



Key Nutritional Principles for Profitable Dairy Farming

How to get the best value out of forages

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How to get the best value out of forages

1. What are forages ?
2. What is the value of high quality forages?
3. What are the main factors to influence it and how can we manage it ?
4. Benchmarks for some forages



Forages



Pasture



Maize silage



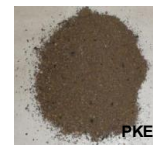
Pasture Silage



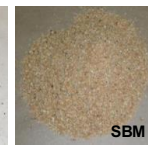
Cereal Silage

- **more fibrous, bulky feed from the green part of plants.**
- **high levels of effective fibre**
 - cell-wall components (NDF)
 - combined with a certain length of particles
- **stimulate ruminants to chew and produce large amounts of saliva;** that keeps the rumen microflora in a healthy state.
- Often forages are grown on-farm and grazed or kept as silage or as hay.

Concentrates



PKE



SBM



Maize grain



Wheat



Molasses



HMC

- Feed with a high concentration of energy
- contain highly digestible components
- mostly processed, i.e. ground, kibbled or pelleted and have very little physically effective fibre.



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Value of forage quality

example baled grass

	good	average	low quality
DM%	40	40	40
ME, MJ/kgDM	11.5	10	9
CP, %DM	18	14	10
NDF, %DM	45	50	55
c/kgDM	35	35	35
c/MJME	3.0	3.5	3.9
c/g CP	19.4	25.0	35.0
potential kg MS/t DM*	115	100	90
\$ from potential milk	523	455	410
advantage to low quality \$/tDM	142	57	0

*assumption 10 gMS/MJME \$4.55 per kgMS

Forage quality should be considered when producing or purchasing feed; it impacts on potential production



Nutrients first-limiting milk production on high quality pasture diets

kg milk/cow/day	Nutrient first-limiting milk production
20	Energy
25	Energy
30	Energy & Protein
35	Protein

When we assume that cows are fully fed to achieve high milk production, then first focus needs to be on energy intake

Kolver 2000



Cows need **energy** and **fibre**

- Cows need a lot of **energy** to support milk production
 - high intake & high energy density in feed
- In order to keep the rumen “healthy”, they need physical effective **fibre**
 - chewing→saliva→rumen pH→microflora
- Conflicting goals: feeds with high energy levels don't have good physical effective fibre

	Concentrates	Forages	Diet (ideally)
energy density	+	?	+
phys. effective fibre	-	+	+



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4. Benchmarks for some forages



Pasture silage harvest time and quality

Proceedings of the New Zealand Grassland Association 60: 259-264 (1998)

259

Effect of date and length of closure and post grazing residual on pasture quality for silage

J.M. MCGRATH, J.W. PENNO, K.L. DAVIS and R. WRENN
Dairying Research Corporation, Private Bag 3123, Hamilton

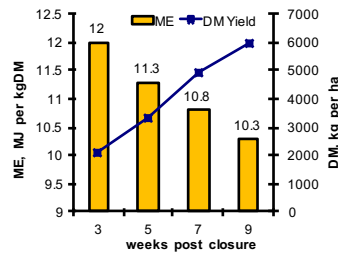
Table 5 CP (%), NDF (%), OMD(%), ME (MJME/kg DM) and DM (kg/ha) of pasture at weeks 3, 5, 7 and 9 after closure. Data are means of all closure dates in experiment 2.

Week post closure	3	5	7	9	SED	
CP	20.9	15.1	12.6	10.4	0.48	
NDF	44.9	48.1	51.9	55.7	0.52	
OMD	79.5	75.9	72.1	68.9	0.30	OM digestibility %
ME	12.0	11.3	10.8	10.3	0.06	ME MJ/kgDM
DM	2065	3315	4950	5930	153	DM Yield kg/ha

progressively older



Harvest time and quality (ME) pasture silage



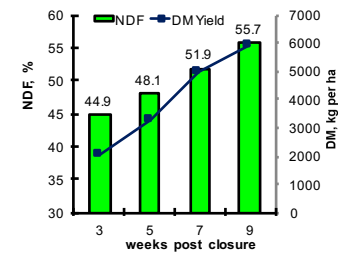
More grass but less quality over time:

- DM Yield goes up over time (blue line)
- ME goes down (yellow bars)

Source: McGrath et al 1998



Harvest time and quality (NDF) pasture silage



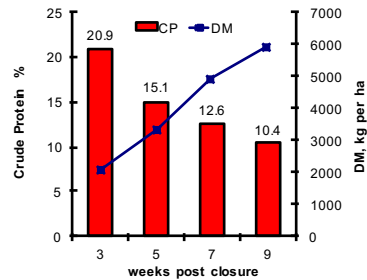
More grass but less quality over time:

- DM Yield goes up over time (blue line)
- NDF (cell wall) goes up (green bars) lower quality with more NDF Plants become "woody"

Source: McGrath et al 1998



Harvest time and quality (Crude Protein) pasture silage



More grass but less quality over time:

- DM Yield goes up over time (blue line)
- CP goes down (red bars)

Source: McGrath et al 1998



Harvesting process grass silage effective wilting

Crop	DM%	Sugar %DM	Buffering capacity ¹	Fermentation coefficient ²
Ryegrass - fresh	20	17.3	52	47
Ryegrass - wilted	35	17.3	52	62
Other grasses - fresh	20	9.2	55	33
Other grasses - wilted	35	9.2	55	48
Red clover - fresh	20	11.5	69	33
Red clover - wilted	35	11.5	69	48

¹ g lactic acid per kg Drymatter

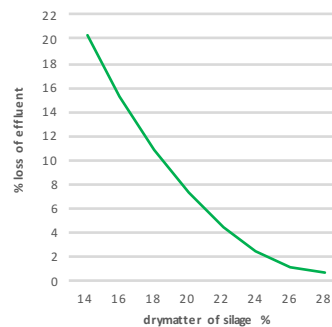
² fermentation coefficient is indicative of crop ability to ferment well (= DM% + 8 x sugar / buffering capacity)

- Low DM, low sugar grass and clover are risky; Chance of Clostridia to take over
- Good grass with high sugar (short and effective wilting) and 35% DM is ideal

Source: Praxishandbuch Futterkonservierung (Manual for practical feed conservation), p.36 DLG Verlag 2006



Silage quality pasture silage



Prevent effluent losses from stack

- Wilt to min 25+ %DM
- No dirt into stack
- ⇒ risk of Clostridia

Source: Bastiman and Altmann 1985



Factors to improve grass silage quality

- Don't cut too late; before grass goes to seedhead
- Harvest after 1 - 2 days of sunny weather to ensure good sugar levels in the pasture.
- Harvest at 30-40%DM
- Make sure that the dirt is not harvested or carried into stacks.
- Use a quality silage inoculant



Cereal silage

Harvest time

- Flag leaf/boot - early ear emergence stages
- Soft dough stage

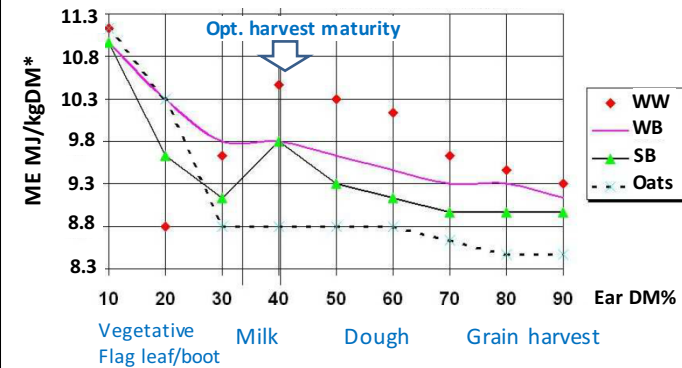
Species	Flag leaf – Boot stage	Soft dough stage
Oats	32 - 40%*	Not recommended
Barley, wheat and triticale	32 - 40%*	36 - 42%

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.

Source: When to cut forage cereals. Agnote 1243. Department of Primary Industries, Victoria, Australia.



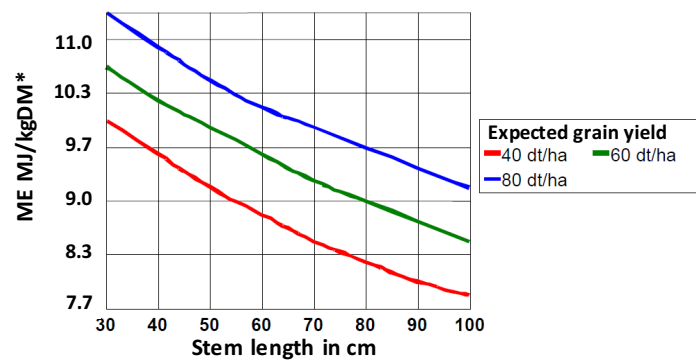
ME of cereal silage at different maturity N. Germany



* converted from NEL MJ/kgDM – NEL/0.6
Source: Thaysen 2010



ME of cereal silage with different cutting height N. Germany



* converted from NEL MJ/kgDM – NEL/0.6
Source: Thaysen 2010



Fermentation quality of cereal silage

Green cereal silages:

- lower in drymatter and have lower 'fermentability' i.e. need to be wilted

Cereal silage harvested at soft dough stage

- low nitrate level -> risk of Clostridia fermentation i.e. butyric acid (bad smell)
- direct harvest – short choplength, compact well



Compaction cereal silage



- Stems harvested at later maturity stages need thorough compaction
- Thin layers (<15cm) and high pressure
- Targets
 - 230 kgDM/m³
 - Feed-out rate >2m/week



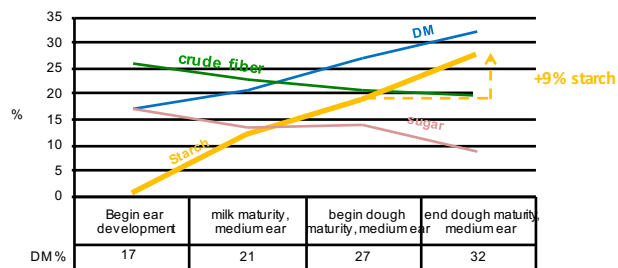
Cereal silage

- Grow a good cereal crop (best practice of all agronomic aspects)
- Harvest at 30-40% DM
- Ensure good harvest technique; chopping processing, inoculant, packing
- Good stack/bunker dimension to ensure good feed-out rate.



Maize silage

Harvest time and composition

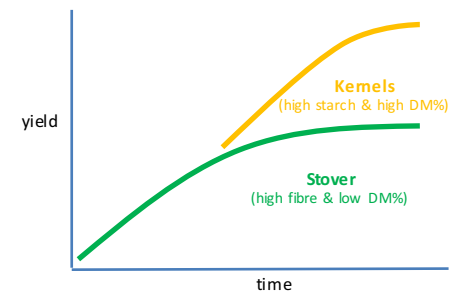


- from begin to end of dough maturity:
- DM & starch increases significantly (5% & 9%)
 - fibre decreases

German feed tables ruminants 1997



Maize changes composition over time

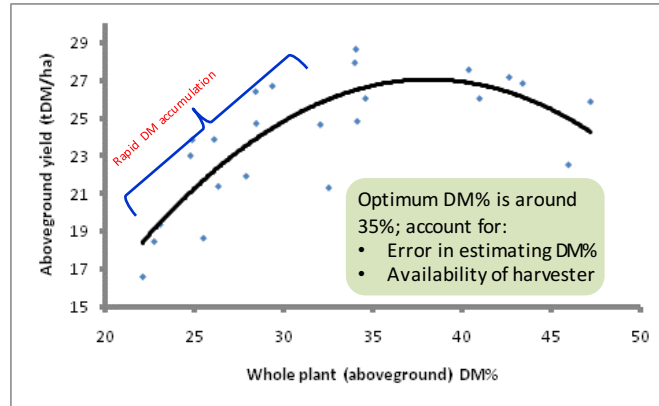


Maize kernels
(13.6 MJ ME/kg DM)

1/2 of drymatter
2/3 of ME



Maize: Silage DM accumulation over time



Genetic Technologies Research data



Harvesting process maize silage Kernel Processing

Inadequate processing score of 35%
(only 35% of starch small enough to pass 4.75mm screen)



Excellent Processing score of 70%
(70% of starch small enough to pass the 4.75mm screen)



Corn Silage Processing Score (CSPS)

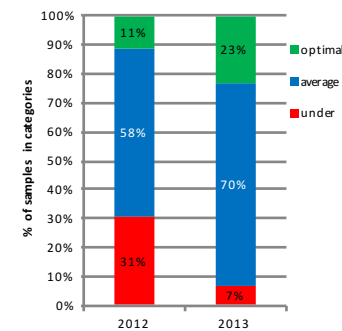
Ranking	Percentage of starch passing through the coarse screen
Optimum	Greater than 70%
Average	50% to 70%
Under processed	Less than 50%

CSPS is % starch passing through the coarse screen (4.75mm) in % of total starch of sample

Sample		Analysis Starch % in sample
Sieve (mm)	starch separations	
19	coarse	Starch % of material retained on 4.75 mm and larger
13	coarse	
9.5	coarse	
6.7	coarse	
4.75	coarse / starch sieve	
3.35	medium	Starch % of material retained on 0.6 mm and larger
2.36	medium	
1.18	medium / fine	
0.6	fine	
pan	fine	



Maize silage kernel processing NZ 2012 & 2013



Kernels in manure

- <5% starch is normal acc. to US farm monitoring studies
- Less undigested maize starch with longer silage fermentation

* % starch through coarse screen



Harvesting process maize silage Chop length of maize silage

Physical Effectiveness Factors (pef)

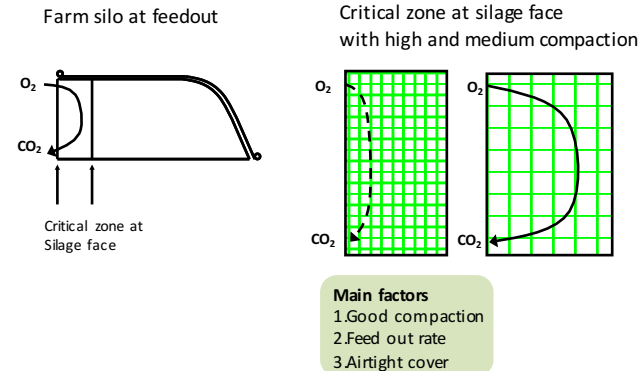
Class	Dimensions (mm)	Grass hay	Grass Silage	Maize silage
Long		1.00		
Coarse	>50	0.95	0.95	
Med-coarse	25-50	0.90	0.90	0.90
Medium	13-25		0.85	0.85
Med-fine	6-13			0.80
Fine	<6			
Ground	>6	0.40		
Ground	<6	0.30		

- In TMR based diets 22% of DM as physically effective NDF (peNDF) maintains rumen health
- Example: maize silage @ 10mm chop length will deliver 36% peNDF (45%NDF x 0.80)
- Slow introduction of maize silage with high quality pasture is necessary

Source: Mertens 2004;NRC 2001.p 39



Harvesting process maize silage stack density



Factors to improve maize silage quality

- Grow a good maize silage crop (best practice of all agronomic aspects)
- Connect early on with your contractor and prepare for harvest
- Harvest at 30-40% DM
- Ensure good harvest technique; chopping processing, inoculant, packing
- Good stack/bunker dimension to ensure good feed-out rate.



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4. **Benchmarks for some forages**



Benchmarks grass silage

Factor measured	Target values	
Drymatter - stack or bunker	30– 40%	
Metabolisable energy (MJME/kgDM)	Greater than 10	Nutritive value
Crude protein (%)	Greater than 16%	
Drymatter digestibility (%)	Greater than 65%	
pH	3.5 - 4.5	Silage quality
Ammonia N (% of total N)	5 - 10	
Lactic acid (% of DM) ¹⁶	8 - 12	
Butyric acid (% of DM)	0.1 - 1.0	



Benchmarks cereal silage

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



Benchmarks maize silage

Factor measured	Target values	
Drymatter (%)	30– 40%	
Metabolisable energy (MJME/kgDM)	10.5-11.1	Nutritive value
Crude protein (%DM)	6-9	
Acid detergent fibre (ADF) (%DM)	25-35	
Neutral detergent fibre (ndf) (%DM)	35-50	
Starch (%DM)	25-35	
pH	3.7-4.2	Silage quality
Ammonia N (% of total N)	0-10	
Lactic acid (%DM)	4-7	
Acetic acid (%DM)	1-3	
Butyric acid (%DM)	0	



Summary

1. Forages are an essential part of cows diets because they deliver energy and physically effective fibre
2. Forage yield and quality are important drivers for potential milk production per ha and per cow
3. With increasing levels of feeding and increased milk yields per cow the management of yield and quality becomes increasingly important
4. Benchmarks for good yield and quality are essential to monitor success and improve management over time

