

GRASS SILAGE 2016 – EARLY SEASON MINERAL PROFILE

HEADLINES:

- PHOSPHORUS CONTINUES TO INCREASE—UP 30% SINCE 2010
- POTASSIUM DECLINES FROM HIGH IN EARLY PART OF THIS DECADE AS FERTILISER INPUTS ARE REDUCED
- CATION-ANION BALANCE FOLLOWS POTASSIUM TREND
- SULPHUR UP BY 27% SINCE 2010 DUE TO FOCUS ON ADDING SULPHUR TO GRASSLAND FERTILISER
- SOIL CONTAMINATION SIMILAR TO 2015, BUT DOWN FROM 2014 PEAK
- MOLYBDENUM UP AGAIN—HAS INCREASED BY 22% SINCE 2010
- RELATIVE COPPER ANTAGONISM REMAINS SIGNIFICANT

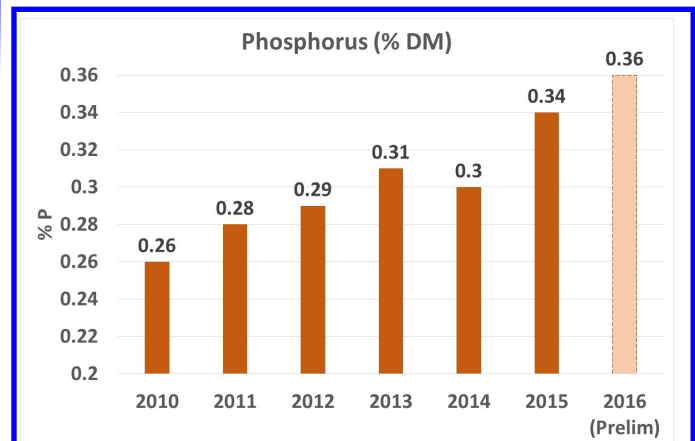
BACKGROUND

Every year has its weather challenges and 2016 was no different. A wet, mild winter highlighted by severe flooding in December '15 provided its own headlines, being the third warmest and second wettest since 1910, with only the 2013/14 winter having more rainfall. This pattern was followed by a cold, wet spring, particularly in April when temperatures were 1°C below the long term average and rainfall was 112% higher. May bounced back with average temperatures 1°C higher than the long term average and it was also a drier month. June maintained the above average temperatures, but it was very wet, which disrupted silage production. Grass growth patterns followed the erratic weather being very slow in March and April, but exploded in May and continued into June under optimal conditions of temperature and moisture for grass growth. The good weather window in late May enabled many farmers to make silage under reasonable weather conditions. Undoubtedly May was a key month for determining not only grass yields, but also mineral composition, which as always is influenced by local climatic conditions.

MACRO MINERALS

Phosphorus

The concentration of Phosphorus would have been largely determined in May when growing conditions were optimal. Phosphorus is a key driver of energy utilisation. The phenomenal dry matter production of over 100kg/ha/day reported on many farms, would have been influenced by the accelerating release of Phosphorus as soils warmed up. Over the past 7 years the average Phosphorus concentration of grass silage has increased by 30%, from 0.26 to 0.36% DM. This trend is probably influenced by two factors. Firstly, by climate change as illustrated by warming late springs in May

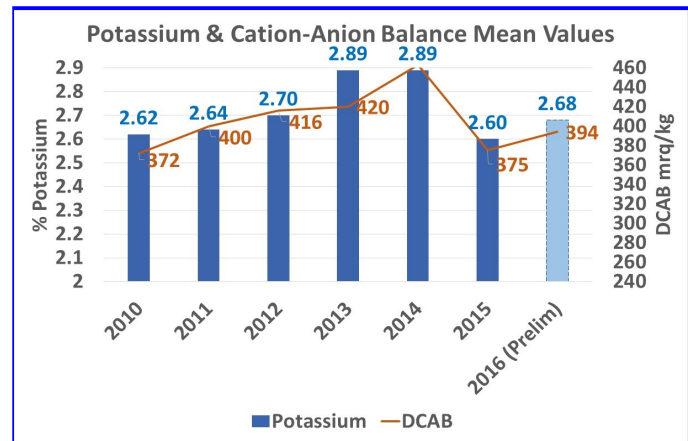


and June. Secondly, by a reducing trend in Calcium of 16% over the same period. The decline in Calcium is attributed to a continuing failure to maintain the lime status of soils. Since 2010, the increase in Phosphorus is equivalent to an increased dietary supply of 8g P/cow/day for dairy diets dependent on grass silage. In turn, this is equivalent to a 5% reduction in the Phosphorus level of a typical dairy mineral supplement fed at 150g/head/day. With UK and Irish grassland soils containing very high Phosphorus reserves, any actions that increase the release of Phosphorus will reduce the need for fertiliser inputs, which represents a potential environmental risk.

Potassium and DCAB

Potassium at 2.68% is similar to the mean 2015 value of 2.60%. Since 2010, the pattern for Potassium has been a progressive increase through to 2013/2014 (2.89%) followed by a marked decline to 2.68%. This trend undoubtedly reflects the Potash fertiliser "holiday" many farms have adopted in the past couple of years as a cost saving measure. Potassium is extremely soluble with vegetative levels reflecting fertiliser and slurry inputs. The current season's mean Potassium level is similar to that reported in 2010 and 2011, which suggests the policy of

applying excessive levels of Potash fertilisers to drive grass growth are over. A more balanced approach which takes account of available soil indices and the contribution from slurry is hopefully being adopted. Cation-Anion Balance (CAB), of course, reflects the Potassium trends with the build up from 2010 to a peak value of +463 in 2014, is followed by a decline this early season to +394 meq/kg. While this decline in the single most important risk factor for hypocalcaemia is welcome, it still remains relatively high. In most cases the Dietary Cation



Anion Balance (DCAB) of the total diet will be calculated within the target range of +200 to +400 meq/DM for a milking cow and the lower value in this season's silage crop will make it slightly easier to achieve a DCAB of less than +100 meq/kg DM for dry cow diets: For close up or Transition diets for average to high yielding herds the challenge is greater to achieve a DCAB of around zero for a partial anionic diet and less than -100 meq/kg DM for a full anionic diet. Failure to achieve these DCAB targets will increase the risk of Hypocalcaemia which includes:

- Retained cleansings
- Uterine infections
- Displaced abomasums
- Depressed Dry Matter intake
- Poor milk initiation
- Ketosis
- Milk Fever

The occurrence of Hypocalcaemia will inevitably depress milk production, fertility and health in the forthcoming lactation. Consequently it is a key action point to analyse grass silage for minerals from which a Cation-Anion Balance can be calculated to be used in balancing pre-calver diets with the purpose of minimising Hypocalcaemia.

Sulphur

Sulphur is an essential macro-element for grass growth and in combination with Nitrogen is important for protein production. Like Nitrogen, Sulphur is mobile in soils, particularly light soils, and needs to be applied annually. The significant atmospheric deposition of Sulphur from coal fired industry has long gone, and the reliance of fertiliser inputs including slurry is critical.

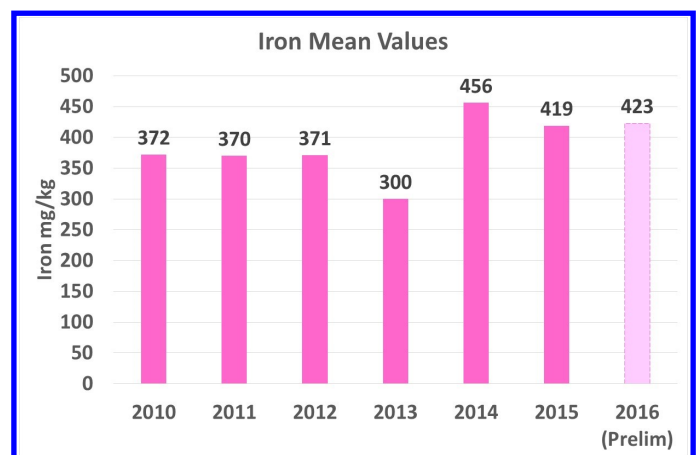
The fertiliser industry has long campaigned for Sulphur to be included in Nitrogen based fertilisers and this policy appears to be paying off, as since 2010 the mean grass silage Sulphur level has increased from 0.19% to 0.23% (a 21% increase). This rise in forage Sulphur levels is equivalent to a 3% unit increase in grass protein levels, which represents a significant reduction on the requirement for imported protein feeds.

TRACE ELEMENTS

Overall, trace elements are reporting similar mean values in this season's grass silage to 2015. However, long term trends in mean values for Iron and Molybdenum are apparent.

Iron

Over the period 2010-2016, mean Iron levels have fluctuated widely, but a long term increasing trend is present. Silage Iron concentration is determined by a combination of soil contamination and root absorption. The extent of soil contamination is primarily weather related, as shown by the peak Iron level in 2014, which was a wet grass harvest year. In contrast, May/June 2013 was dry and the opportunity for soil to be picked up with grass was reduced. However, since 2010 mean Iron concentration has increased from 372 to 423 mg/kg (+14%), which suggests the contribution from plant uptake is significant. A key contributory factor is compaction, which renders soils anaerobic and increases the solubility of Iron, thereby raising root absorption.



With livestock dietary Iron requirement reported at between 50-100mg/kg DM, the levels found in grass silage are clearly well in excess of animal needs. A combination of minimising soil contamination at harvest, and reducing soil compaction through the introduction of a soil improvement plan will help to arrest, and hopefully reduce, forage Iron concentration. High Iron intakes are a risk to the absorption of related cations (Manganese, Zinc and Copper) and consequently represents a risk to cow health and fertility. In addition, published research demonstrates that within silage clamps Iron contributed by soil contamination becomes solubilised which makes it more reactive

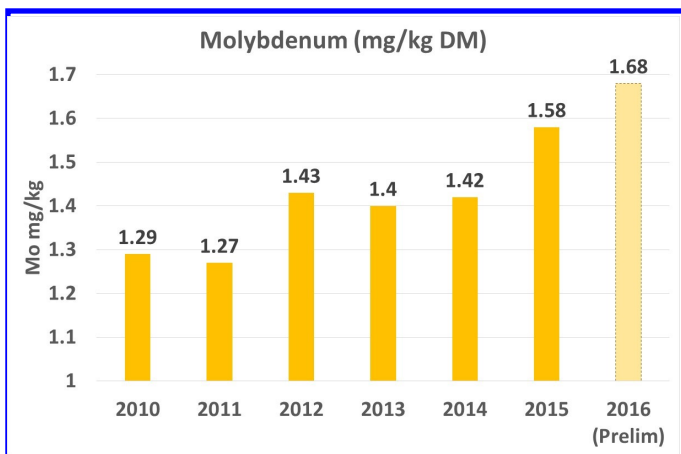
and oxidative. In this highly active form Iron will readily bind with Copper and Sulphur in the rumen to form insoluble Iron-Copper Sulphides, thereby reducing Copper availability and increasing the dietary requirement. In addition, reactive Iron will increase oxidative stress in cattle to the detriment of health and productivity.

To limit damage check forage Iron levels and use the data to estimate total dietary levels, which can be used to determine the risk to cow health.

Provide a balanced mineral supplement containing Novus MAAC chelates of Copper, Manganese and Zinc, which are well protected from Iron competitive pressures and absorbed at different gut sites.

Molybdenum

The relentless rise in average grass silage Molybdenum levels continues with the preliminary 2016 data reporting the highest value (1.68 mg/kg) since this survey started in the 1990s. Over



the period 2010-2016, Molybdenum has increased by 22%.

Of all the elements, Molybdenum is the most sensitive to anaerobic soil conditions. In well aerated soils Molybdenum is oxidised which renders it insoluble, thereby making it difficult for plants to absorb through the roots. Once air is excluded from soils by compaction, the chemistry of Molybdenum changes, which makes it more soluble and available for root absorption.

In addition, soil pH and Sulphur also play a role in either stimulating or suppressing Molybdenum uptake by grass. Having a knowledge of the mineral composition of both soil and grass is a pre-requisite to developing a soil improvement programme designed to reduce forage Molybdenum levels.

Molybdenum is well recognised as a Copper antagonist which reduces the availability of this essential element through the formation of insoluble compounds. An increased dietary Copper requirement results. The antagonism from Iron and Molybdenum on Copper availability requires additional Copper

suppression of these antagonists. While recognition of the increased antagonistic challenge to Copper availability in the forthcoming winter season is important, the longer term strategy to reduce both Iron and Molybdenum lies in both soil improvement and practical actions at grass harvesting. Actions based on analytical information are also important to prevent both Copper toxicity and the more prevalent and economically damaging Copper deficiency diseases.

SOIL IMPROVEMENT PROGRAMME

Soil compaction is the greatest threat to grassland production and can reduce yields by up to 40%. The anaerobic conditions created in soil by compaction has a deleterious effect on the mineral status of forages, as demonstrated by an increased uptake of Potassium, Iron and Molybdenum.



Furthermore, biological activity is reduced which adversely impacts grass health and productivity. A recent survey has indicated about 70% of grassland soils are compacted. Many causes of compaction exist including livestock poaching, machinery, heavy rainfall, soil mineral imbalances and heavy applications of high ammonia, putrid slurry. The consequences of soil compaction not only impact grass growth, but have an environmental downside including an increased risk of surface nutrient run-off and an estimated 30% increase in the release of Nitrous Oxide, which is a potent greenhouse gas. In addition, it takes 2.5 x more Nitrogen to grow the same amount of grass on compacted soil vs a non compacted soil.

The Soil Improvement Plan has been developed to reduce compaction by taking 3 key actions:

STEP 1—Physical

- Aeration to disrupt surface compaction and allow AIR into the soil
- Aeration improves surface drainage, stimulates rooting and enables AIR penetration in support of SOIL LIFE

STEP 2—Chemical

- Analyse soil for key chemical parameters to check:
 - Liming status
 - Available Nutrients (Phosphorus, Potassium, Sulphur)
 - Calcium - Magnesium balance
- Develop a lime/fertiliser programme to optimise soil fertility
- Correct Calcium—Magnesium balance to create a more “open” stable soil structure, to allow air interchange, provide an environment for soil life to flourish, encourage

Forage Mineral Report

SAMPLE TYPE		Grass Silage	FARMER	Mean of 383 samples			
SAMPLE REF		2016	FIELD ID	2016			
DISTRIBUTOR		Thomson & Joseph Ltd.	POST CODE				
DISTRIBUTOR'S REF			DATE	22 August 2016			
Dry Matter 29.9%							
MINERAL ELEMENT (DM BASIS)		ASSAY	VERY LOW	LOW	MEAN	HIGH	VERY HIGH
Calcium	Ca %	0.61	0.3	0.5	0.6	0.7	0.9
Phosphorus	P %	0.36	0.2	0.3	0.35	0.4	0.55
Magnesium	Mg %	0.18	0.1	0.15	0.2	0.25	0.4
Potassium	K %	2.68	0.5	1.5	2	2.5	5
Sodium	Na %	0.25	0.1	0.2	0.25	0.3	0.4
Chloride	Cl %	0.91	0.3	0.6	1	1.4	2
Sulphur	S %	0.23	0.1	0.15	0.2	0.25	0.4
Cation-Anion Balance	meq/kg	394	50	100	200	300	500
Manganese	Mn mg/kg	115	50	75	100	125	200
Copper	Cu mg/kg	6.7	5	8	10	12	15
Zinc	Zn mg/kg	30.6	25	40	60	80	130
Cobalt	Co mg/kg	0.19	0.1	0.2	0.25	0.3	0.4
Iodine	I mg/kg	0.67	0.25	0.5	1	1.5	2
Selenium	Se mg/kg	0.08	0.05	0.1	0.15	0.2	0.25
Boron	B mg/kg	6.7	1	2	4	6	10
Iron	Fe mg/kg	423	50	100	150	200	350
Aluminium	Al mg/kg	167	25	50	100	150	300
Molybdenum	Mo mg/kg	1.68	0.1	0.35	0.8	1.25	2
Lead	Pb mg/kg	0.61	1	2	2.5	3	10
Relative Copper Antagonism							
Soil Contamination Index							

Forage Year		2014	2015	2016	% Difference 2016 v 2015
No. of Samples		399	400	383	
<i>Dry Matter</i>	%	—	—	29.9	—
<i>Calcium</i>	%	0.60	0.61	0.61	—
<i>Phosphorus</i>	%	0.31	0.36	0.36	—
<i>Magnesium</i>	%	0.18	0.18	0.18	—
<i>Potassium</i>	%	2.89	2.60	2.68	+ 3
<i>Sodium</i>	%	0.28	0.28	0.25	- 11
<i>Chloride</i>	%	0.99	0.95	0.91	- 4
<i>Sulphur</i>	%	0.19	0.23	0.23	—
<i>CAB meq/kg</i>		+463	+375	+394	+ 5
<i>Manganese</i>	mg/kg	139	116	115	—
<i>Copper</i>	mg/kg	7.9	7.3	6.7	- 8
<i>Zinc</i>	mg/kg	32.0	30.5	30.6	—
<i>Cobalt</i>	mg/kg	0.20	0.21	0.19	—
<i>Iodine</i>	mg/kg	0.80	0.81	0.67	- 17
<i>Selenium</i>	mg/kg	0.06	0.08	0.08	—
<i>Boron</i>	mg/kg	—	—	6.7	—
<i>Iron</i>	mg/kg	456	419	423	—
<i>Aluminium</i>	mg/kg	226	181	167	- 8
<i>Molybdenum</i>	mg/kg	1.43	1.62	1.68	+ 4
<i>Lead</i>	mg/kg	—	—	0.61	—
<i>Relative Copper Antagonism</i>		High	High	High	—
<i>Soil Contamination—Titanium</i> <i>mg/kg</i>		9.3	7.0	6.7	

Data covers the period 1st June to 8th September.

Results are expressed on a Dry Matter basis.

SOIL IMPROVEMENT PLAN continued

nutrient release from soil reserves and improve drainage.

STEP 3—Biological

- Compost (aerobically digest) slurry with DIGEST-IT a liquid microbial culture.

DIGEST-IT:

- Increases Nitrogen by capturing volatile Ammonia and converting it to Organic Nitrogen
- Breaks down bottom solids to release Phosphorus
- Improves slurry consistency to reduce costs of stirring
- Reduces odour
- Switches slurry microbial balance from anaerobic (putrid) to aerobic (composting) to enhance positive soil life.



3 STEP SOIL IMPROVEMENT PLAN

- **Improve soil fertility by reducing compaction**
 - **Grow more grass**
- **Increase utilisation of farm resources in soil and slurry**



SUMMARY

The 3 key mineral risk factors to cow health and productivity are Potassium, Iron and Molybdenum. While Potassium and Iron have declined, they remain at levels well in excess of the dietary requirement for ruminant livestock. Coupled with the significant increase in Molybdenum, the probability of involvement in Hypocalcaemia, Infertility and Oxidative Stress remains a real possibility. Only through the regular analysis of grass silage can these risk factors be identified and a balanced mineral supplementation developed.

In the longer term, forage mineral risk factors to cow health and productivity can be reduced through soil improvement and adopting an appropriate nutrient management plan for grassland. Having an integrated approach to the mineral nutrition of soils, grass and cows is the answer to improving grass and cow productivity in a sustainable and profitable manner.

This review relates only to the mean of the first 383 Grass Silage samples analysed from this year's 1st Cut. The mineral status of silage is extremely variable and the only certain way of establishing the mineral content from an individual farm is by regular analysis.

MINERAL ACTION PLAN

To ensure cow health, fertility and production is not compromised

by unidentified Mineral Risk Factors use:

- ♦ **T&J Forage Mineral Analysis Service**
- ♦ **T&J Mineral Check to formulate nutritionally balanced supplements**
- ♦ **T&J Soil Improvement Plan to improve soil fertility, grassland production and forage mineral balance**

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