The Mineral Specialists

GRASS SILAGE 2017 –EARLY SEASON MINERAL PROFILE

HEADLINES:

- **PHOSPHORUS STEADY AT 0.36% - UP 38% SINCE 2010**
- **POTASSIUM REPORTS SLIGHT INCREASE TO 2.80% BUT REMAINS LOWER THAN PEAK IN 2013/14**
- **CATION-ANION BALANCE FOLLOWS POTASSIUM TREND AND IS SIMILAR TO 2016 HIGH VALUE AT +391 meq/kg**
- **SOIL CONTAMINATION SIMILAR TO 2016, AS REFLECTED IN IRON LEVEL OF 401mg/kg, BUT DOWN FROM 2014 PEAK**
- **MOLYBDENUM UP AGAIN TO 1.71mg/kg—HAS INCREASED 33% SINCE 2010**
- **RELATIVE COPPER ANTAGONISM REMAINS HIGH**

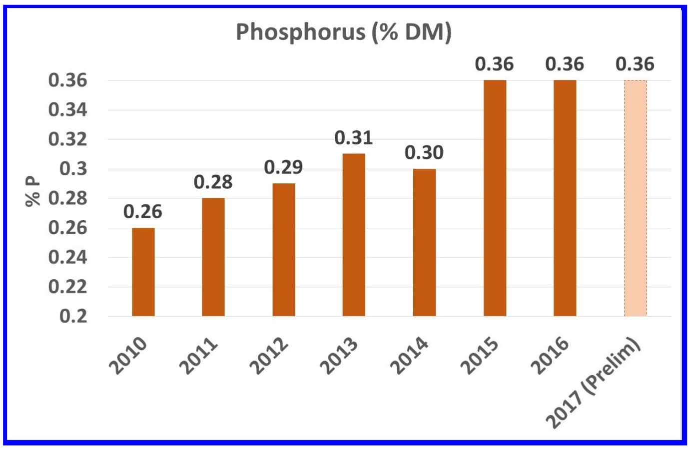
BACKGROUND

This year is likely to be a record year for grass growth due to the dry and mild conditions which occurred during the 2016/2017 winter and continued into the spring. March and early April were warmer than average at +1.8°C above the long term average. However, grass growth slowed in the second half of April due to cold nights including frosts. Temperatures recovered in May, to be +1.7°C above the long term average. Overall, this spring was the UK's second warmest on record with only 2011 being slightly warmer. Rainfall was sporadic, with wet periods interspersed with dry spells. Overall, spring rainfall was close to the long term average. Direct sunlight is an important driver for grass growth and this spring was considerably sunnier than the long term average, with March +121%, April +109% and May +115%. This favourable weather pattern not only drove grass growth but also ensured weather conditions were generally favourable when 1st cut silage was made. As always, spring weather patterns will have an impact not only on grass DM yields, but also mineral composition, which is reported here.

MACRO MINERALS

Phosphorus

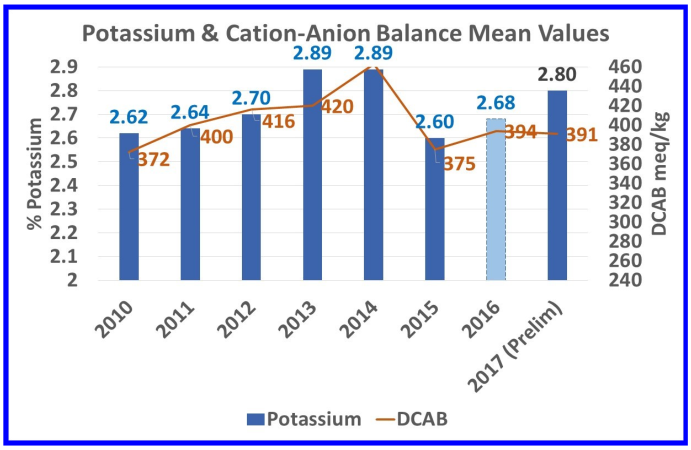
The concentration of Phosphorus would have been largely determined in May when growing conditions were optimal. Phosphorus is a key driver of energy utilisation. The phenomenal dry matter production of over 100kg/ha/day reported on many farms, would have been influenced by the accelerating release of Phosphorus as soils warmed up. Over the past 8 years the average Phosphorus concentration of grass silage has increased by 38%, 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 the increasing trend of re-seeding, which has resulted in more productive silage pastures containing grasses with a higher energy content. Since 2010, the increase in Phosphorus is equivalent to an increased dietary supply of 10g P/cow/day for dairy diets dependent on grass silage. In turn, this is equivalent to a 6% 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 benefit.

Potassium and DCAB

Potassium at 2.80% is slightly higher compared to the mean 2016 value of 2.68%. Since 2010, the pattern for Potassium has been a progressive increase through to 2013/2014 (2.89%) followed by a decline to 2.80%. 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. Although Potassium levels are off the peak of 2013/2014, a trend of increasing Potassium levels over the past 3 years (2015-2017) is apparent, which may be driven by the same factors that are responsible for the increase in Phosphorus, i.e. climate and re-seeding. However, 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 +391 meq/kg. While this decline is welcome, as DCAB is the most important risk factor for hypocalcaemia, 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

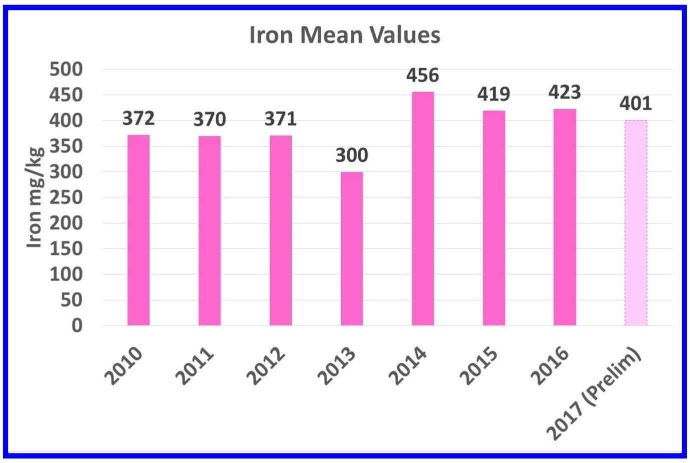
Sulphur is an essential macro-element for grass growth and in combination with Nitrogen is important for protein production. Like Nitrogen, Sulphur is mobile in soils, particularly light soils, and needs to be applied annually. The significant atmospheric deposition of Sulphur from coal fired industry 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 0.24% (a 26% increase). This rise in forage Sulphur levels is equivalent to a 4% 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 2016. However, long term trends in mean values for Iron and Molybdenum are apparent.

Iron

Over the period 2010-2017, 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 401 mg/kg (+8%), 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



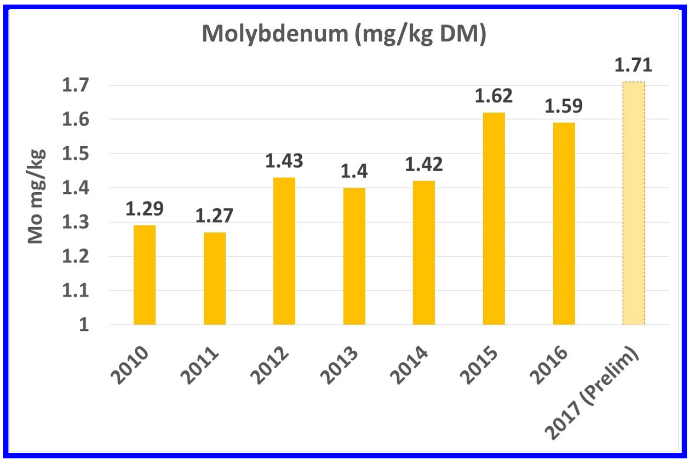
root absorption. With livestock dietary Iron requirement reported at between 50-100mg/kg DM, the levels found in grass silage are clearly well in excess of animal needs. A combination of minimising soil contamination at harvest, and reducing soil compaction through the introduction of a soil improvement 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 2017 data reporting the highest



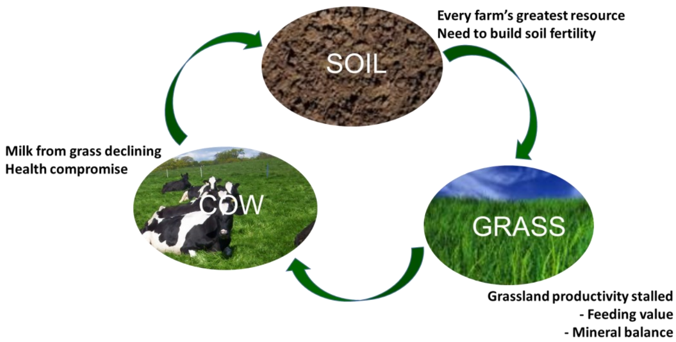
value (1.71 mg/kg) since this survey started in the 1990s. Over the period 2010-2017, Molybdenum has increased by 33%.
Of all the elements, Molybdenum is the most sensitive to anaerobic soil conditions. In well aerated soils Molybdenum is oxidised which renders it insoluble, thereby making it difficult 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.

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**

INTEGRATED NUTRITION



Forage Mineral Report

SAMPLE TYPE	**Grass Silage**	FARMER	**Mean of 431 samples**
SAMPLE REF	**2017**	FIELD ID	**2017**
DISTRIBUTOR	**Albion Lab Services**	POST CODE	
DISTRIBUTOR		DATE	**11 September 2017**

Dry Matter 31.2%

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	%	0.19	0.1	0.15	0.2	0.25	0.4
Potassium	K	%	2.80	0.5	1.5	2	2.5	5
Sodium	Na	%	0.29	0.1	0.2	0.25	0.3	0.4
Chloride	Cl	%	1.06	0.3	0.6	1	1.4	2
Sulphur	S	%	0.24	0.1	0.15	0.2	0.25	0.4
Cation-Anion Balance		meq/kg	391	50	100	200	300	500
Manganese	Mn	mg/kg	110	50	75	100	125	200
Copper	Cu	mg/kg	7.1	5	8	10	12	15
Zinc	Zn	mg/kg	30.5	25	40	60	80	130
Cobalt	Co	mg/kg	0.23	0.1	0.2	0.25	0.3	0.4
Iodine	I	mg/kg	0.43	0.25	0.5	1	1.5	2
Selenium	Se	mg/kg	0.09	0.05	0.1	0.15	0.2	0.25
Boron	B	mg/kg	5.2	1	2	4	6	10
Iron	Fe	mg/kg	401	50	100	150	200	350
Aluminium	Al	mg/kg	175	25	50	100	150	300
Molybdenum	Mo	mg/kg	1.71	0.1	0.35	0.8	1.25	2
Lead	Pb	mg/kg	0.72	1	2	2.5	3	10
Relative Copper Antagonism								
Soil Contamination Index								

Forage Year		2015	2016	2017	% Difference
No. of Samples		400	383	431	
Dry Matter	%	—-	29.9	31.2	—
Calcium	%	0.61	0.61	0.61	—
Phosphorus	%	0.36	0.36	0.36	—
Magnesium	%	0.18	0.18	0.19	—
Potassium	%	2.60	2.68	2.80	+4
Sodium	%	0.28	0.25	0.29	+16
Chloride	**%**	0.95	0.91	1.06	+16
Sulphur	%	0.23	0.23	0.24	—
CAB meq/kg		+375	+394	+391	—
Manganese	mg/kg	116	115	110	—
Copper	mg/kg	7.3	6.7	7.1	+6
Zinc	mg/kg	30.5	30.6	30.5	—
Cobalt	mg/kg	0.21	0.19	0.23	—
Iodine	mg/kg	0.81	0.67	0.43	-36
Selenium	mg/kg	0.08	0.08	0.09	—
Boron	mg/kg	—-	6.7	5.2	—
Iron	mg/kg	419	423	401	-5
Aluminium	mg/kg	181	167	175	+5
Molybdenum	mg/kg	1.62	1.68	1.71	—
Lead	mg/kg	—-	0.61	0.72	—
Relative Copper Antagonism		High	High	High	—
Soil Contamination—Titanium mg/kg		7.0	6.7	8.4	—

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

Results are expressed on a Dry Matter basis.

GRASS SILAGE 2017 -

EARLY SEASON MINERAL PROFILE

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 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 are relatively stable, 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 431 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.

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