THOMSON & JOSEPH LTD

The Mineral Specialists

GRASS SILAGE 2013 -MINERAL PROFILE

HEADLINES:

- **LATE START TO GRASS GROWING SEASON COUPLED WITH RAPID VEGETATIVE GROWTH RESULTS IN INCREASED POTASSIUM (+7%) AND LOWER CALCIUM (-8%).**
- **PHOSPHORUS MAINTAINED AT 2012 LEVELS DUE TO REDUCED CALCIUM.**
- **ALTHOUGH POTASSIUM IS HIGHER, CAB IS CLOSE TO 2012 VALUE.**
- **IDEAL WEATHER CONDITIONS AT GRASS HARVESTING HAS RESULTED IN A 25% REDUCTION IN SOIL CONTAMINATION.**
- **ESSENTIAL TRACE ELEMENTS ARE SIMILAR TO 2012 LEVELS.**
- **MOLYBDENUM REDUCED BY 10% DUE TO DRIER SOILS.**
- **IRON AND MOLYBDENUM ANTAGONISM TO COPPER AVAILABILITY IS REDUCED.**

RISK FACTORS:

- **HIGHER POTASSIUM AND CAB INCREASES RISK OF HYPOCALCAEMIA.**
- **LOWER SOIL CONTAMINATION WILL AID SILAGE FERMENTATION AND REDUCE COMPETITIVE PRESSURE FROM IRON ON ESSENTIAL TRACE ELEMENTS.**
- **LOWER MOLYBDENUM AND IRON REDUCES ANTAGONISTIC PRESSURE ON COPPER AVAILABILITY.**

What a difference a year makes! Last year's early warm spring followed by almost continual summer rainfall resulted in reduced yields of lower quality silage which had an extremely adverse mineral profile for cow health and productivity. This year didn't start much better as spring temperatures were well below average, with March recording a 3°C average lower temperature compared to the 1981-2010 mean.

These lower temperatures were associated with above average rainfall in May, and it was June before spring finally arrived. The inevitable late start to the grass growing season, by up to two months in some parts of the country, meant it was July/August before grass caught up. This delayed start to grass growth resulted in rapid compensatory growth once soils warmed up and the rain stopped in June. As a result, grass tended to be at an earlier growth stage when cut for silage and this is reflected in the average mineral profile. This trend is most obviously seen in the lower Calcium and higher Potassium values which would be indicative of early vegetative growth.

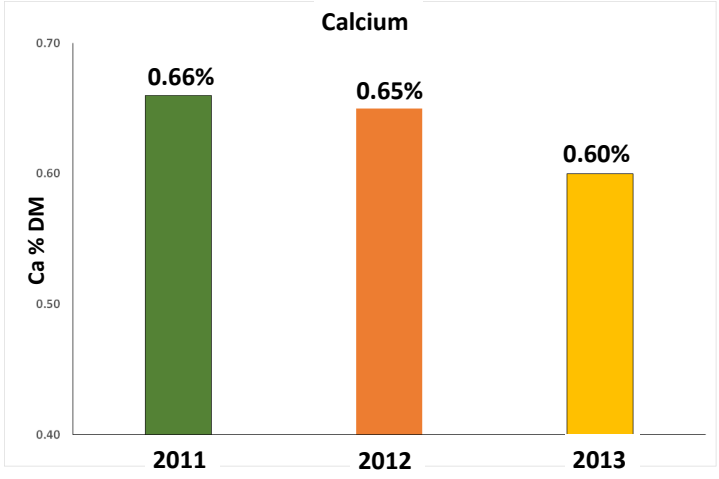
Another key feature of this year's grass silage mineral status is the markedly lower level of soil contamination, which is directly related to the drier conditions at grass harvesting. This aspect is also supported by the reduced levels of Iron, Aluminium and Cobalt, compared to 2012 grass silage.

So, a mixed bag of comparisons with 2012, which overall should be beneficial to cow health and fertility; the exception is Potassium, which maintains pressure on cow health at calving. Certainly a less challenging year than 2012, but with a mineral profile which needs to be recognised and acted on to ensure cow productivity is not compromised.

MACRO MINERALS

Calcium

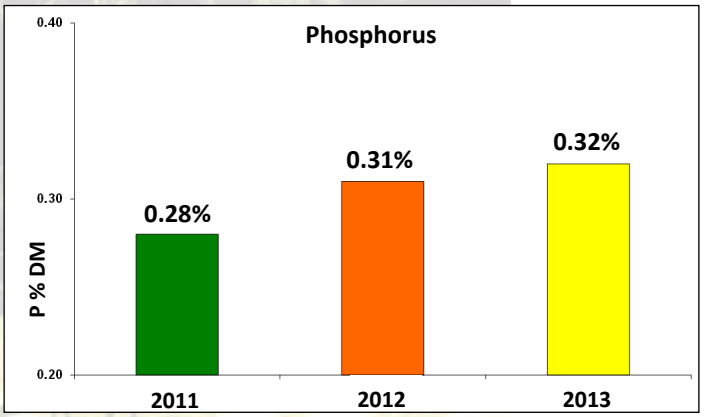
The different growth patterns of grass in the spring/summer of 2012 and 2013 is shown in these mean Calcium values. Calcium has a key role in supporting cell wall fractions and is therefore associated with the fibre fraction. In early vegetative



growth Calcium is low, but rises through the season as fibre increases. The mean 8% drop in Calcium levels to 0.60% is indicative of grass bring cut at an earlier growth stage than in previous years.

In feeding terms, the decline in Calcium content is equivalent to a reduced intake of 6g Calcium/day for dairy cattle exclusively dependent on grass silage. This is a fairly inconsequential drop in terms of animal performance and is within the natural variation found in feeds and forages. Consequently no action is recommended.

Phosphorus

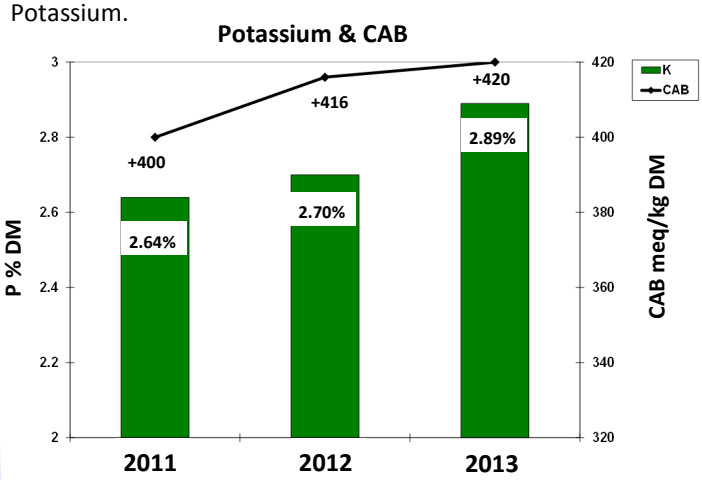


In contrast to Calcium, the Phosphorus mean levels are very similar between 2012 (0.31%) and 2013 (0.32%), but are a significant improvement on 2011. Of all the macro minerals, Phosphorus is the one most sensitive to soil conditions (pH, temperature, fertility and mineral balance) and plant growth. Phosphorus is the main driver for energy which is the key limiting factor for grass growth. An early warm spring in 2012 was undoubtedly the key influencing factor in increasing herbage Phosphorus values.

Although the 2013 growing season has been very different, the combination of grass being cut at an earlier stage and a lower Calcium level may well have helped to maintain average Phosphorus at a level which is capable of sustaining all classes of stock with the exception of dairy cattle. Phosphorus has the opposite trend to Calcium through the growing season in that it starts high and then declines as dry matter digestibility declines. This comparatively satisfactory average level of Phosphorus does not suggest a change in dietary supplementation is necessary.

Potassium & CAB

Mean Potassium jumped 7% in this year's silage to 2.89% compared with 2012 (2.70%). The key reason is the same as for the decline in Calcium and no change in Phosphorus, namely grass cut at an early vegetative growth stage. In addition, there is an inverse relationship between Potassium and Calcium which would have favoured an increase in Potassium.



The concern of a mean Potassium level which is 45% higher than the plant's requirement and nearly three times higher than the cow needs is, of course, a high risk factor for hypocalcaemia and milk fever.

Although Potassium is 7% higher this year its impact on Cation-Anion Balance (CAB) , which is another indicator of hypocalcaemia risk, is relatively small. This is because the compensating effect of Chloride anion has also increased for reasons that are not altogether clear. However, Chloride fluctuates widely and is probably most influenced by the timing of slurry applications and rainfall. The lower summer rainfall this year compared to 2012 may well be a factor. But the bottom line is that an average CAB at +420 meq/kg DM is close to the 2012 value of +416 meq/kg DM. So the risk from grass silage of hypocalcaemia remains high, and it will be important for dairy farmers to get their silage analysed and pre -calving diet balanced for minerals to reduce the incidence of hypocalcaemia and its attendant problems of retained cleansings, uterine infections, displaced abomasums, poor milk initiation mastitis, lower fertility, compromised immunity and ketosis.

TRACE ELEMENTS

Iron and Soil Contamination

The most dramatic change in the 2013 mineral profile of grass silage is the very substantial decline in soil contamination (-25% as measured by Titanium) and the associated trace elements of Iron (-19%) and Aluminium (-23%). The much improved weather this year when grass was cut is, of course, responsible. 2012 was a horrendous year for harvesting grass and these adverse conditions were responsible for maintaining Iron levels close to the 2011 mean. Iron in grass is not only influenced by soil contamination, but also soil, fertility and pH.

Forage Mineral Report

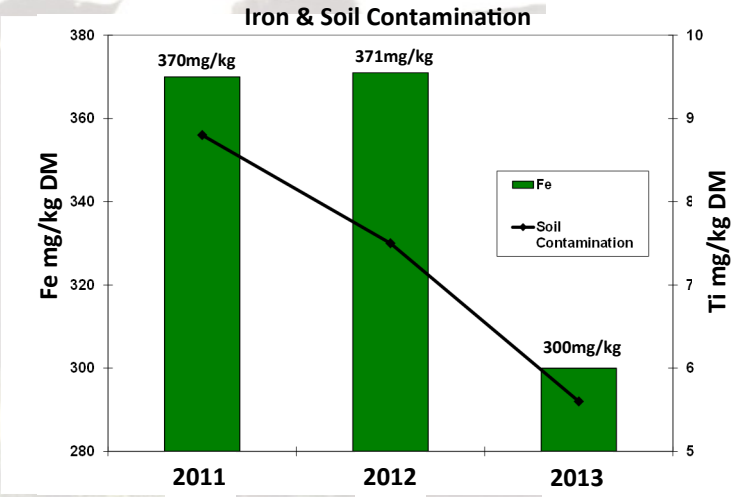
SAMPLE TYPE	Grass Silage	FARMER	Mean of 392 Samples
SAMPLE REF	2013	FIELD ID	2013
DISTRIBUTOR	Thomson & Joseph Ltd.	POSTCODE	
DISTRIBUTOR'S REF		DATE	12 September 2013

MINERAL ELEMENT (DM BASIS)			ASSAY	VERY LOW	LOW	MEAN	HIGH	VERY HIGH
Calcium	Ca	%	0.60	0.3	0.5	0.6	0.7	0.9
Phosphorus	P	%	0.32	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	%	2.89	0.5	1.5	2	2.5	5
Sodium	Na	%	0.24	0.1	0.2	0.25	0.3	0.4
Chloride	Cl	%	1.09	0.3	0.6	1	1.4	2
Sulphur	S	%	0.19	0.1	0.15	0.2	0.25	0.4
Cation-Anion Balance		meq/kg	418	50	100	200	300	500
Manganese	Mn	mg/kg	120	50	75	100	125	200
Copper	Cu	mg/kg	7.5	5	8	10	12	15
Zinc	Zn	mg/kg	31.0	25	40	60	80	130
Cobalt	Co	mg/kg	0.13	0.1	0.2	0.25	0.3	0.4
Iodine	I	mg/kg	0.68	0.25	0.5	1	1.5	2
Selenium	Se	mg/kg	0.08	0.05	0.1	0.15	0.2	0.25
Iron	Fe	mg/kg	300	50	100	150	200	350
Aluminium	Al	mg/kg	127	25	50	100	150	300
Molybdenum	Mo	mg/kg	1.37	0.1	0.35	0.8	1.25	2
Relative Copper Antagonism								
Soil Contamination Index								

Forage Year		2011	2012	2013	% Difference 2013 v 2012
No. of Samples		369	342	392	
Calcium	%	0.66	0.65	0.60	-8
Phosphorus	%	0.28	0.31	0.32	—-
Magnesium	%	0.19	0.19	0.18	—-
Potassium	%	2.64	2.70	2.89	+7
Sodium	%	0.31	0.24	0.24	—-
Chloride	%	1.04	0.93	1.09	+17
Sulphur	%	0.19	0.19	0.19	—-
CAB meq/kg		+400	+416	+420	—-
Iron	mg/kg	370	371	300	-19
Aluminium	mg/kg	171	165	127	-23
Manganese	mg/kg	117	123	120	—-
Copper	mg/kg	6.8	7.9	7.5	—-
Zinc	mg/kg	30.5	31.3	31.0	—-
Cobalt	mg/kg	0.13	0.16	0.13	-19
Iodine	mg/kg	0.89	0.75	0.68	-9
Selenium	mg/kg	0.05	0.06	0.08	—-
Molybdenum	mg/kg	1.14	1.53	1.37	-10
Relative Copper Antagonism		High	Very High	High	—-
Soil Contamination—Titanium		8.8	7.5	5.6	-25

Data covers the period 1st June to 10th September.

Results are expressed on a Dry Matter basis.



When soils are compacted and anaerobic then Iron uptake is exaggerated and this may help to explain the discrepancy between the Iron and Titanium levels; the latter being used as a marker for soil contamination. The fact that Iron levels, on average, have fallen dramatically this year will help to take some of the pressure off Copper and other trace elements Iron competes with for gut absorption.

Published research has demonstrated that Iron, contributed by soil contamination, becomes solubilised and more chemically reactive and oxidative in the acidic and anaerobic conditions found in a silage clamp. In this highly reactive form, Iron readily binds with Copper and Sulphur in the rumen to form insoluble Iron-Copper Sulphides which reduce Copper availability, thereby increasing the dietary requirement. In addition, reactive Iron will increase oxidative stress in cattle to the detriment of cow health and productivity. An increased level of dietary supplied antioxidants (Vitamin E, Selenium and Copper) are necessary to neutralise the potentially damaging effects of "oxidative" Iron.

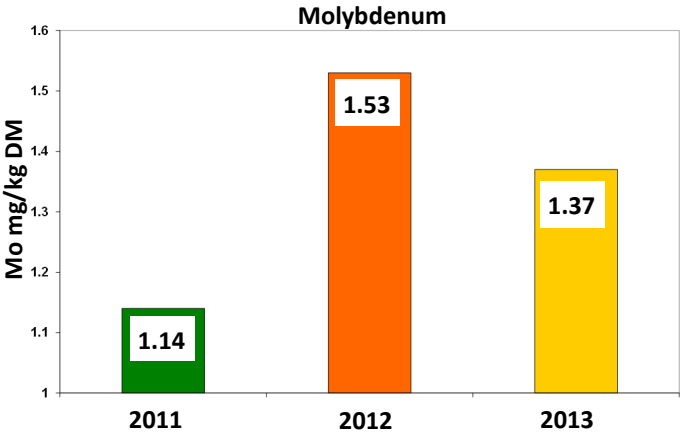
Although the risk to cow health from excess forage Iron is reduced this year, the average level suggests a significant number of dairy herds will be at risk to the depressive effect of high forage Iron levels on cow health and fertility.

Finally, it is important to note that the decline in average Cobalt levels by 19% mirrors that of Iron. As Cobalt levels in soil are about two hundred times higher than is found in the plant Cobalt is also a useful marker for soil contamination.

Molybdenum

Improved weather conditions at grass harvesting would be expected to reduce mean Molybdenum and indeed this is the case, with a 10% reduction from 1.53mg/kg (2012) to 1.37mg/kg (2013). Molybdenum is highly sensitive to soil conditions. Wet, anaerobic conditions are ideal for the formation of chemically reduced and highly soluble forms of Molybdenum, which can be readily absorbed by the roots. Molybdenum is, of course, a well recognised Copper antagonist through its actions in the rumen to form insoluble Copper-Molybdenum-Sulphur (thiomolybdates). However, Molybdenum also directly interferes with the action of hormones, specifically oestrogen, that impact fertility.

In recent years our understanding of Molybdenum interactions has increased to the point where effective Copper supplement strategies involving up to four different Copper additives have been introduced. The notion of "sacrificial" Copper to bind both Molybdenum and Iron to reduce their antagonistic effects has become a regular part of dietary Copper supplementation, in support of the Copper dependent processes of energy utilisation, fertility and health.



The reduced antagonism to Copper absorption this year from Molybdenum, coupled with the lower competitive effect of Iron, has resulted in a reduction in the dietary requirement equivalent to 300mg/kg Copper in a dairy mineral supplement fed at 150g/day. This assumes all the forage component of the diet is derived from grass silage. For forage regimes based on a 50% grass silage and 50% maize or whole crop silage, the estimated reduction in Copper requirement is equivalent to 125mg/kg less Copper in a mineral supplement, compared to 2012. However, it is important to reiterate that even in a good summer for grass growth, as we have experienced in 2013, antagonism from both Iron and Molybdenum remains high.

When designing a Copper supplementation programme for dairy cows, it is important to:

- Analyse grass silage for minerals to provide information on the level of Copper antagonists (Sulphur, Molybdenum, Iron).
- Use this data in a mineral formulation program to calculate the mineral composition of the total diet using standard mineral values for alternative forages, feed materials and concentrates.
- Only consider total diet Copper supplementation above 20mg/kg if the combined antagonism from Sulphur,

Molybdenum and Iron is above average values

- Take account of Copper supplied from all sources (boluses, drenches, blocks) when formulating balancing mineral supplements.
- Provide the dairy farmer with a Copper Audit to enable justification of the dietary Copper supplementation programme.

Actions based on analytical information are important to prevent both Copper toxicity and the more prevalent and economically damaging Copper deficiency diseases.

Also remember the answer to Copper antagonism lies in the soil. Improving soil fertility in the longer term can cause dramatic reductions in the forage levels of Iron and Molybdenum, as well as improving grassland productivity.

SUMMARY

Weather patterns have been on a roller coaster over the past three years, with 2013 surprising us after a very cold spring with the warmest summer in living memory. In general, the average mineral profile of Grass Silage has improved this season to the benefit of cow health and productivity, however, significant risks still remain, notably Hypocalcaemia, Infertility and Oxidative Stress.

This review relates only to the mean of the first 400 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.

Only by using specific farm data can balancing mineral supplements be formulated and targeted to livestock groups with confidence that they will support the overall dietary strategy of improving livestock production.

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 Action Plan to improve soil fertility, grassland production and forage mineral balance**

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