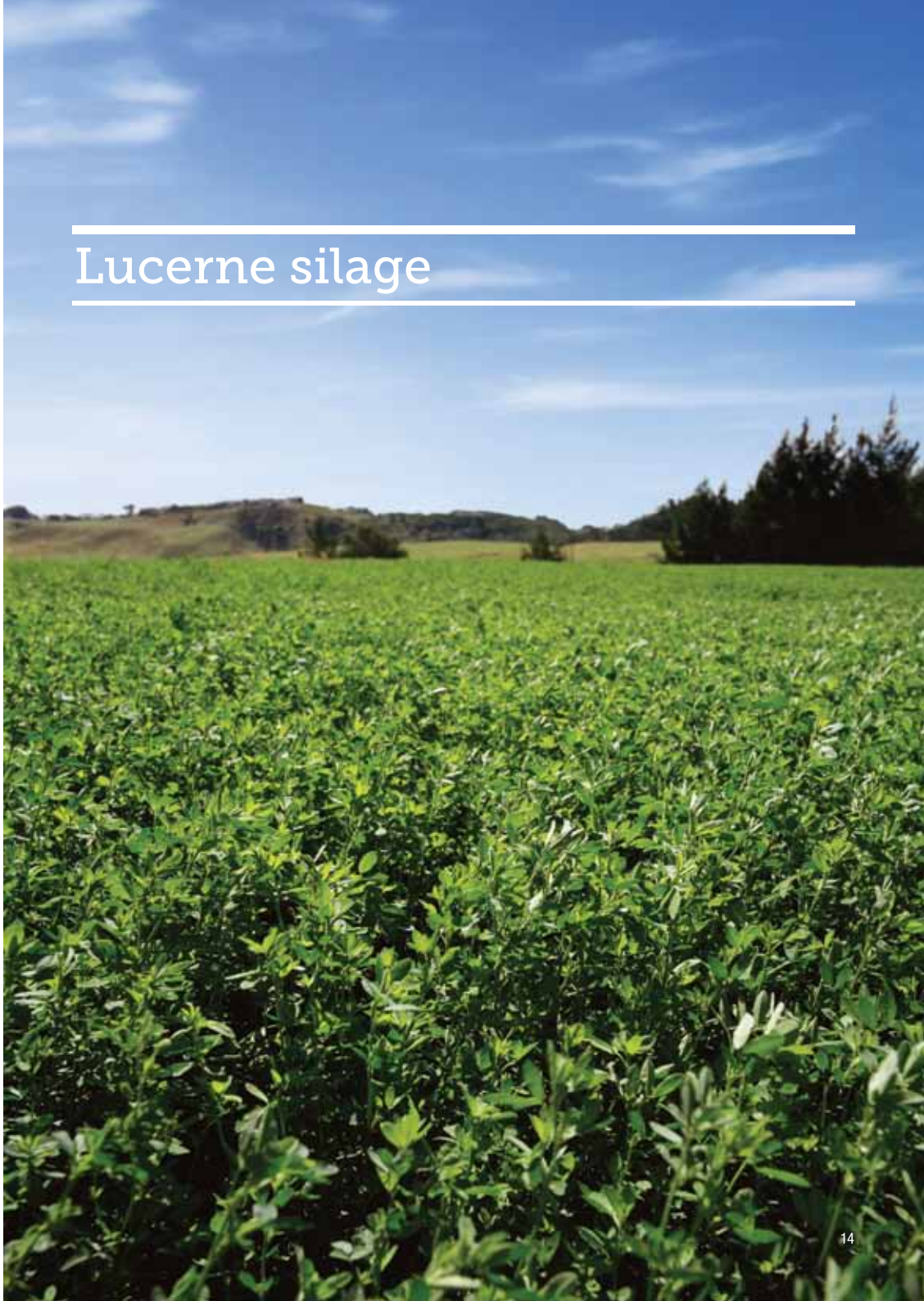
Wheat, barley and triticale crops that are at the soft dough stage will be in the desired harvest drymatter range as a standing crop. Climatic conditions approaching harvest time will greatly influence the increase in crop drymatter percentage. Research has shown triticale can increase by approximately 1% drymatter per day and barley by 1.5 - 2.0% per day, however under very hot dry conditions these drying rates will increase substantially and they can be slower in overcast conditions[11].

To maximise silage quality:

- Collect a representative sample and send it to a commercial laboratory to determine drymatter levels.
- Preferably harvest using a precision chop forage harvester.
- Cut at approximately 7 - 10 cm in height.
- If the crop is drier, use a shorter chop length (20 mm) to assist with compaction.
- If the crop is wetter, increase the chop length to 50 mm.

[11]Forage Cereals: Harvesting whole-crop cereal silage. Agnote 1244. Department of Primary Industries, Victoria, Australia.

Lucerne silage



Time of harvest

As lucerne maturity increases, yield increases but quality decreases. This is because the proportion of fibrous stems increases and the percentage of leaves decreases. Lucerne leaves are high in protein and low in fibre so the highest quality lucerne silage is cut in the pre-bud to bud stage when the leaf-to-stem ratio is highest.

Table 5: Feed analysis of lucerne cut at various stages of maturity[12]

Percentage drymatter basis

Stage	Leaves % of total DM yield	Crude Protein (%)	Acid detergent fibre (ADF, %)	Neutral detergent fibre (NDF, %)	Metabolisable energy (MJME per kg/DM)
Bud	>40	>19	<30	<40	11.5
Early bloom	30 - 40	16 - 19	30 - 35	40 - 45	11.0
Mid bloom	20 - 29	13 - 15	36 - 40	46 - 50	10.5
Full bloom	<30	<13	>40	>50	10.5

The first cut should be taken early in the season when the plants are around 30 cm in height. Leave a 10 cm residual after cutting to avoid damaging the crown buds and to promote tillering of the plant. Second and subsequent cuts should be taken at 28 - 33 days later or at mid bud (whichever is earliest).

Autumn harvest management of lucerne in cool regions (lower South Island and at altitude) involves balancing the need for extra feed against the risk of crop damage due to winter injury. When the previous cutting interval has been 35 days or less, avoid harvesting before the first winter frost. This allows plants to enter the winter with higher carbohydrate root reserves. Leaving stem and leaf stubble insulates the crown of the plant and reduces the risk to the crop.

[12]Pioneer Lucerne Manual. 2011. Genetic Technologies Ltd, Auckland NZ.

Harvest management

The principles for ensiling lucerne are the same as for any other crop. Lucerne is a high protein feed with low carbohydrate levels and a higher buffering capacity. This means that a lot of acid must be produced to drop the pH, yet it is difficult for this to occur since carbohydrates (sugar substrate for the fermentation bacteria) are limited. For lucerne, extra care must be taken to wilt, harvest and store as quickly as possible. Using a quality silage inoculant will ensure that the limited amount of sugar available is efficiently converted to acid.

Table 6: Target drymatter content for ensiling lucerne[13]

	Stacked silage	Baled silage
Vegetative to early bloom	30 - 35%	35 - 50%

Wilt as quickly as possible. This can be achieved by using a mower conditioner and making the windrow wide and thin especially if the crop is dense. It is important that lucerne is not over-wilted, as the leaves as well as some of the nutrient value will be lost in the dust created by the harvesting equipment.

Wilt time will depend on the wind, humidity, heat and sun but is normally between 12 and 24 hours. The “squeeze test” can be used to help determine lucerne drymatter content (see page 7).

To ensure good compaction, precision chop lucerne at 8 - 12mm.

[13]Producing high quality alfalfa silage requires paying attention to harvest maturity, wilt times and length of cut. Pioneer Hi-Bred International, Inc.

Silage inoculants

During silage making, bacteria ferment sugars producing acid which preserves the pasture or crop. Nutrient and energy losses occur during silage fermentation so silage is always slightly lower in feed value than the material which was ensiled. The type and number of silage making bacteria present in your pasture or crop will influence the amount of drymatter and nutrients you lose in the ensiling process.

Pioneer® brand inoculants provide patented strains of fermentation bacteria in ideal numbers for a fast, efficient fermentation. They help lock in nutrients and drymatter so your livestock can produce more milk or meat delivering a greater financial return from every tonne of pasture, cereal or lucerne you ensile.

Only Pioneer inoculants offer a complete range of benefits which include:

- Products that improve fermentation quality increasing silage yield and quality.
- Patented bacterial strains and crop specific products.
- Comprehensive, global, product-specific research*.
- Quality assurance with IS09001:2000 accredited quality control system.
- Guaranteed bacteria levels on the label of every bottle.
- Exclusive Appli-Pro® inoculant applicator technology for more consistent and precise inoculant application.
- Extensive local technical back-up including Forage Specialists, Animal Nutritionists and a Veterinarian.

* Trial results available on request.

Water soluble or granular inoculants?

For best results, silage inoculants must be evenly applied to the crop. For higher drymatter silage, inoculant applied in water soluble form works more efficiently than if applied in granular form[14].

To order your Pioneer® brand inoculants contact your local merchant representative and contractor today.

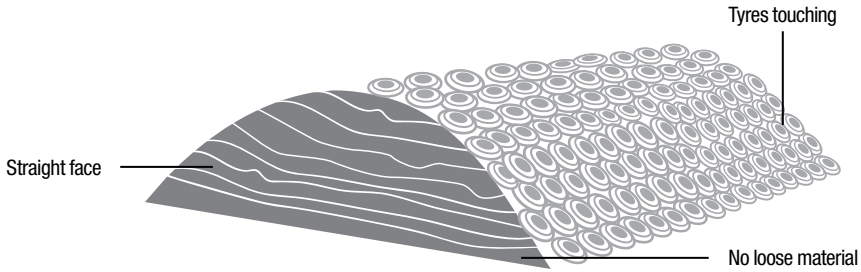
[14]Whiter and Kung. 2001. J. Dairy Sci. 84:2195–2202.

Choosing the right silage inoculant

	Farming challenge	Product solution	Product benefit
PASTURE	I want to lock in my silage nutrients and maximise the return on my pasture silage investment.	PIONEER® BRAND 1127	Produces top quality pasture silage and improves drymatter recovery and animal performance.
PASTURE	I want a lower cost multi-crop inoculant which will improve silage quality and reduce losses.	PIONEER® BRAND 1174	Improves drymatter recovery and silage quality of all forage crops.
CEREAL	I want a lower cost multi-crop inoculant which will improve silage quality and reduce losses.	PIONEER® BRAND 1174	Improves drymatter recovery and silage quality of all forage crops.
LUCERNE	I want to lock in my silage nutrients and maximise the return on my lucerne silage investment.	PIONEER® BRAND 11H50	Produces top quality lucerne silage for all high producing livestock operations.
LUCERNE	I want a lower cost multi-crop inoculant which will improve silage quality and reduce losses.	PIONEER® BRAND 1174	Improves drymatter recovery and silage quality of all forage crops.

Storage and feed-out management

Good stack or bale storage management plays a critical role in maximising silage quality and reducing feed wastage.



Aim to have the face of stacks or bunkers tight throughout the entire feed-out period. Silage that is loose allows the air to penetrate into the stack. This air allows yeasts and moulds to grow causing silage to heat, reducing quality and quantity.

- Choose a storage area that is well drained and away from trees.
- Fence around stacks or bales to keep stock out.
- Place rat bait in bait stations around the stored silage.
- Check regularly and mend holes that develop in the cover or wrap immediately.
- **Never feed mouldy silage to animals.**

Laboratory feed analysis

Feed analysis is an important step in the silage making process. The results will allow you to determine the best time to feed your silage and may also help you identify ways to improve silage quality next season.

Silage should be sampled when it is fully fermented. This is normally one to four weeks after ensiling depending on silage drymatter and inoculant use. To collect a representative silage sample:

- Use a silage corer or collect handfuls from at least five different places in the stack. If you are sampling baled silage, take a core sample from at least five bales.
- Mix the samples together thoroughly and take a 1 kg subsample.
- Place the 1 kg subsample into a laboratory sample bag, or a clean plastic bag.
- Squeeze the air out of the bag and seal it.
- Send the sample immediately by courier or FASTPOST to the laboratory (do not send samples on a Friday unless you are sure they will reach the laboratory before the weekend).
- Samples that cannot be submitted immediately should be stored in the refrigerator overnight, or frozen.

If you have sampled a closed stack or bales that you do not plan to feed immediately, fill the sample holes with salt and reseal the cover using silage tape.

The important things to get analysed are drymatter, crude protein and an estimate of the metabolisable energy content. The pH and ammonia nitrogen percentage will tell you about the success of the silage preservation process. The amounts of volatile fatty acids (lactic, acetic and butyric) are also useful.

Targets for pasture silage

High quality silage is produced when high quality pasture or crop is ensiled well. The targets for high quality silage are shown in the table below for pasture and on page 22 for cereal and lucerne. Record the feed analysis results for your own silage in the last column.

Table 7: Targets for high quality pasture silage[15]

Factor measured	Target values	My silage
Drymatter - stack or bunker	25 - 30%	
- bales	30 - 35%	
Metabolisable energy (MJME/kgDM)	Greater than 10	
Crude protein (%)	Greater than 16%	
Drymatter digestibility (%)	Greater than 70%	
pH	3.5 - 4.5	
Ammonia N (% of total N)	5 - 10	
Lactic acid (% of DM)[16]	8 - 12	
Butyric acid (% of DM)	0.1 - 1.0	

High quality pasture silage will have a tobacco smell and be greenish-yellow or greenish brown in colour. It will always be cool and free of mould.

[15]DairyNZ farmfact 1-46. What is high quality pasture silage?

[16]Kung and Shaver, 2001, Interpretation and use of silage fermentation analysis reports. Focus on Forage Vol 3: No 13. University of Wisconsin.

Targets for cereal and lucerne silage

Table 8: Target values for whole crop cereal silage

Factor measured	Target values	My silage
Drymatter % - Flag leaf/boot	32 - 40%	
- Soft dough stage	36 - 42%	
Metabolisable energy (MJME/kgDM)	Greater than 10	
Crude protein (%)	7 - 10%	
Drymatter digestibility (%)	Greater than 60 - 70%	
pH	4.0	
Ammonia N (% of total N)	5 - 8	

Table 9: Targets for lucerne silage[17]

Factor measured	Target values	My silage
Drymatter %	30 - 40%	
Metabolisable energy (MJME/kgDM)	10 - 11.5%	
Crude protein (%)	20%	
ADF (%DM)	30	
NDF (%DM)	40	
pH	Less than 4.5	
Lactic acid (%DM)	Greater than 2%	
Ammonia N (% of total N)	Less than 15%	

For further technical assistance on making or feeding silage contact your local Pioneer Forage Specialist on 0800 PIONEER (0800 746 633).

[17]Seglar, W. 2003. Fermentation analysis and silage quality testing. Proceedings of the Minnesota Dairy Health Conference College of Veterinary Medicine. University of Minnesota.

For more information go online or phone the Pioneer Advice Line toll-free

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