Mob-grazing case study – results for farms

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Research was funded by the Biotechnology and Biosciences Research Council (BBSRC) and funded through the South-West Doctoral Training Partnership (SWDTP).

Contents

1 Introduction

Below are the results for the research conducted across three mob-grazing farms. The purpose of the work was to take a first-glance scientific look at mob-grazing. There are a wide range of reported benefits to the practice, particularly within the organic sector. Benefits have been reported to pasture productivity, soil quality, local ecology and biodiversity, epidemiology, and more. However, these are largely anecdotal and, whilst founded on scientific principle, there has not been specific scientific research to-date. All relevant research in this field looks into rotational grazing in general, which is only partially representative of mob-grazing. As an example Briske et al. (2008) found that rotational grazing (of rangeland) increased pasture production and animal production.

Throughout this document, Farms are referred to by letters. Farms A, B, and C are organic farms, practicing mob-grazing. Farm X is Rothamsted Research's Farm Platform at North Wyke. Evidently, and as shown by the results, no individual farm within the study is 'better' than any other. Whilst an individual farm may yield more favourable results for a particular metric, it all balances out. It is also important to consider the variations in factors such as climate, soil type, stocking density, and the grazing of other animals, all of which are highly influential.

2 Soil organic matter

Soil organic matter was measured by removing herbage from the top of the soil and taking 8.5cm deep soil cores. Stones and foreign debris were removed from the samples, which were then dried at 65°C until a constant weight. After drying, soils were furnaced at 360°C for >6hrs to determine organic matter content as a proportion of dry matter.

Within the graph the asterisks represent the mean value, the line in the centre of each box is the median value. The top and bottom borders of the box represent Quartile 1 and Quartile 3, whilst the 'whiskers' show the range. Numbers above the plots represent statistical difference. If two plots share a number in common (it need only be one number), those two results are not statistically different to one another. The classifications of soil quality as "very low" to "very high" are based on FAO definitions outlined in a report on topsoil organic matter across the whole of Europe (Fraters et al., 1993).

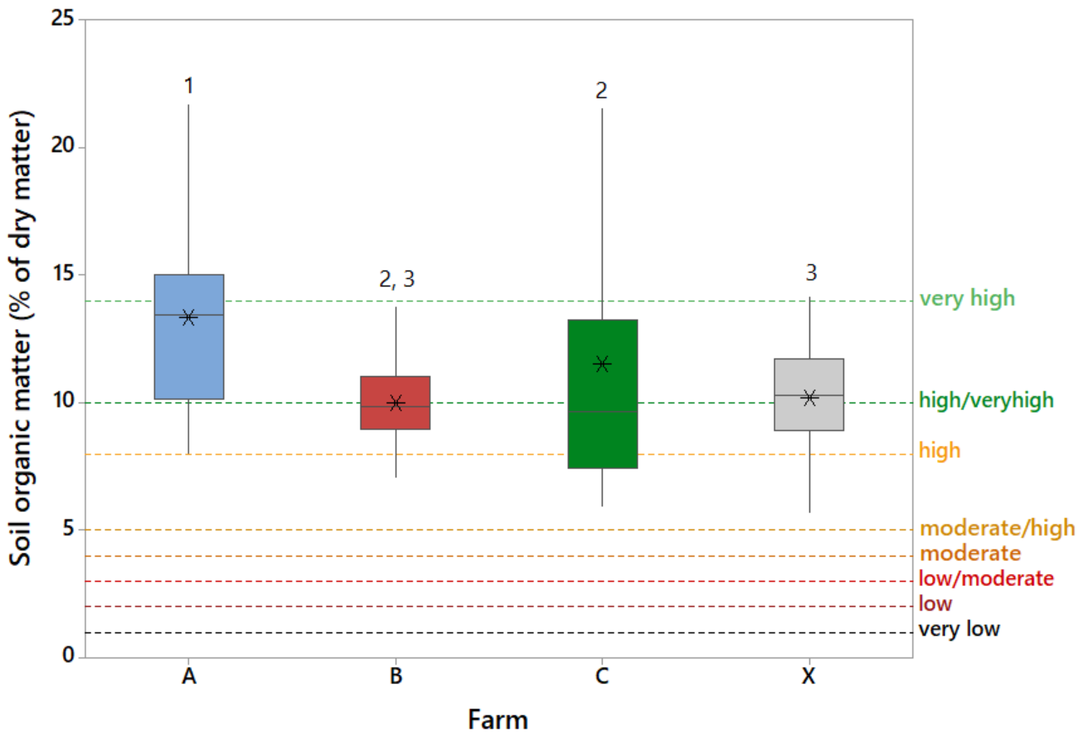

Figure 1 - Boxplots of soil organic matter (as a percentage of soil dry matter) across the four farm sites. Asterisks represent sample mean. Numbers above boxplots represent statistical groupings, as defined by a Tukey test. Groups sharing the same number are not significantly different. Reference lines on soil organic matter classification are providing in-line with FAO definitions (Fraters et al., 1993).

All farms had soil classified as high/very high (Fraters et al., 1993), but showed significant differences between each other. Within the studied farms, Farm A had the highest soil organic matter content. Climate is one potential driver of this, with Farm A being the warmer and wetter than Farms B and C. Findings by Burke et al., (1989) found that precipitation was positively linked with soil organic matter, however also commented that high soil clay content can also lead to high soil organic matter. Farm A sits on mudstone, which has a high clay content and therefore may be somewhat responsible for the high organic matter observed. However, Farm X is also based on mudstone, yet has the lowest soil organic matter content, although that clay is deeper (British Geological Survey, n.d.). The higher forage biomass of Farms A-C, compared to X, may promote soil organic matter content due to the more extensive and diverse root systems required to support this flora. This high biomass could also have a stabilising effect on the O-horizon and topsoil by creating a microclimate, trapping moisture and reducing temperature fluctuations, creating a more stable soil environment. Whilst the significant differences observed are not dramatic, their importance should not be understated. Soil is the biological foundation of pasture systems and is essential for their long-term productivity and resilience.

3 Parasite burdens

Parasitic nematode eggs were counted in faecal samples by way of a flotation technique using Flotac and Mini-Flotac apparatus. Only gastrointestinal nematodes were counted (i.e. no fluke, no tapeworm), although no liver fluke eggs were found in any samples from any farms. The first chart represents the average (mean) eggs per gram of all animals' sampled on each farm, across the entire season. The dots represent mean whilst the whiskers represent standard deviation from the mean.

The prevalence of infection varied between farms and was highest on farm A, with 25.0% of faecal samples testing positive for GIN eggs, compared to 8.3%, 13.3%, and 19.3% on farms B, C, and X, respectively. The second chart represents the egg counts only for the animals which had infections.

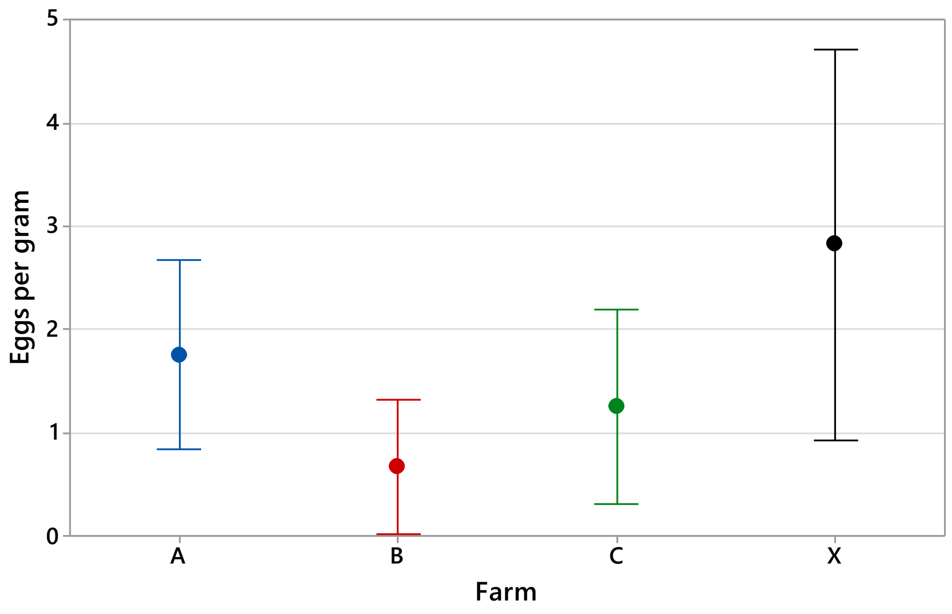

Figure 2 - Interval plot of faecal egg count results, as eggs per gram. Results represent the entire herd data for each farm. Intervals are standard deviation.

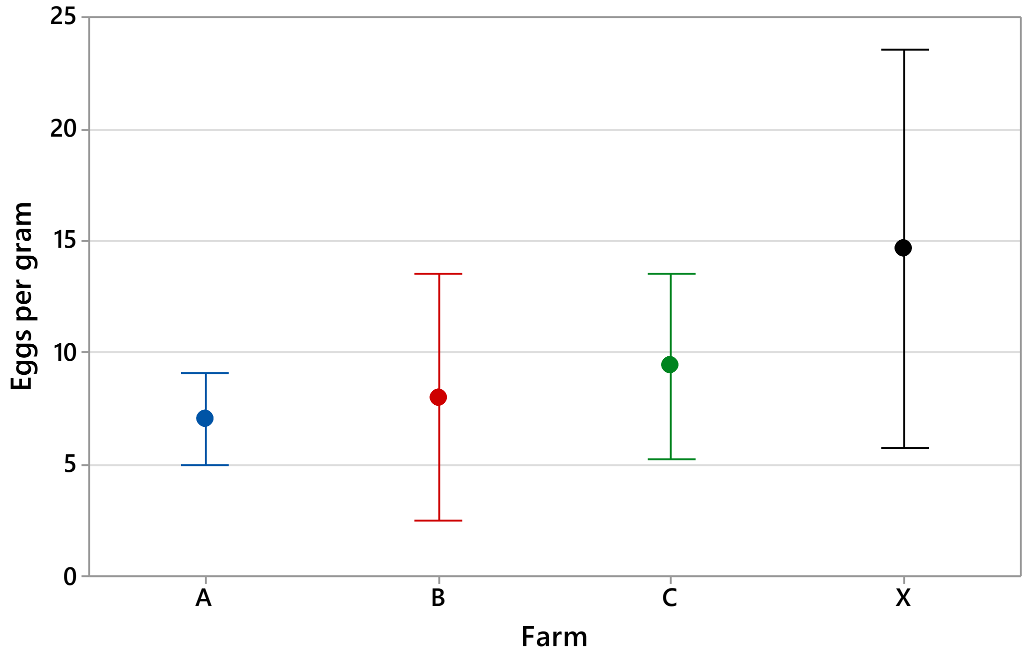

Figure 3 - Interval plot of faecal egg count results, as eggs per gram. Results represent data for infected individuals only, for each farm. Intervals are standard deviations.

Faecal egg count results found parasite burdens to be lower on mob-grazing farms than on the control. It is also notable that farm X had a high variation in results. Within agricultural systems, variation and inconsistencies can be problematic and mean that developing an effective parasite control strategy is more difficult. These results go some way to supporting the hypothesis that the rotational nature of mob-grazing can be used as a method of GIN control. Whilst Farm A had the greatest proportion of infected animals, the mean epg of those animals was the lowest of all farms. This suggests the possibility that the animals are resilient and able to tolerate low or moderate levels of infection. Farm A also had the least variation in FEC results between infected individuals. The location of farm A (Cornwall, UK) is particularly high risk for GIN infections due to the relatively warmer and wetter climate. Combining these strands of evidence suggests that individuals on Farm A have a relatively high GIN challenge, but have consequently developed tolerance mechanisms. The practical benefit of this would be that, whilst GIN risk is persistent, the chance of atypical losses from GIN infections is relatively low. To clarify, tolerance is the ability to cope with infections without any notable signs of pathology. However, this trait would likely require energy and therefore may have an influence on animal performance. Therefore, the net effect of tolerance, with respect to total production, can be positive or negative. Parasitic burdens across all four farms (particularly A-C) are considered as being very low. Whilst there is scientific literature supporting rotational grazing for parasite control, epidemiologic is a highly complex topic and the data gathered within this study cannot conclusively determine the reason for these low burdens.

4 Gross forage composition

The following graphs show the nutritional composition, component by component, of all forage samples taken for each farm. On each visit, 4 herbage samples were taken from each of 6 fields. Samples were taken above 4cm (to represent lowest grazing height). Results were gained by near-infrared spectroscopy on dried herbage.

4.1 Organic matter and ash

Organic matter and ash are opposites of one another, in that anything that isn't organic matter is ash, and vice versa.

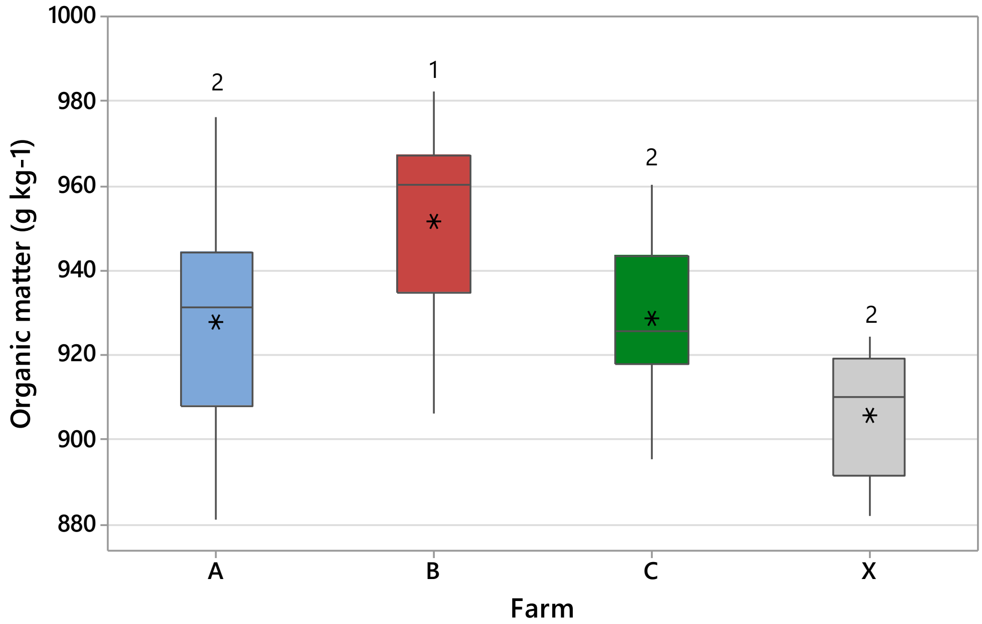

Figure 4 - Boxplots showing the distribution of organic matter content (g kg^{-1}) of forages recovered from each farm. Boxplots that do not share one or more similar number above them are significantly different. Asterisks represent mean values.

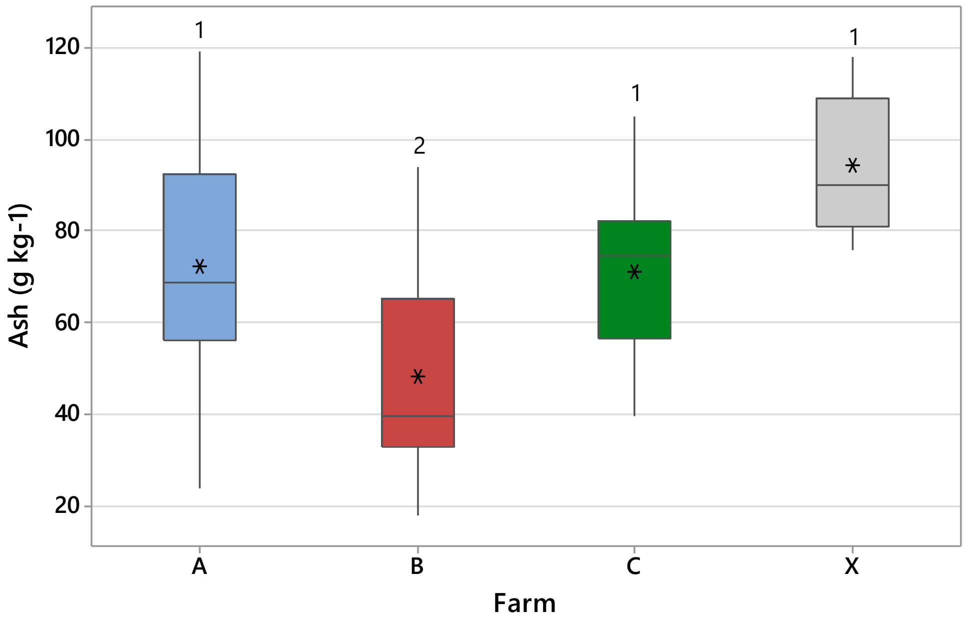

Figure 5 - Boxplots showing the distribution of ash content (g kg^{-1}) of forages recovered from each farm. Boxplots that do not share one or more

4.2 Fibre

The primary measure of fibre is neutral detergent fibre (NDF), which relates highly to forage digestibility. However, a sub-component of NDF is acid detergent fibre (ADF) which is highly indigestible. Therefore, a high ratio of NDF to ADF is considered most beneficial.

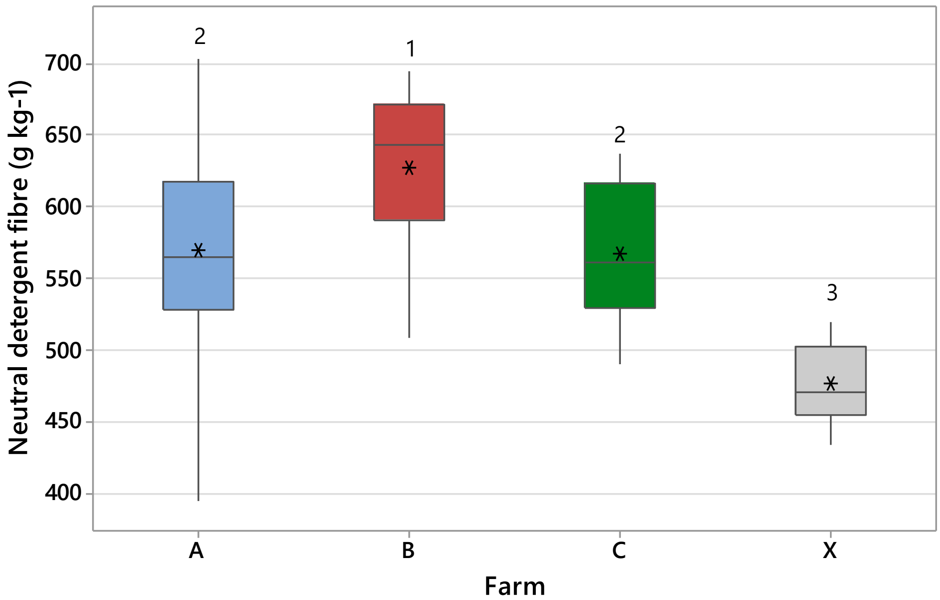

Figure 6 - Boxplots showing the distribution of neutral detergent fibre content (g kg^{-1}) of forages recovered from each farm. Boxplots that do not share one or more similar number above them are significantly different. Asterisks represent mean values.

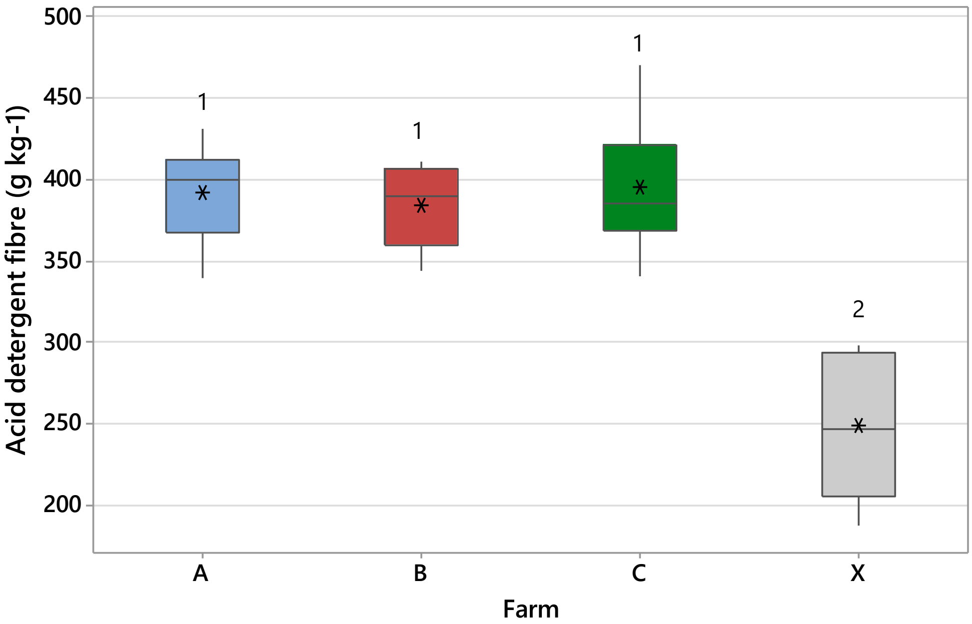

Figure 7 - Boxplots showing the distribution of acid detergent fibre content (g kg^{-1}) of forages recovered from each farm. Boxplots that do not share one or more similar number above them are significantly different. Asterisks represent mean values.

4.3 Protein

Protein is essential for maintenance and growth of the animals, along with ensuring a healthy immune system.

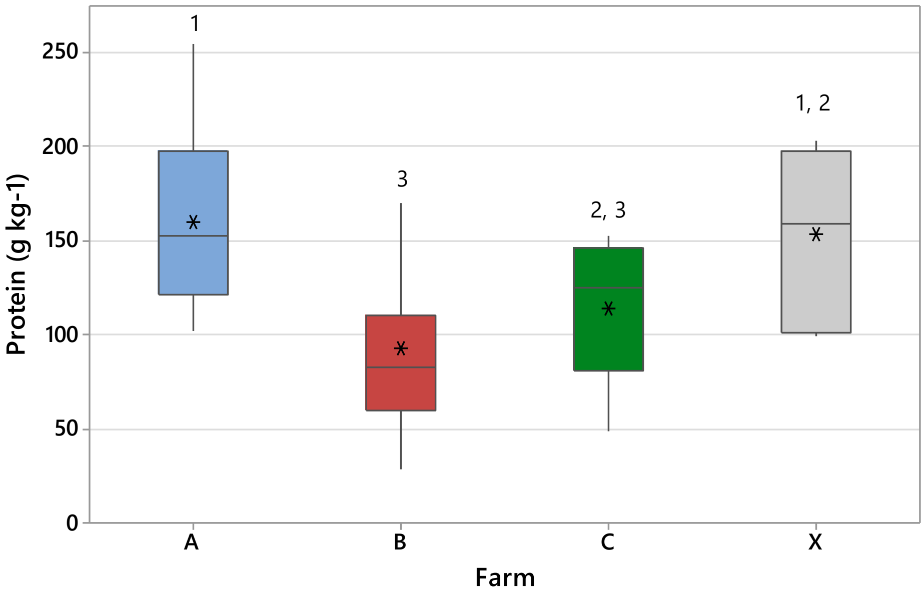

Figure 8 - Boxplots showing the distribution of protein content (g kg^{-1}) of forages recovered from each farm. Boxplots that do not share one or more similar number above them are significantly different. Asterisks represent mean values.

4.4 Carbohydrates and lipids

Due to resource limitations, during this analysis, it was necessary to measure carbohydrates and lipids as one. From past work I have done, lipid content typically ranges from 30-70 grams per kilo of dry matter. Non-fibrous carbohydrates (NFC) have a high energy value and can also promote digestibility of fibre.

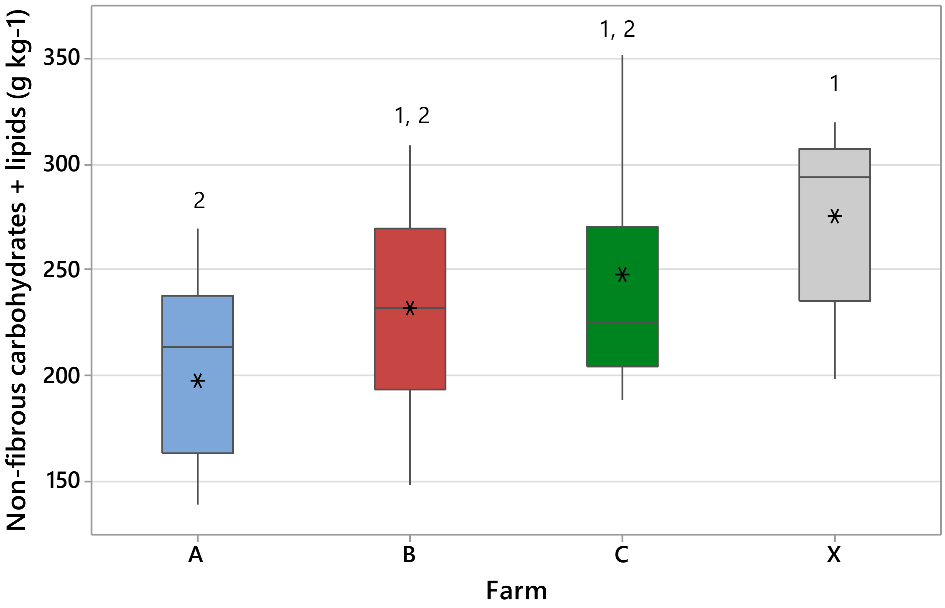

Figure 9 - Boxplots showing the distribution of combined non-fibrous carbohydrate and lipid content (g kg^{-1}) of forages recovered from each farm. Boxplots that do not share one or more similar number above them are significantly different. Asterisks represent mean values.

4.5 Summary

The multi-factorial nature of forage nutrition analysis means it is generally not possible to say if any particular forage is 'better' than any other. OM results is a good broad indicator as it represents the portion of forage which can potentially be utilised by the animal. OM concentrations were significantly greater on Farm B than on Farms A, C, and X, which were all statistically similar. However, a closer look at the composition of that OM component reveals a much more complex picture.

NDF and ADF yielded particularly interesting results. NDF is typically associated with forage digestibility and is therefore considered beneficial trait (Mertens and Ely, 1979; Oba and Allen, 1999). Farms A-C had significantly greater NDF concentrations than Farm X. Whilst this may seem like an obvious benefit in favour of the mob-grazing farms, when looking deeper into the nutritional quality, which is not necessarily the case. A primary component of NDF is ADF, which is considered highly indigestible and therefore has a negative association with nutritional quality. ADF levels were significantly higher in Farms A-C than in Farm X. It is also important to consider that lower levels of a particular nutrient can mean that another nutrient is more abundant. Farm X had the highest levels of NFC and lipids, however this was only significantly greater than Farm A and not B and C. NFC is a highly valuable nutrient which is energy rich and can aids digestibility of NDF (Arroquy et al., 2005; Haddad and Grant, 2000). Whilst NFC and lipids were combined due to the limitations of NIR technology, lipids values would likely range from 10-70g kg^{-1}. Protein concentrations yielded complex results and was noticeably highest on Farm A, despite not being significantly different to Farm X. Protein is highly important and relates positively with growth and final weight, it is also especially important during times of stress (Beaty et al., 1994). The lowest protein concentrations were found on Farm B, which also does not house over winter, this has the potential to cause problems during particularly harsh winters and could reduce animal performance. Nevertheless, this is not a characteristic of mob-grazing itself. It should also be noted that legumes are particularly protein rich and can also fix nitrogen from the environment, this may be particularly important to organic farming which does not rely on external animal nutrient and fertiliser inputs.

The composition of forages could be considered of similar quality between the farms. Whilst significant differences were present for certain components, the true implication of them is unknown and circumstantial. For example, dry matter consumption can be variable on different pastures and could not be considered within this study.

5 Forage changes

As you may recall sampled fields fell into one of two categories, fields that cattle were about to be grazed (named as 'return') and fields that cattle had just been moved off of (named as 'recent'). The below graphs show how the forage composition varies between these two types of fields. See section 3 for descriptions of each component.

5.1 Organic matter and ash

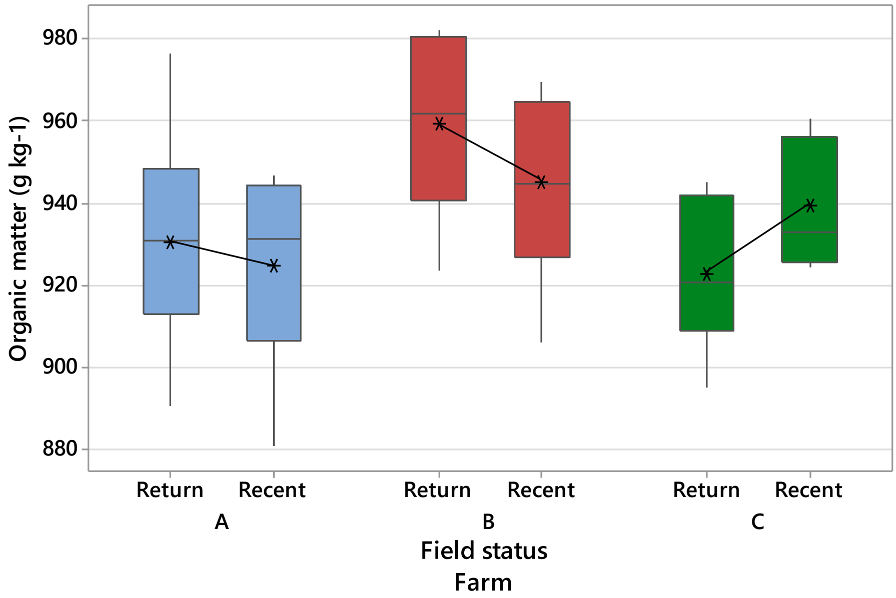

Figure 10 - Differences in organic matter concentration (g kg^{-1}) between 'return' and 'recent' fields on mob-grazing farms (Farms A-C). Asterisks represent mean.

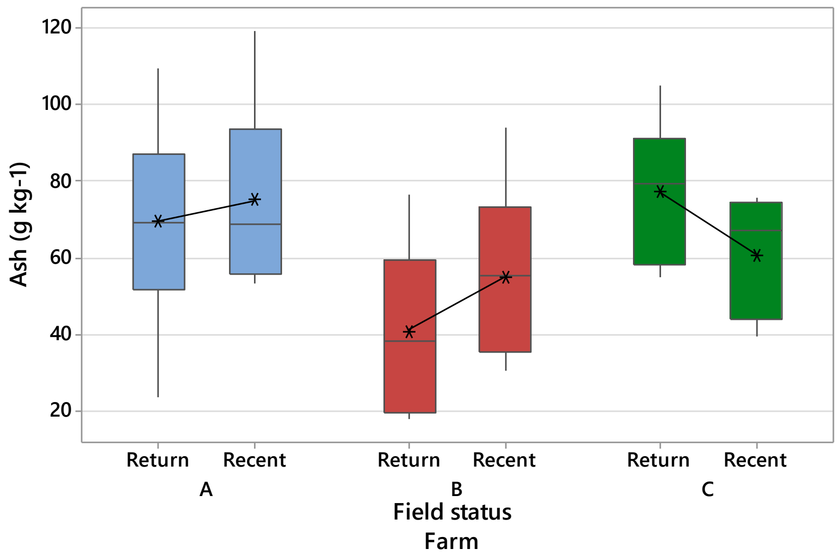

Figure 11 - Differences in ash concentration (g kg-1) between 'return' and 'recent' fields on mob-grazing farms (Farms A-C). Asterisks represent mean.

5.2 Fibre

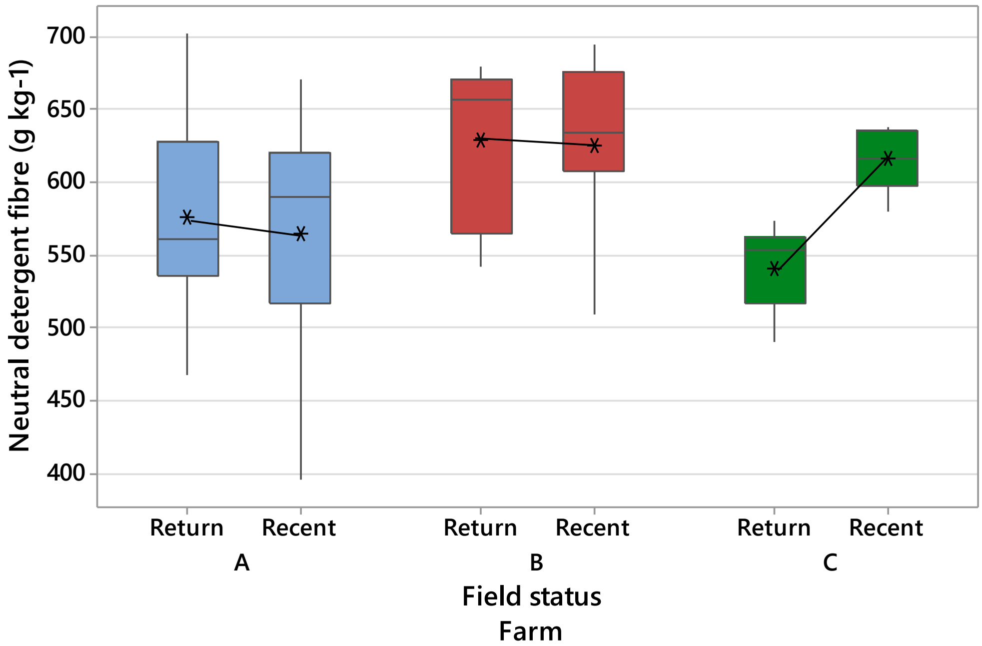

Figure 12 - Differences in neutral detergent fibre concentration (g kg-1) between ‘return’ and ‘recent’ fields on mob-grazing farms (Farms A-C). Asterisks represent mean.

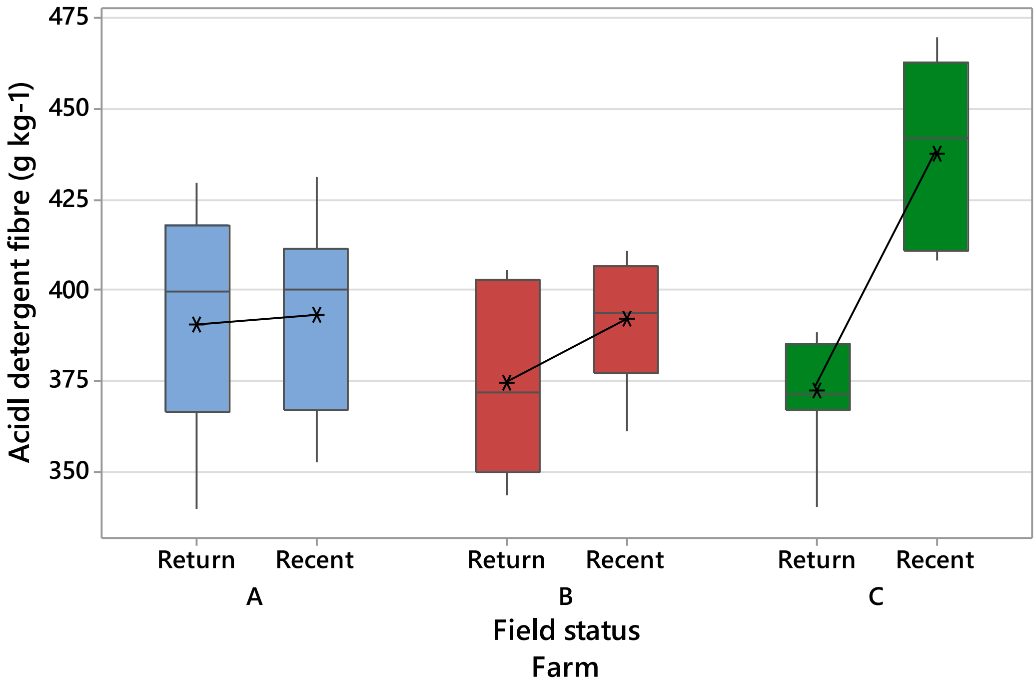

Figure 13 - Differences in acid detergent fibre concentration (g kg-1) between ‘return’ and ‘recent’ fields on mob-grazing farms (Farms A-C). Asterisks represent mean.

5.3 Protein

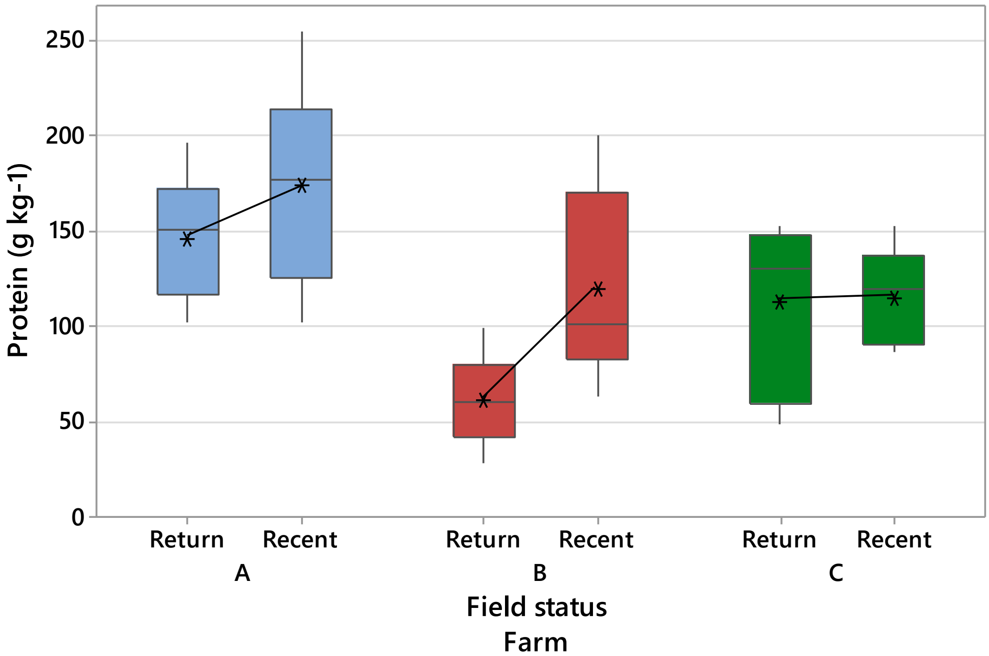

Figure 14 - Differences in protein concentration (g kg-1) between 'return' and 'recent' fields on mob-grazing farms (Farms A-C). Asterisks represent mean.

5.4 Carbohydrates and lipids

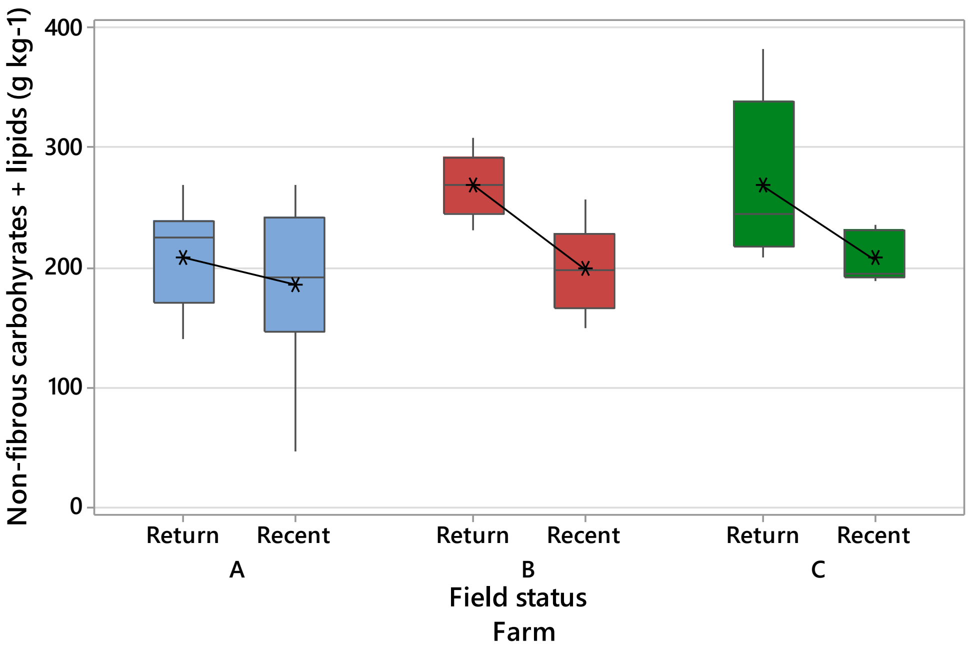

Figure 15 - Differences in combined carbohydrate and lipid concentration (g kg-1) between 'return' and 'recent' fields on mob-grazing farms (Farms A-C). Asterisks represent mean.

5.5 Summary

Comparing the forage nutritional composition of different statuses of fields yielded a number of interesting results. The statistically significant differences seen could be down to a number of different factors (1) That cattle are selectively grazing in favour of forage with particular nutrients (2) As forage grows the proportions of nutrients within it alter, for example, more lignin to provide stability (3) The nutritional composition of taller forages varies from those lower down, meaning that cattle are grazing nutrients disproportionately to the fields average composition. In reality, it is likely that all of these factors were at play. During field visits, cattle were observed to be actively selected particular plants, such flower heads from chicory. Equally, cattle typically graze the top portion of herbage.

One of the most notable differences were for combined carbohydrate and lipid concentrations which, in all instances were higher in 'return' fields than in 'recent' fields. Whilst, from the data, it is not possible to determine what the precise ration of carbohydrates to lipids are, from evidence gathered in past work it can be assumed that it is overwhelmingly carbohydrate. Therefore, cattle entering a fresh grazing cell are disproportionately consuming carbohydrate, which is a highly digestible and energy-rich resource (Hoover and Stokes, 1991). This result also infers that, during the fallow period between grazing, the proportion of carbohydrate in the forage is increasing. Whilst more specific evidence would be needed to confirm this, this is likely to be beneficial for cattle performance and therefore this may represent a production benefit of mob-grazing, compared to conventional systems which have shorter fallow periods. However, Farms A-C had lower concentrations of carbohydrates in general and the highest mean level of those farms at any point (Farm C, return, 269.4g kg^{-1}) were slightly less than the mean for Farm X (275.4g kg^{-1}). Carbohydrate results tie in well with ADF results, which showed an increase in concentrations from 'return' to 'recent' fields. ADF is highly indigestible and, as a result, is inversely linked to forage digestibility. The increases seen suggest that ADF rich feeds are not being consumed. Whilst this is beneficial on the mob-grazing farms, it is noted that the forages on these farms had a higher proportion of ADF than Farm X in the first place. Without further specific research into this one factor, it is not possible to assess if the ADF consumption varies between any of the study farms.

The evidence that pasture growth changes in the nutritional composition of forages is highly important when considering mob-grazing as a grazing technique. This importance stems from the large differences in dry matter levels seen between fields that are about to be grazed and those that have recently been grazed, differences far greater than those on the control farm (Farm X). As a result, greater fluctuations in the nutritional profiles of forages would be expected on mob-grazing farms and is a key consideration for the weight gain and health of cattle.

6 Pasture performance

The graph below shows the difference in kg per hectare of dry matter forage. For each farm, results are presented for fields which were about to be grazed (return) and fields which had recently been grazed (recent). The purpose of this was to provide information on regrowth and consumption. On each visit 4 samples were taken from 3 fields of each type. Each sample was a 40x40cm quadrat, with herbage taken above 4cm. This herbage was later dried at 65°C until a constant weight and results scaled up.

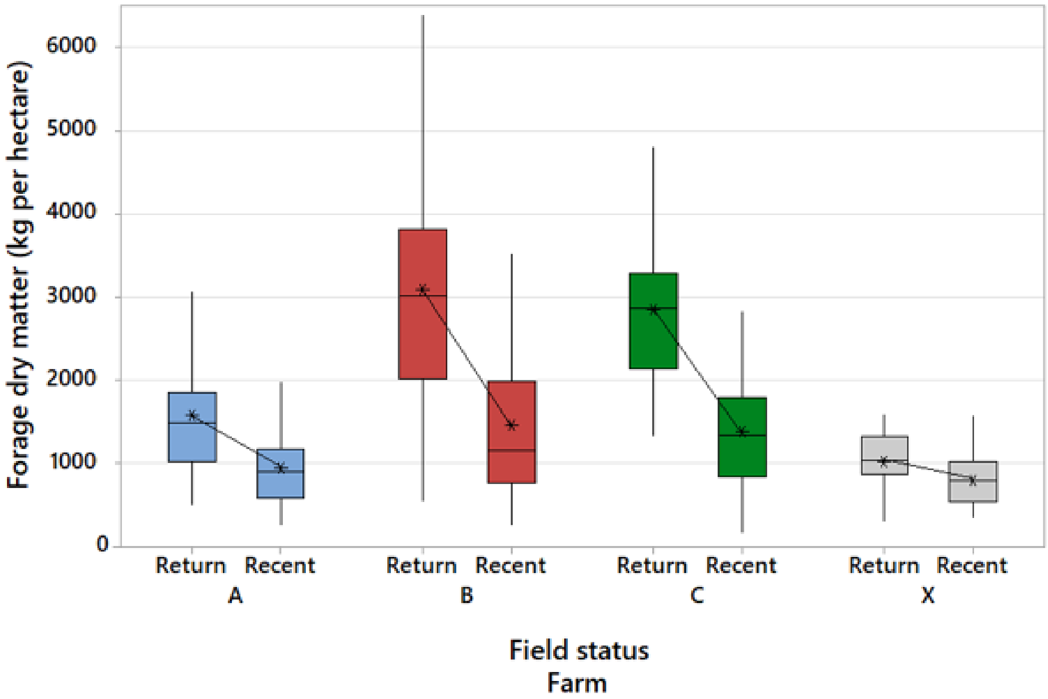

Figure 16 - Forage dry matter mass (kg per hectare) for the four farms. "Return" refers to fields which are at the end of a fallow period, between grazing. "Recent" refers to fields which cattle were grazing, but have come off, within the last three days. Asterisks represent means.

There was a notable difference in dry matter (kg ha^{-1}) between the farms, particularly between Farms A-C and Farm X. The mob-grazing farms had greater dry matter on pasture when cattle were put onto it and when they were taken off, leaving a greater residual. In between being grazed, herbage on Farms A-C had significant growth of 67%, 112%, and 207%, respectively, whilst Farm X had growth of just 29%. These differences are exaggerated if considering total differences. Even if percentage increases were the same, the greater residual herbage levels of Farms A-C would result in a greater total herbage gain than Farm X. These results support the idea that mob-grazing can be used to control foraging behaviour to the benefit of pasture productivity.

7 Conclusion

For all metrics, the mob-grazing farms (A-C) performed equal to or better than the proxy control (X). However, it is worth noting that the study did not include the assessment of animal productivity in terms of total meat production. As you know, the way in which aspects of systems are measured vary greatly and, as a consequence, the results reported here may not be directly comparable to results gathered in a different study.

Results provide supporting evidence for the further investigation of mob-grazing as a method for the management of grazing beef production systems. In particularly, economic and environmental life cycle assessments would be able to investigate the financial aspects of the practice, balanced with an understanding of environmental ramifications relative to other systems. Further case-study work would be highly beneficial, particularly on a larger scale and with more resources. However, this should be conducted in tandem with controlled field trials and computer modelling.

8 References

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