

SIP



SUSTAINABLE INTENSIFICATION
RESEARCH PLATFORM



SCIENCE, POLICY AND PRACTICE NOTE 4 Sustaining Trace Elements in Grazing Sheep





The Issue

Sheep systems generate high quality protein outputs from land that is often unsuitable for other forms of agricultural production. Grass leys are also increasingly being adopted in arable rotations as a means of weed control and soil improvement. In many grazing situations, the only nutrients that a sheep will receive are from the pasture, with no supplementary/additional feed. Whilst this reduces costs, it may compromise production if sheep become deficient in the **trace elements** needed for development, growth, and the health of the flock. A sheep's requirement for trace elements varies throughout the year (e.g. with higher levels required to raise fertility, or when lambs are undergoing rapid muscle development during growing). It is also known that trace element levels vary in grass according to a number of factors, including season, soil type and pH, and the plant species being grazed.

Trace Elements – minerals within the body in mg/kg concentrations rather than the g/kg quantities for macro elements (Ca, P, Mg, K, Na etc). Some of these are essential for normal function and the major elements of issue in sheep are cobalt, selenium, copper and iodine. Trace elements are not actively stored and rely on dietary supply and passive storage via elevated status and tissue turnover.

SIP's Response

Our work aimed to explore the seasonality within grazed pasture and leys of the key trace elements for sheep production:

- **cobalt** for ruminal synthesis of vitamin B12, which is required for propionate and one carbon metabolism; deficiencies of which will result in a loss of appetite, decreased growth rate and conditions such as pine where sheep show depraved appetites (eat soil, etc.);
- **selenium** plays a key role in antioxidant function, with deficiencies resulting in decreased immunity, production and ultimately conditions such as white muscle disease;
- **copper** has roles in immune function, wool growth and energy metabolism; copper deficiency during gestation can cause swayback. Copper toxicity is another consideration, especially for sheep as different sheep breeds are less tolerant of high copper e.g. Texel, whilst others are more likely to have deficiency issues e.g. Swaledale. Copper toxicity can be an especial problem at post grazing housing. We also

monitored the elements (iron, sulphur and molybdenum) that can interact with copper – it is the sudden decrease in iron at housing along with potential increase in copper due to other feeds than can cause the toxicity.

Simulated grazing samples (see Figure 1) were collected on 17 occasions from 15 fields on one farm across two grazing seasons (2015-16) and these were analysed for trace element composition by ICP-MS after microwave acid wet digestion. Blood samples were taken from un-supplemented sheep to compare their trace element status with the concentrations in the grazed pasture.



Figure 1: "Pinch" sampling of pasture. The gloved hand (to prevent contamination of samples) pinches grass to be 'grazed' which is 'bitten' off using the scissors and collected. Grass collected should be representative of what is being grazed e.g. avoid areas of faecal and urine soiling and plants not readily consumed.

What SIP Learnt

We found that the trace element status of the sheep grazing the pasture is dependent on the trace element composition of the pasture.

Previous nutrition also had a carry-over effect. Most of the sheep sampled were housed prior to lambing, and fed a ration containing trace elements. The elevated selenium and cobalt status from consuming the mineralised ration whilst housed was able to ameliorate the effect of low selenium and cobalt pastures in the spring after turnout. There was a slow reduction in the elevated glutathione peroxidase activity and vitamin B12 concentrations in response to the marginal grazing status.

The cobalt status of the sheep was low in the summer into the early autumn, reflecting the low cobalt status of the grazed ryegrass at this time of year. The selenium status of grazed grass was generally below requirements and selenium status was marginal in most fields.



Work in association with Bangor University showed that although pasture improvements (fertiliser application, liming, and re-seeding) improved grass yield (hence could increase sheep stocking density), they lowered the trace element status of the pasture (decreased manganese, zinc and copper, with increased molybdenum and iron concentrations) and within the sheep grazing those pastures (decreased zinc, cobalt, manganese and selenium status at weaning).

In summary:

The time of year affected the trace element composition of grass:

- We found that cobalt levels were lower in summer/early autumn and higher in spring
- Iron levels were similarly higher in early spring and late autumn. Iron interacts with copper and sulphur to reduce copper availability within the rumen and beyond lowering absorption and allowing more thiomolybdate toxicity

The weather affected trace element composition of grass:

- Cobalt concentrations in grass were lower in the dry spring of 2015 (~70-90% of 1981-2010 rainfall average), compared to the wet spring of 2016 (~110% of 1981-2010 rainfall average)

The sward species composition affected the trace element status of grazing sheep:

- Pastures containing white and red clover had higher cobalt concentrations than predominantly ryegrass swards

How to improve the trace element status in grazing sheep

Targeted supplementation of trace elements that are shown to be deficient in the grazing and/or in the animal can be beneficial to livestock performance. However, it is important to remember that supplementation beyond adequate status is unlikely to yield any further benefits and is only going to add to costs. Analysing the trace element status is therefore of importance prior to any form of supplementation.

The trace element status of the animal (through blood sampling) reflects recent history, whilst grass analysis tells us about the levels in the forage that they are about to eat. It may be useful to compare across seasons and years to identify the times when trace element levels fall to a point where supplementation can be justified, or where a natural increase in levels is to be expected in the pasture, and supplementation may not be required. For example, we found cobalt status was low in animals and pasture in early autumn, but we saw a late autumn

increase in cobalt concentration of the pasture (Figure 2) and a corresponding increase in the cobalt status of the animal.

The application of a trace element bolus is regarded as the most reliable form of supplementation. However, it is not the only option as changes in management regimes can be effective such as grazing swards that include clovers to enhance mineral content (clovers have a higher summer cobalt concentration than ryegrasses).

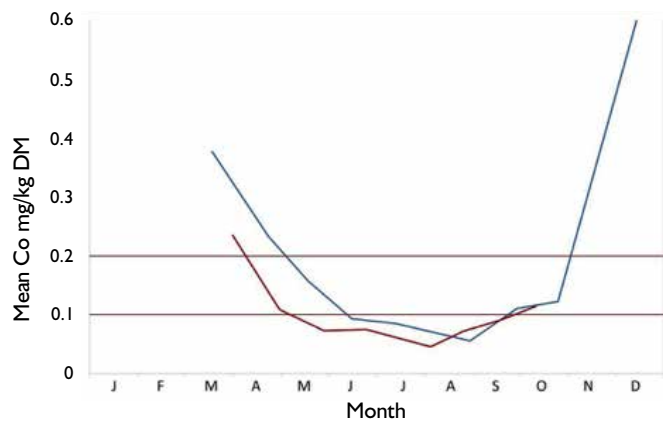


Figure 2: Mean cobalt concentrations (mg/kg DM) for predominantly ryegrass pastures (permanent and a new ley) for 2015 (red) and 2016 (blue). The lower cobalt concentration in the spring of 2015 correlates with a dryer spring. The horizontal lines are the recommend cobalt requirements for sheep as published by NRC (National Research Council, USA) which are used as industry standards in UK.

Opportunities for Policy and Practice

Ensuring adequate levels of trace elements is an important and often over-looked part of efficient sheep production systems. However, given the many factors that influence sheep trace element status, it is often difficult to determine whether supplementation is needed and therefore whether it can be justified. This applies in a range of grazing systems from short-term arable leys to upland pasture. This work has further confirmed the importance of sampling and analysing trace element levels in sheep before taking measures to supplement. It has also shown the clear correlation between trace element levels in sheep and the pastures that they graze.

Auditing the flock to determine trace element status is relatively easy, but should involve a team of farmer, nutritionist/consultant and farm vet. The team can then determine which fields and animals need sampling and it should be remembered that sometimes the results are more relevant to the time around sampling next year than when results are received this year – it should be an ongoing process building on history and can be included in the flock health plan.



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Further Resources

Kendall, N.R. and Bone P. (2017) *Farm and laboratory assessment of mineral availability in ruminants*. In: *Recent Advances in Animal Nutrition 2015* (Eds Garnsworthy, P.C. and Wiseman, J.) In Press

Kendall, NR and Bone PA (2014) 'Sheep mineral supplements: what do they do and when should they be used?' *Animal Health Advisor* August 6-8

Kendall, NR (2014) 'Understanding and advising on the need for mineral supplements in livestock.' *Animal Health Advisor* June 12-13

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The Sustainable Intensification Research Platform (SIP) is a multi-partner research programme comprising academia, farmers, industry experts, environmental organisations, and policymakers.

Funded by Defra and the Welsh Government, the platform explores the opportunities and risks of Sustainable Intensification (SI) from a range of perspectives and landscape scales across England and Wales.

The Platform, run from 2014-17, has investigated ways to increase farm productivity, reduce environmental impacts, and increase the benefits that agricultural land provides to society.



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Rhaglen ymchwil aml-bartner yw'r Plafform Ymchwil i Ddwystrau Cynaliadwy (SIP) sy'n cynnwys academaïa, ffermwyr, arbenigwyr y diwydiant, sefydliadau amgylcheddol, a gwneuthurwyr polisi.

Arfennir y plafform gan Defra a Lywodraeth Cymru, ac mae'n archwilio'r cyfioedd a'r risgiau sydd ynghlwm wrth Ddwystrau Cynaliadwy o amrywiaeth o safbwyntiau a graddfeydd tirwedd ar draws Cymru a Lloegr.

Mae'r Plafform, a oedd yn gweithredu o 2014-17, wedi ymchwilio i ffyrdd o gynhyrchiant ffermydd, lleihau effeithiau amgylcheddol, a chynyddu manteision tir amgelyddol i'r gymdeithas.

Kendall, N.R. and Bone R (2017) *Farm and laboratory assessment of mineral availability in ruminants*. In: Recent Advances in Animal Nutrition 2015 (Eds Garnsworthy, R.C. and Wiseman, J.) In Press

Kendall, N.R. and Bone R (2014) 'Sheep mineral supplements: what do they do and when should they be used?' *Animal Health Advisor* August 6-8

Kendall, N.R. (2014) 'Understanding and advising on the need for mineral supplements in livestock.' *Animal Health Advisor* June 12-13

Adnoddau pellach

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all-had) wedi gwella pwsau'r borta (ac felly gallai gynyddu dwysedd stocio defaid), roeddent yn gostwng statws effen hybrid y tir pori (llai o fanganis, sinc a chop, gyda chynnydd yn y crynodiadau molybdenwm a haearn) ac o fewn y defaid a oedd yn pori'r tir hwmn (statws sinc, cobalt, manganis a seleniwm is ar addeg diddymu).

Yn gryno:

Roedd adeg y flwyddyn yn effeithio ar gyfansoddiad effen hybrid y borta:

- ▶ Canfuwyd bod lefelau cobalt yn is yn yr haf/ar ddechrau'r hydref ac yn uwch yn y gwanwyn
- ▶ Yn yr un modd roedd lefelau haearn yn uwch ar ddechrau'r gwanwyn ac ar ddiwedd yr hydref. Mae haearn yn rhyngweithio a chopr a sylffwr i leihau argaeledd copr o fewn y rwmn a thu hwnt i leihau amsugno a chaniatâu mwy o wenwyndra thiomolybdate

Roedd y tŷwydd yn effeithio ar gyfansoddiad effen hybrid y borta:

- ▶ Roedd crynodiadau cobalt mewn porta yn is yn ystod gwanwyn sych 2015 (~70-90% o gyfartaledd glawiad 1981-2010), o'u cymharu â gwanwyn gwlyb 2016 (~110% o gyfartaledd glawiad 1981-2010)

Roedd cyfansoddiad rhywogaethau porta yn effeithio ar statws effen hybrid y defaid pori:

- ▶ Roedd gan dir pori a oedd yn cynnwys miliion gwlyn a hoch grynodiadau cobalt uwch na phorta a oedd yn cynnwys rhygwellt yn bennaf

Sut i wella statws effen hybrid mewn defaid pori

Gall ychwanegu effennau hybrid sy'n ddiffygiol yn y borta a/neu yn yr antfai mewn modd wedi'i dargedu fod yn fuddiol i berfformiad da byw. Fodd bynnag, mae'n bwysig cofio bod ychwanegu y tu hwnt i statws digonol yn annhebygol o arwain at ragor o fantision ac yn debygol o gynyddu costau. Felly mae'n bwysig dadansoddi'r statws effen hybrid cyn cyflwyno unrhyw atchwanegiadau.

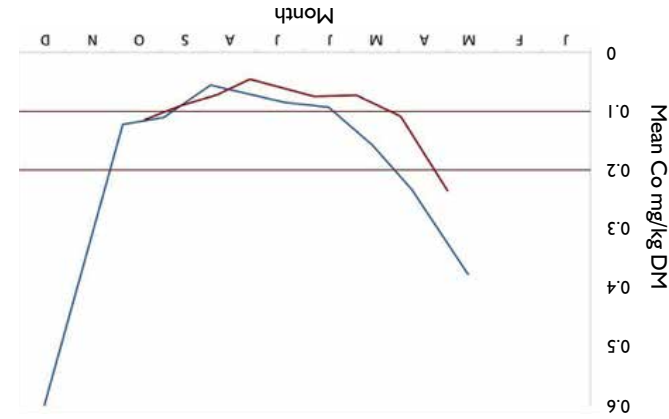
Mae statws effen hybrid yn antfai (drwy gasglu samplau gwaed) yn adlewyrchu hanes diweddar, tra bod dadansoddiad o laswellt yn dweud wrthym am y lefelau yn y portiant maent ar fin ei fwyta. Gall fod yn ddehnyddiol cymharu ar draws tymhorau a blynyddoedd i nodi'r adegau pan fydd lefelau effennau hybrid yn disgyn i bwynt lle y gellid cyflwyno atchwanegiadau, neu lle y gellid disgwyl cynnydd naturiol mewn lefelau yn y tir pori, ac na fyddai angen atchwanegiadau. Er enghraifft, canfuwyd bod statws cobalt yn isel mewn antfeliadau a thir pori ar ddechrau'r hydref, ond gwelwyd cynnydd ar ddiwedd yr hydref yn y crynodiad cobalt yn y tir pori (Ffigur 2) a chynnydd cyfatebol yn statws cobalt yr antfai.

Cyflioedd ar gyfer Polisi ac Ymarfer

Mae sicrhau lefelau digonol o effennau hybrid yn rhan bwysig o systemau cynhyrchu defaid ac yn un a gaiff ei dystyru yn aml. Fodd bynnag, o gorio'r ffactorau niferus sy'n dylanwadu ar statws effen hybrid defaid, yn aml mae'n anodd pennu a oes angen atchwanegiadau ac felly a ellid cyflwynu hyn. Mae hyn yn berthnasol mewn amrywiol systemau pori o wndwr ar ymor byr i dir pori ucheldir. Mae'r gwaith hwn wedi cadarnhau ymhellach bwysigrwydd y broses o samplu a dadansoddi lefelau effennau hybrid mewn defaid cyn mynd ati i gyflwyno atchwanegiadau.

Mae hefyd wedi dangos y gydborthynas glir rhwng lefelau effennau hybrid mewn defaid a'r tir y maent yn ei pori.

Mae archwilio'r ddiadell i bennu statws effen hybrid yn gymharol hawdd, ond dylai gynnwys tîm o bobl sy'n cynnwys ffermwr, maethegydd/ymgyngorwydd a milleddyg fferm. Yna, gall y tîm bennu pa gaeau ac antfeliadau y mae angen casglu samplau ar eu cyfer a dylid cofio bod y canlyniadau weithiau yn fwy penodol i'r amser ar gyfer casglu samplau yn y flwyddyn ddilynol yn hytrach na phryd y caiff y canlyniadau eu derbyn eleni – dylai fod yn broses barhaus sy'n seiliedig ar hanes ac y gellid ei chynnwys yng nghyllun technyd y ddiadell.



Ystyrir mai bolws effen hybrid yn yr atchwanegiad mwyaf dbyrnadwy. Fodd bynnag, nid dyma'r unig opsiwn oherwydd gall newidiadau mewn cyfndrefnau rheoli fod yn effeithiol, fel tir pori sy'n cynnwys miliion i gynyddu'r mwyneuau a gynhwysir ynddo (mae gan feillion grynodiad cobalt uwch yn yr haf na rhygwelltau).

Ffigur 2: Crynodiadau cobalt cymedr (mg/kg DM) ar gyfer tir pori sy'n rhygwellt yn bennaf (parthol a gwmdwn newydd) ar gyfer 2015 (coch) a 2016 (glas). Mae'r crynodiad cobalt is yn ystod gwanwyn 2015 yn cyd-fynd â gwanwyn sychach. Y llunellau llorweddol yw'r gofynion cobalt a argymhellir ar gyfer defaid fel y cyhoeddwyd gan NRC (Cyngor Ymchwil Cenedlaethol, USDA) a ddefnyddir fel safonau diwydiant yn y DU.



Y Problem

Mae systemau defaid yn creu cynnyrch proteïn o ansawdd uchel o dir sy'n aml yn anadlas ar gyfer mathau eraill o gynhyrchu. Mae gwndwn porta hefyd yn cael eu mabwysiadu'n amaethyddol. Mae gwndwn porta hefyd yn cael eu mabwysiadu'n gynyddol mewn cyichdroadau â'r fel dull o reoli chwyn a gwella'r pridd. Mewn sawl sefyllfa bori, bydd yr unig faethymau y bydd datfad yn eu cael yn dod o'r tir pori, heb unrhyw bortiant ategol/chwanegol. Er bod hyn yn lleihau costau, gall arwain at gyfaddawdu ar gynhyrchu os bydd diffyg elfennau hybryn sydd eu hangen ar ddefaid er mwyn i'r ddiadell allu datblygu, tyfu a bod yn iach. Mae'r elfennau hybryn sydd eu hangen ar ddefaid yn amrywio drwy gydol y flwyddyn (e.e. bydd angen lfeiau uwch er mwyn cynyddu ffrwythlondeb, neu pan fydd cyhyrau wryn yn datblygu'n gyflym wrth iddynt dyfu). Gwyddom hefyd fod lfeiau elfennau hybryn yn amrywio mewn porta yn dibynnu ar nifer o ffactorau, gan gynnwys y tymor, y math o bridd a pH, a'r rhywogaethau o blanhigion sy'n cael eu pori.

Elfennau Hybryn – mwyau o fewn y corff mewn cryodiadau mg/kg yn hytrach na meiniau g/kg ar gyfer elfennau macro (Ca, P, Mg, K, Na ac ati). Mae rhai o'r rhain yn hanfodol er mwyn gallu gweithredu a'r prif elfennau pwysig mewn defaid yw cobalt, seleniwm, copr ac iodid. Ni chaffi elfennau hybryn eu storio'n weithredol ac maent yn dibynnu ar gyflenwad dietegol a storio goddefol drwy statws uchel a throsiant meinwe.

Ymateb SIP

Nod ein gwath oedd ymchwilio i natur dymhorol yr elfennau hybryn ar gyfer cynhyrchu defaid o fewn tir pori a gwndwn:

- **cobalt** ar gyfer synthesyddio fitamin B12 o fewn y rwmen, sydd ei angen ar gyfer metabolaeth propionad ac un carbon; bydd diffygion mewn perthynas â hyn yn arwain at gollir archwaeath, cyfradd tyfu is ac amodau fel diffyg colbat (neu pine) lle mae defaid yn dangos archwaeath rhyfedd (bwyta pridd, ac ati);
- mae **seleniwm** yn chwarae rhan allweddol mewn perthynas â swyddogaeth gwirthocsidd, gyda diffygion yn arwain at lai o imwneidd, lai o gynhyrchu ac yn pen draw amodau fel clefyd cyhyrau gwyn;
- mae **gan gopr** ran i'w chwarae hefyd mewn perthynas â swyddogaeth y system imiwneidd, twf gwlan a metabolaeth ynni; gall diffyg copr yn ystod beichiogrwydd achosi cefn gwam. Mae gwenwyntra copr yn ystyriaeth arall, yn enwedig ar gyfer defaid gan fod bridiau gwahanol o ddefaid yn llai able i oddef lfeiau copr uchel e.e. Texel, tra bod eraill yn fwy tebygol o ddiodder yn sgil diffyg copr e.e. Swaledale. Gall

Yr Hyn a Ddysgodd SIP

Canfuwyd bod statws effen hybryn y defaid a oedd yn pori ar y tir yn dibynnu ar gyfansoddiad effen hybryn y tir pori.

Catodd maetheg flaenorol effaith drosglyddadwy hefyd. Catodd y rhan fwyaf o'r defaid a samplwyd eu lleiya cyn wyna, a chwasant ddogan a oedd yn cynnwys elfennau hybryn. Llwyddodd y statws uwch o ran seleniwm a chobalt o ganlyniad i fwyta'r dogan llawn mwyau tra roeddent yn cael eu lleiya i wella effaith y tir pori â lfeiau isel o seleniwm a chobalt yn y gwanwyn ar ôl troi'r anifeiliaid allan. Gwelwyd gostyngiad araf o ran gweithgarnwch peroxidase glutatione uwch a chrynodadau fitamin B12 mewn ymateb i'r statws pori ymlo.

Roedd statws cobalt y defaid yn isel yn yr haf ac ar ddechrau'r hydref, gan adlewyrchu statws cobalt isel y rhyngweli a borwyd ar yr adeg hon o'r flwyddyn. Roedd statws seleniwm y borfa a borwyd yn gyffredinol is na'r gofynion ac roedd y statws seleniwm yn ymlo yn y rhan fwyaf o'r caeau.

Dangosodd gwath mewn cydwethrediad â Phrifysgol Bangor er bod gwelliannau i'r tir pori (defnyddio gwrtaith, calchun, ac



Figur 1: Samplu "pnsiad" o dir pori. Mae'r llaw mewn maneg (er mwyn atal y samplau rhag cael eu halogi) yn pinsio'r borfa sydd i'w phori sy'n cael ei bon ddefnyddio'r siswm a'i chasglu. Dylai'r borfa a gesglir gynyddio'r hyn sy'n cael ei bon e.e. osgoi arddloedd lle mae bow ac wrn a phlanhigion na ellid eu bwyta'n hawdd

Casglwyd samplau pori wedi'u hetelychu (gweler Figur 1) ar 17 achysur o 15 cae ar un fferm ar draws dau dymor pori (2015-16) a chwasant eu dadansoddi ar gyfer cyfansoddiad elfennau hybryn gan ICP-MS ar ôl treulioad gwlyb asid microdon. Cymeryd samplau gwaged gan ddefaid na chwasant atchwangladau er mwyn cymharu eu statws o ran elfennau hybryn gyda'r crynodadau yn y tir pori.

gwenwyntra. sydyn mewn haearn yn y llely ynghyd â chynnydd posibl mewn copr o ganlyniad i fwyddedd eraill sy'n gallu achosi



NODYN GWYDDONIAETH, POLISI AC YMARFER 4
Cynnal Effennau Hybrin mewn
Defaid Pori

