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Influences affecting management and productivity of red deer, a semi domesticated species in an intensive farming system

Written by:

Daniel Charles De Baerdemaecker NSch

December 2025

A NUFFIELD FARMING SCHOLARSHIPS REPORT

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"Leading positive change in agriculture. Inspiring passion and potential in people."

Date of report: September 2023

Title	Influences affecting management and productivity of Red deer, a semi domesticated species in an intensive farming system
Scholar	Daniel Charles De Baerdemaecker
Sponsor	Studley College Trust
Objectives of Study Tour	Given the limited research on farmed red deer, particularly regarding housing, and the minimal presence of commercial deer farming outside the UK and New Zealand, it is necessary to examine deer farming systems, comparable livestock operations, and relevant non-domesticated species. This approach facilitates informed conclusions for the effective management of this semi-domesticated species.
Countries Visited	New Zealand, Canada, UK and Europe
Messages	• Spreadsheets and production targets must not dictate our systems; the biology and behaviour of the deer must come first. • Deer farming is a relatively new livestock industry, and the question remains: can we sustainably intensify production? • As we work with a semi-domesticated species, we should learn from other established livestock sectors to improve efficiency and productivity. • Unlike most livestock industries, deer farming faces direct competition from wild populations, which influences markets, management, and perception. • Improving productivity must go hand-in-hand with understanding and working with the natural behaviours and biological cycles of deer. • By aligning farming systems with natural deer behaviour, we can improve animal welfare, health, and performance.

	• The future of the industry will depend on balancing intensification with welfare, environmental sustainability, and consumer expectations.

EXECUTIVE SUMMARY

Red deer (*Cervus elaphus*) have only been farmed as recognised today since the 1970s (Cordery et al., 1989). Commencing in the United Kingdom (UK) and in New Zealand at around the same time (Fletcher, 1994), New Zealand is now widely regarded as the industry leader. In 50 years of deer farming, limited genetic selection for productivity and domestication has resulted in a semi-domesticated species. Deer within a farming system may only be a few generations away from their wild relatives (Asher et al., 1996) compared to other farmed livestock which has been farmed for hundreds of years. Farmed deer, therefore, are essentially wild animals habituated to the farm environment. Deer still act, behave and cycle as their wild relatives do. This clearly contrasts dramatically with farmed ungulates such as sheep, goats and cattle, which have undergone profound physiological, morphological and behavioural changes over a long time of domestication (Asher et al., 1996). This presents farming deer intensively with many challenges of managing wild natural behaviours inside a domesticated farming system. Red deer are free roaming grazing/browsing, social animals by nature preferring family groups that are hierarchal in structure (Clutton-Brock et al., 1983).

Over the past five decades, deer have been kept in confinement, but they have only experienced minimal genetic selection aimed at increasing productivity and domestication, making them semi-domesticated.

A question is whether deer should be farmed at all currently when the general move is away from intensification to extensification, considering economics and the competition, certainly in the UK farmed venison market from wild venison products considering public perceptions.

However if deer are going to be continued to be farmed, we need to look at some of the key times in the year when the animal's natural behaviour has the greatest influence on management and productivity, namely calving, weaning and mating (Pollard & Stevens, 2003). Winter housing is developing as a fourth key time and a key focus of this study

With limited research on farmed red deer especially at housing, and the lack of commercial deer farming outside of the UK and New Zealand, there was a need to look at deer farming systems, other livestock systems and non-farmed species to draw conclusions to better manage a semi domesticated species.

Key Words: Cervus elaphus, red deer, intensification, enrichment, venison, wild deer, farmed deer, livestock.

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CONTACT DETAILS

Daniel De Baerdemaecker

East Sussex

dan@dcdrural.co.uk

Nuffield Farming Scholars are available to speak to NFU Branches, agricultural discussion groups and similar organisations.

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email : office@nuffieldscholar.org
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CHAPTER 1: INTRODUCTION

Figure 1: The author, Daniel De Baerdemaecker NSch

Daniel De Baerdemaecker is a UK-based deer industry specialist with more than two decades of experience in deer management, farming, and rural land stewardship. His career has focused on developing sustainable deer farming systems, improving venison production, and advancing professional standards within the deer industry both in the United Kingdom and internationally.

After studying Countryside Management, Daniel began his career working with deer and quickly developed a strong reputation within the sector. Early in his professional journey he worked at the historic Woburn Abbey Deer Park, where he later became deer manager at the age of 26. During this time he gained extensive experience managing large herds and working with a variety of deer species in both parkland and managed environments.

Throughout his career Daniel has worked with multiple species of deer and has been involved in both commercial farming and conservation-based projects. His experience includes participation in international conservation initiatives, including work related to Père David's deer (Elaphurus davidianus) conservation programmes in China, contributing to the management and development of deer populations within protected and managed reserves.

In recent years Daniel has been involved in the development and management of large-scale commercial deer farming operations, including helping establish one of Europe's largest red deer farms focused on venison production. His work has extended internationally, contributing to deer farming and estate management projects across Europe, China,

Russia, and New Zealand, advising on deer farming systems, infrastructure, fencing, and herd management.

Daniel is the founder of DCD Rural, a consultancy and contracting company specialising in deer management, deer farm development, and rural infrastructure. The company also specialises in the installation of all types of agricultural and forestry fencing, supporting farms, estates, forestry projects, and conservation initiatives with high-quality fencing solutions.

In 2021 Daniel was awarded a Nuffield Farming Scholarship, researching the influences affecting the management and productivity of deer as a semi-domesticated species within intensive farming systems. His work focuses on improving welfare, productivity, and long-term sustainability in modern deer farming.

Daniel has also played an active role in representing the deer industry. He previously served as Chair of the British Deer Farms & Parks Association, helping promote best practice within the UK deer farming and park sector. He currently serves as 2nd Vice President of the Federation of European Deer Farmers Associations (FEDFA), contributing to collaboration and knowledge exchange across the European deer farming community.

Through his work in farming, consultancy, conservation, and research, Daniel continues to promote innovation, sustainability, and high welfare standards in deer farming, wildlife management, and rural infrastructure worldwide.

CHAPTER 2: BACKGROUND TO MY STUDY SUBJECT

Figure 2: Red hinds in New Zealand

Deer especially Red deer (*Cervus elaphus)* and fallow deer (*Dama dama*) have been enclosed within parks throughout Europe and Asia for over a thousand years but there were few efforts to domesticate them (Fletcher, 2011). Red deer (*Cervus elaphus*) have only been farmed as recognised today since the 1970s (Cordery et al., 1989). Commencing in the United Kingdon (UK) and in New Zealand around the same time (Fletcher, 1994), New Zealand is now widely regarded as the industry leader.

Within the last 50 years deer have been confined but have undergone only limited genetic selection for improved productivity and domesticity (semi-domesticated). Deer within a farming system may be only a few generations away from their wild relatives (Asher et al., 1996). Farmed deer, therefore, are essentially wild animals habituated to the farm environment. Deer still act, behave and cycle as their wild relatives do.

This clearly contrasts dramatically with farmed ungulates such as sheep, goats and cattle, which have undergone profound physiological,

morphological and behavioural changes over a long time of domestication (Asher et al., 1996, Schafberg & Swalve, 2015). This presents farming deer intensively with the many challenges of managing wild natural behaviours inside a domesticated farming system.

Red deer are free-roaming grazing/browsing, social animals by nature, preferring family groups that are hierarchal in structure (Clutton-Brock et al., 1983). In a farming environment, these groups are managed by age, sex and live-weight groupings rather than by genetic lineage, potentially increasing social issues when forced to cohabit with specific individuals, which can impact on management and productivity.

There are some key times in the year when the animal's natural behaviour has the greatest influence on management and productivity, namely calving, weaning and mating (Pollard & Stevens, 2003). Winter housing would be a fourth key time.

With climatic changes, public perceptions of farming and animal welfare high on the agenda, more UK deer farmers are turning to housing adult hinds over the winter. The UK is one of the only countries to house any number of red deer over the winter months. It is commonplace for UK deer farms to house calves in their first winter after birth (Alexander & Buxton, 1986). This study has seen indicators that there is an increase in the number of adult hinds being housed over winter in the UK and stags in New Zealand. This increase is likely to be farm specific, and management driven, and linked to any number of reasons including climate conditions, environmental benefits, intensity, grazing area, soil erosion, soil compaction and cost of pasture repair rather than linked to animal performance. Another main reason is public perception about the animal's welfare when kept outside during winter.

With a true lack of literature on the behaviour of red deer when housed, there was a significant need for research on the subject to formulate some basic recommendations and advice on the topic with the aim of increasing welfare and improving production.

In New Zealand, and in recent years the UK, with stable venison markets developing, there has been a move away from extensive farming practices to intensive lowland systems. This has maximised the number of deer that can be kept per hectare (stocking rates of 8–12 deer/ha) through increasing inputs such as forage production, labour, fertiliser, and supplementary feed (Asher et al., 2014). However, environmental constraints, available space, land use, legislation, secure venison markets and the New Zealand

velvet industry have created differences between the UK and New Zealand in the growth, size and direction of the industries albeit that the basic management practices of deer are the same. Climate change and shifting economics may see further changes as to how deer are farmed influenced also by alterations in the behaviour of consumers in their buying, eating and attitudes to food.

CHAPTER 3: MY STUDY TOUR

A lack of commercialised deer farming, apart from in the UK and New Zealand, and the absence of much literature on the housing of deer and their behaviours, justified the need to look at other ungulates within an enclosed environment. Commercial deer farming was looked at in the UK and New Zealand. The focus area in New Zealand was the South Island with 35 deer farms visited. Alberta and British Columbia in Canada were also visited to look at cattle feed lots, (three cattle feed lots visited) and farmed White-tailed deer (*Odocoileus virginianus*) and Plains bison (*Bison bison*) (one white-tail farm and one bison farm visited). Enclosed zoo animals (*Camelida, Elephantidae, Giraffidae and Cervidae*)(five zoos visited), pigs (*Sus domesticus*) and chickens (*Gallus gallus domesticus*) (one pig farm and two chicken units visited) were looked at in the UK and Europe. Three salmon and trout farms where also visited.

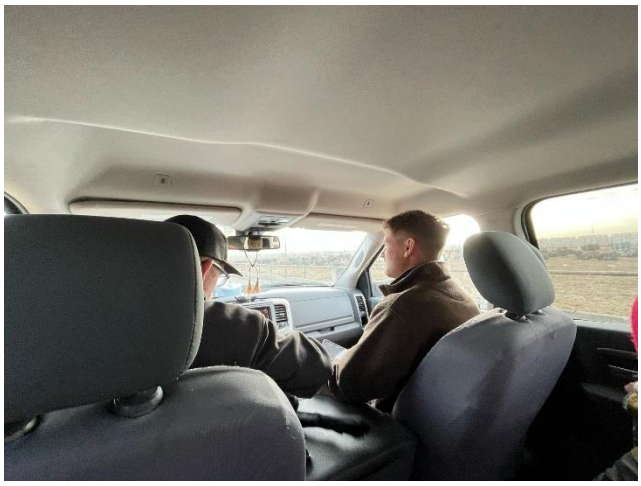

Figure 3. Dan at Cattle Land, Canada

Participating deer farms were initially randomly selected in countries and the size of the operation was not considered before visiting. A snowball approach by word of mouth while conducting visits led to further visits, some with more specific reasons in relation to the topic. Zoos, pig farms and chicken operations were used to look at animal enrichment. Cattle feed lots were visited in order to look at productivity and intensification of a farmed species. Loose quantitative data was collected.

Deer farms were visited to look at different deer farming systems and with the object of finding ways to help improve management at the key times in the year when the animal's natural behaviour has the greatest influence on management and productivity, namely calving, weaning, mating and winter housing (Pollard & Stevens, 2003).

Figure 4. Barry Chernuka, an elk farmer, with Dan and his sons, Angus and Morris, looking at an elk crush in Canada.

The farm visits were carried out in a relaxed tour format being shown around the units and being told/shown how the said operation functioned and was managed. Quantitative questions regarding enrichment, stocking density, behaviour and general welfare and management were asked during the tour rather than in formal interviews.

Winter housing in this study is the removal of stock from the grazing platform during winter predominantly bringing stock inside and confining the deer rather than looking at the use of winter forage crops and other out-wintering methods.

There was no fixed upper limit on the number of farm/site visits and interviews. Data saturation was felt when no new issues where arising, repetition was being seen and no new themes were emanating from data. The first level of analysis was case by case followed by the second level cross-case and eventually at the final level. Financial restrictions and time were limiting factors on the study. Covid restrictions also led to the study taking longer than planned and restricted travel at the start of the study.

CHAPTER 4: MATERIALS AND METHOD

This study started at the end of 2020 and ran through until July 2023, with the bulk of the study taking place between July 2022 and July 2023.

An initial qualitative questionnaire (appendix 1) was created and circulated through the British Deer Farms and Parks Association (BDFPA) to 200 members to gain base data of the British deer farming industry in 2021: 50 responses were received. In the survey people were asked generally about their deer farming enterprise focusing on winter housing of all ages and sexes. However, this review focuses on the winter housing of adult hinds rather than calves. This is due to the variables in housing calves as a result of weights, feeds, genetics and the uncertainly around hierarchies and dominance development when certain weights/ages are reached. This study therefore focuses on the potential to improve welfare and standardise basics when housing adult deer over winter and examines how behaviour, which can cause social issues (especially bullying), could be reduced. Winter housing, in this instance, is defined as anywhere into which deer are removed from fields.

This research study, predominantly a descriptive one, primarily relates to the farming of Red deer (*Cervus elaphus*) within an enclosure. It aims to improve welfare, husbandry and management of stock to increase productivity through predominantly qualitative research. Elk (*Cervus canadensis*) and the hybrids between Red and Elk were also examined in deer farm systems. Some other species within the Cervidae family were also looked at if enclosed.

CHAPTER 5: RESULTS

5.1 Winter housing

5.1.1. Why?

Figure 5. Red hinds housed for the winter

An increasing number of deer farmers in both the UK and New Zealand are investing in indoor wintering systems. These systems are gaining popularity among farmers due to several factors that vary according to specific farm needs. Climate change and unpredictable seasons and economic benefit were the main reasons. Concerns over the need to reduce water runoff, nutrient loss and soil damage associated with intensive out-wintering of stock, as well as public perception due to the negative visual impact of deer wintering on muddy pastures, were high in answers from farmers. The rising running costs of farms has led people to look at ways to avoid damaging land through the winter with the concurrent high re-seeding and re-establishment costs in the spring and the loss of grazing platform in the spring. Winter housing allowed farmers to run higher stocking densities whilst avoiding winter ground issues. Staff mental health was also noted to be better when animals were housed appropriately.

5.1.2. Grouping

Red deer are free roaming grazing/browsing social animals by nature, preferring family groups that are hierarchical in structure. In a farm these groups are managed by age, sex and live-weight groupings rather than by genetic lineage, potentially increasing social problems associated with agonistic behaviour when deer are forced to cohabit with specific individuals (such as bullying). This creates problems in management and reduces productivity. Practical advice on how to resolve these problems and improve the welfare of the animals and increase their performance, is limited. Individuals when housed are regularly observed being bitten,

kicked, head butted and continually pursued all resulting in skin wounds, hair loss, rapid weight loss and, in some cases, death. Animals seen to be subordinate when outside in the field are the most likely to be affected when transferred indoors.

In the pig industry, pigs with lighter live weights, lower body condition scores, and ranking lower in the dominance hierarchy lost more agonistic encounters. Farmers noted that most pig studies took place over a short time period. Where feed was ad-lib and feed across all groups was constant, the possible light weights could be linked to social pressures and affect the ability of individuals to feed freely, highlighting live weight as a social status indicator. Therefore, grouping animals on live weight and body condition could help reduce social behavioural issues, especially if live weight is a proxy for social status. On average deer calves in the UK are housed in groups of 60 with the average farm housing 170 deer calves. UK farms are housing adult hinds in groups of 40 on average, with some farms housing hinds in groups of >125. In the UK 33% of farms house calves in mixed sex groups, 20% house on size, weight and 70% on single sex.

5.1.3. How?

Winter housing in the UK uses some purpose-built deer sheds similar in design to cattle sheds, but the majority are converted cattle sheds now used for deer. Outdoor yards (barns with no roof) were being used for adult hind stock both in the UK and New Zealand. Polly-tunnels and other converted barns are also popular if enough height is available. Outside areas joined onto smaller converted sheds are quite popular for adult deer allowing more overall space.

92% of UK deer farmers are housing calves in their first winter; 84% of UK farms use barns to house their calves. 45% of UK deer farmers are now housing mixed aged hinds over winter (35% in barns, 20% in yards, 44% other). In New Zealand, the trend is towards people housing adult stags. 97% of UK deer farmers use straw as bedding. Wood chip, sawdust and sand are also popular as bedding and function well so long as kept dry and fresh. The composting bedding system used in cattle could work well for deer and see a reduction in straw use for farms. The inquisitive nature of deer and their behaviours associated with their role as prey means they are happier in a barn which they can see out of easily.

5.1.4. When?

Housing is seasonal: 30% of UK farmers house calves in September tying this in with pre-rut weaning and 70% house calves in November onwards linking in with a post-rut wean or when the weather deteriorates for the pre-rut weaned calves which have been out side. 70% of farmers house hinds post rut in November with the remainder being housed from January onwards. 150 days is the average time that stock are housed in the UK. Reducing the time animals are housed will considerably help to reduce the social stress on the animals. The majority of social stress in adult deer appears after about 55 days of being housed. Adult hinds in New Zealand tend to be housed for shorter periods, up to 84 days.

5.1.5. Space

Most of the information on housing red deer is from empirical evidence, including the stocking rates commonly used in the industry (see Fig 1. (*Quality Assured Farm Venison Standard*, n.d.). The majority of UK deer farmers worked to Fig 1 with calves being given an allocation of 2.5m ^{2}. Hinds on average in the UK are housed at 1.46m^2 inside only and 3.5m^2 when housed in a combination barn. New Zealand farmers are working on 4m^2 per mature stag when housed but for approximately 60 days.

This might imply there is some correlation between hormone cycles of the sexes and when housing takes place as in goats when progesterone levels increase so does aggression(Alvarez et al., 2010). To date I cannot find any research undertaken on space allowance for adult deer when housed over winter. Research facilities like Ag-Research in New Zealand continue to develop answers.

Some work has been undertaken in weaned red deer calves at approximately three months of age in wild and farmed systems looking at immune response, liveweight gain and behaviour while housed (Hanlon et al., 1994). In this work they used a 2x2 factorial experiment using 40 calves housed for 22 weeks at 1.8m^2 and 4.5m^2 per deer. Activity and immune responses were identified as indices of housing stressors in weaned calves. They also imply measurement of antibody responses may be valuable in assessing the short- and long-term effects of housing density (Hanlon et al., 1994).

The relationship between stocking rates and behavioural issues has been studied with older deer grazing outside (Blanc & Thériez, 1998). The authors studied 20 hinds of similar live weights and daily live weight gains (DLWG)

in their second grazing season after being housed. The 20 animals were allowed time to adapt to grass and the other 19 test subjects before the study commenced.

They were then entered into either a high stocking density (HD) (150 animals/Ha, 66sqm/H) or low stocking density (LD) (37 animals/Ha) at grazing and observed over two 28-day periods. Within the HD group there were more agonistic encounters (biting, kicking, butts) and HD induced a social stress that affected subordinate animals most significantly. The study would have benefited from being extended with increased observations and subject quantities to render the data conclusive.

Class	Age	weights	Meter squared per deer (m^2)
Weaned calves	3-5 months	25-40kg	2
Calves	5-11 months	40-90kg	2.5
Yearlings/Adults	1 year +	80kg +	3
Stags	1 year +	130 kg +	5

Recommended stocking densities for housed Red deer (Quality Assured farm Venison standards).

Cattle housed on cattle-feed lots which could be seen as comparable to winter yards used in the UK for deer in design, showed increased welfare is achievable by increasing the space allowed per cow. A cattle feed lot trial looked at cows with an average weight of 400kg on feed lots housed at either 6m^2, 12 m^2 or 24m^2 per head over a 12-week period (Macitelli et al., 2020) Cattle all received the same treatment before housing and the same feed was fed via feeder wagon four times a day to all groups.

Environmental based-indicators were recorded weekly (dust, mud and air) and animal-based indicators (body cleanliness, health and maintenance behaviour) monitored throughout (*Welfare Quality ® Assessment Protocol for Cattle*, 2009). They concluded from the welfare indicators assessed that reduced pen size/area per animal saw reduced environmental conditions and higher levels of stress and health problems (Macitelli et al.). Also, a decrease in lying time and an increase in aggressive encounters in the dairy industry have been shown to be associated with a lower space allowance of 4.5m^2/h. Cattle have also shown increased use of shelter when space per animals is increased from 4m^2 to 6m^2 or 8m^2 (Schütz et al., 2015).

The turkey industry has equally displayed the benefits of lower stocking rates when it comes to welfare of stock and productivity (Erasmus, 2017). It has also highlighted that with higher stocking density comes an increase in management to deal with factors such as husbandry and waste. Stocking rates would appear to be optimally set at rates which benefit the welfare of the turkey but don't necessarily link with productivity and the associated economic costs of lower stocking rates.

Figure 6. Feeding red hinds on outdoor winter pads

This study has highlighted that a minimum area of 5.8m^2 per adult hind has been identified as a size at which bullying is reduced, and 3m^2 for calves, based on answers to the survey conducted and observations.

5.1.6. Feed space/feeding

Feed efficiency is well documented in the cattle industry but not so much the behavioural issues around feeding and their effects on efficiency. Not surprisingly, dominant animals had the priority over subordinate animals but the knock-on effect on the subordinate and young animals was greater as they are forced to spend less time at the feed front, take more steps per day and show a reluctance to come to the feed front, all equating to less intake and poorer efficiency. The less feed space available, the more agonistic encounters and the greater the effect on the individual. The less feed an animal eats will contribute to its being smaller and lighter, thus increasing its chances of being dominated and being subjected to social pressures, thereby decreasing its welfare and productivity. The cattle feed lots visited also found that each cow needed 25cm feed space for an effective stocking rate. Again, in laying hens (non-caged) increasing the feed space reduced agonistic behaviour, increasing welfare but decreasing productivity slightly as feed space was increased.

Quality, quantity and consistency of feed and feeding routine for deer to keep them settled could be linked to reducing social anxiety. An ad-lib feeding system for deer is more likely to keep animals calm based on their feeding habits. Depending on the feeding system at least 75% of the group need to be able to feed at any one time. If concentrate feed is being fed 100% feed space is needed unless the deer are fed ad lib. An increased fibre

diet in laying hens has been seen to reduce feather pecking so the composition of the ration could have a major influence on animals' behaviour. The dairy sector looks for 7/10 cows to be cudding at any one time for healthy rumen function and feed intake (Tucker et al., 2021). Increasing good rumen function and cudding in deer by good feed rationing could also help relax animals and increase productivity.

Figure 7. Red deer calves feeding on a TMR mix

New Zealand deer farmers have seen a 9% lower feed in-take in housed stock compared to animals grazed intensively on forage crops. A greater growth rate and retained condition can be achieved from housing young stock over the winter despite the reduced feed in-take. Feed waste is also reduced by less trampling and contamination. Farmers who have moved to an indoor system from an outdoor baleage system have seen a reduction of bales used by 10-25%. Increased pasture growth in the spring and autumn is also a notable benefit of housing stock over the winter due to the reduced winter grazing damage of pastures, correlating to increased growth rates.

5.1.7. The environment

A lot of forage crops on farms will lead to the loss of sediment, Nitrogen (N) and Phosphorus (P), along with other nutrients and bacteria into groundwater and streams. Such losses vary from farm to farm, depending on slope, soil-type and rainfall. Their impact on stream and groundwater quality also varies with the locality, the catchment and the region. Also, winter-grazed pasture soils can become highly compacted. As a result, pastures become exhausted and need to be replaced more frequently. This is costly and increases a farm's greenhouse gas (GHG) footprint. In contrast, well-managed wintering barns produce no liquid effluent or run-off. Nutrients in the bedding are returned to the land during the warmer months where they contribute to pasture growth.

Greenhouse gas emissions: in simple terms, ruminants produce greenhouse gases (GHGs) in direct proportion to the quantity of feed they consume. This means a 9% reduction in feed eaten by deer wintered indoors translates into a 9% reduction in GHG output. A reduced need for cultivation for forage cropping, or to replace winter-damaged pasture, will further reduce GHG emissions. However, there has been little research into the GHG emissions of deer being fed different feeds during winter. In addition, individual farms vary greatly in terms of the energy (fossil fuels) used during winter feeding. For these reasons it is difficult to make a blanket statement about the impact of indoor wintering on the GHG emissions of deer. One potential benefit may be the ability to reduce GHG emissions by manipulating diets, or by feeding GHG-reducing additives, if these become viable options in the future.

5.1.8. Environmental enrichment

Enrichment is a way to improve the quality of captive animal care by providing stimulation structures and devices which promote psychological and physiological behaviours and welfare keeping animals “busier for longer”. As there is little or no literature on environmental enrichment for deer, this study needed to look at other animal sectors for comparison. As demonstrated previously, in the poultry industry lower stocking density would appear to have a benefit on animal welfare and productivity. Along with lower stocking densities, enrichment has shown to have many positive effects in other animal sectors. Video surveillance in the poultry sector allowed monitoring of groups and the use of plumage assessments to help assess the level of feather pecking. Feather pecking and other associated issues were reduced by moving from high stocking densities to high stocking densities with enrichment and reduced further with low stocking densities and enrichment.

The use of environmental enrichment for other animals tends to be designed to promote species specific behaviours and enhance the environment of confined animals. In the zoological sector, enrichment has shown a reduction in stereotypical behaviours and repetitive behaviours seen in captive animals such as pacing and bar chewing. Numerous examples have been documented in horses, cattle, pigs and poultry where enrichment has been shown to have positive effects on animal behaviour, less agonistic encounters, production benefits and increased welfare. For example, tail biting in pigs is a serious welfare issue for the pig industry

which has seen a reduction in tail biting and aggression, with long-term social benefits, when adequate feed space and enrichment are provided.

The types of enrichment used for other livestock have shown that it does not need to be complicated but is species specific to mirror natural behaviours e.g., pecking blocks and bales for poultry and rubbing brushes for cattle replicating self-grooming. Scented enrichment saw slightly more use when first introduced to animals but over time the scented enrichment balanced out with standard rubbing brushes. Enrichment usage was greatest on the first day of having enrichment. In the UK it is a legal obligation to provide enrichment for pigs. Using malleable and destructible enrichment such as rope, used in pigs with good results to reduce tail biting although it would appear that further development is needed to enable enrichment that is compatible with slatted floors.

In regard to deer, which are naturally a curious animal and motivated to explore their environment, enrichment would need to suit their natural behaviours including feeding habits, which are described as both browsers and grazers or mixed feeders. Their inquisitive nature would suggest that enrichment would need to be changed regularly to maintain interest and mitigate boredom to imitate what they would encounter in the wild. For enrichment to be used in commercial settings it needs to allow for easy management. Bedding animals daily is a simple daily enrichment. 37% of UK deer farmers use enrichment such as licks and fishing buoys hung up, although 80% don't change their enrichment through the winter.

Figure 8. Elephants at Whipsnade Zoo, UK

5.1.9. Lighting

Providing continuous light while deer are housed (minimum 50 lux) is recommended as it reduces panicking and allows animals to be checked

24 hours a day. Care must be taken if calves are housed not to suddenly turn lights on and off causing temporary blindness and panic leading to injuries. The use of light to manipulate day length to 16 hours a day in the winter to increase daily live weight gain (DLWG) promoted in the 1980s can see DLWGs of 250g/d achieved through the winter. In the current climate this is seen as a possible conflict with public perceptions that deer should be seen to be farmed as naturally as possible. With the increased electricity costs and feed budgets a very early kill would be needed to balance against increased costs and the risks of losing live weight gains over the spring from grass. The increased light could also trigger oestrus confusing animals' natural cycles.

5.2 Calving

Figure 9. Red deer calves and hinds

During calving in late spring to early summer, red deer hinds change their social behaviour, seeking isolation from the herd and selecting habitats with good cover and security for their new-born calves. These sites are highly contested, and hierarchy comes into play. When calving environments are suboptimal this leads to competition for prime sites and subordinate hinds are adversely affected. Several studies of intensively farmed red deer have established that when the ability of parturient hinds to find isolated birth sites is compromised through high population density (i.e. >8 hinds/ha), inappropriate social conditions or habitat homogeneity, peri-natal calf mortality can be excessive due to dystocia or neonate abandonment and aggression from hinds on the calves. For this reason alone, when cell grazing is used for deer, it needs to be removed to allow hinds to select birth sites. In an intensive system cell grazing can give the benefit of keeping an area of field longer in cover. The loss of rotation in an intensive system can then lead to a loss of grass quality at a key time which is a compromise on milk production and daily live weight gain.

Figures 10 (left). Rhys Gill with a red deer calf. Figure 11 (right). Red deer calf in grass.

5.3 General deer farming

Intensification of deer farming could be classed at a stocking rate of above 10 hinds per hectare which is the desirable number for low land deer farming or 5-7/ha for hill blocks. Having the right hinds that suit the farm/region is also key to a productive farming operation. They must meet the demands that are going to be put on to them at times of stress and pressure and retain an average body condition score of 3.5. The selection of the sire stag to use over the hinds needs to be considered. To use a pure elk bull over red hinds, the hinds need to have an average body weight of approximately 120kg. There are also potential future gains to be had from using hinds weighing 130-150kg, but these animals will need different and higher input management than a 100kg red hind. Better results could perhaps be achieved if a lower input system is adopted by using reds over reds rather than elk X terminal sires especially if feed conversion rates are looked at for cost effectiveness. Hybrid vigour can be seen with as little as 25% of new genetics. Sexual dimorphism in deer could be used further to make gains when selecting potential sires on their seasonal growth rates and traits. Elk are a much more social animal than reds and so there is a need to manage them appropriately. Elk benefit from bigger mobs unlike reds which prefer matriarchal groups (15-30 in the wild). Elk are best weaned post rut to allow brain development and maturity which appears to be slower than that of red deer. Tagging of calves three weeks prior to weaning and the administration of magnesium at weaning has seen calf

stress reduced which is very important when calf weaning weight is so closely correlated with carcase weight. The farming system needs to consider whether there is a desire to finish animals quicker with greater inputs or follow a lower input system and take longer to finish animals. Economics and markets will be the biggest driver of the decision.

Figure 12 (left). Don Hudson with an Elk Bull NZ. Figure 13 (right). Red deer being rotationally grazed behind an electric fence.

5.4 Milk

Figure 14. Deer milking parlour

A major key time in the production of deer is between birth and weaning while the calf is still suckling from the mother. Growth rates here will be regularly >400g/day. The largest DLWG that is going to be seen in an animal's life. The artificial milking of deer in New Zealand is showing what lactating hinds need in order to achieve high yields of milk. This should be a direct correlation to the calf's growth rate. Hinds need to be grazing covers of 2650-2750kg/Dry matter (dm)/hectare (Ha) for optimum milk yields. Over 2800kg/dm/ha and milk yields drop by 10%. A hind and calf needs 5kg/dm/d. Milking units have also seen hinds being able to conceive 43 days after giving birth. 21 days after conception milk quality drops causing natural weaning of the calf and a change in its behaviour. Udder conformation and teat position is also key to the ability of the calves to feed and the ability of the hind to lactate in all four quarters of the udder.

Deer milk is 26% milk solid, 14% protein, 12% fat and has a lactoferrin count of approximately 620 mg/l which is 9 x higher than cow's milk. Deer milk is very close to human milk in substance and could be used as a natural infant human milk substitute.

Figure 15. Red deer- spikers waiting in a raceway.

CHAPTER 6: DISCUSSION

There does seem to be a common pattern occurring in other livestock which is presumably relevant to deer. One could conclude that decreasing stocking densities of all housed livestock will see an advantage in productivity and especially in improved welfare of the stock.

Linked to this is the feed space available. Increasing feed space per animal or lowering stocking density will see a benefit to the subordinate animals. The ability to have 100% of all animals able to feed at any one-time would be advantageous. Grouping animals on size, live weight and age could help with social behavioural issues around stress and again dominance. Enrichment will certainly see greater welfare of animals when confined and allow them to conduct natural behaviours, possibly mitigating boredom.

For intensification to be undertaken infrastructure and farm layout need to be designed to help reduce animal stress and allow higher animal welfare especially at times of high climatic pressure on animals such as during winter and dry summers especially during calving.

Deer by their nature tend to grow and finish slowly meaning that forcing animals to grow quicker is challenging and questionably uneconomic. The need to take longer to grow and finish an animal is possibly better long term than trying to force an animal to finish quicker. This is a view that a lot of regenerative farmers will follow.

The future for venison would appear to be promising with its high nutritional density and health benefits and its sustainable production methods. Deer farming is one of the very few farming sectors which has a wild alternative; therefore, the safeguarding of public perception is key and the desire to produce a superior and traceable product is paramount. There are lessons to be learnt from looking at one of the only other farming sectors which has a wild counterpart. The salmon farming industry has gone full circle from making farmed salmon an everyday protein to now having to defend itself against critical public perception after failing to take care of its wild counterpart and its surrounding eco-system in pursuit of cheaper food production. This provides parallels for UK deer farmers as wild deer numbers increase. The rising cull of wild deer provides a sustainable, marketable product of increasing quality at a low price. Deer farmers must compete successfully with this if deer farming is to have much of a future.

There are still lessons to be learnt from the larger livestock sectors which have moved to a more intensified system. A lot of these new ways of thinking can be implemented with deer if the natural cycle of the animal is followed, especially taking account of their behaviours at key times of pressure in the lifecycle. Otherwise there will be damaging impacts on farmed deer and the promise of increased production will not be seen or gained.

CHAPTER 7: RECOMMENDATIONS

There is still further quantitative work needed on the housing of deer over winter in order to try and work out why an individual animal is selected by dominant deer to be bullied, what square meterage of floor space per deer when housed, which diets may be related to stress, how hormone levels change during the winter and which shed design minimises stress in housed deer. The use of different coloured lights may be another point which may help settle animals further. The true economic losses caused by bullying need to be quantified.

Commercial scale enrichment needs to be looked at for deer to highlight the true benefits. Even in field enrichment could be looked at in intensive systems.

The largest failing of this study was the lack of quantitative data collected to form sound answers. A greater understanding of deer milk production, udder conformation relating to calf growth rates and the possibilities of breeding high growth rate and milk yield genetics is needed. Venison markets and the increasing competition between the wild and farmed product needs reviewing as well as the economics of UK deer farming in a monopoly market.

CHAPTER 8: CONCLUSIONS AFTER MY STUDY TOUR

In conclusion, red deer which are habituated to a farm are quite well adapted to be in a farming system. Deer farming would appear to work well if the type of farming system is suited to the landscape and climate of the area. In addition, the animal type selected needs to suit the farm and the farming system, especially if a more intensive farming system is needed.

The more extensively the deer are managed, the better for the animal, allowing it to express its natural behaviours rather than having to adapt to a farming system where stresses or social stresses are then seen in the animal's behaviour. If intensification of deer farming is sought, then care must again be taken to select animals which can tolerate the intensification that is required and to ensure that space at all opportunities is maximised per animal at the key times through the year when animals are following their natural cycles and behaviours. When stock is housed farmers should aim for $6m^2$ per adult hind, minimising the time stock is housed for, careful selection on grouping and a large emphasis on enrichment at housing will help reduce bullying and increase welfare.

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APPENDIX 1. SURVEY QUESTIONS

Questions for winter housing:

1. What animals do you house over winter?

   Calves, MA hinds yearlings, stags

2. What is the main reason for you farming deer?

   Commercial venison, Small scale venison, live sales, antlers, hobby, other

3. What type of deer do you farm?

   English Red, eastern red, elk, X breed, Mix of deer, Other

4. If you have different types of deer, do you house/treat them differently?

   Yes NO

5. How do you house your stock? E.g. Barns, winter pads/yards, woods, other

   Hinds? -

   Calves? -

   Yearlings? -

   Other ?

6. Do they have outside space as well?

   Yes/No

7. How many deer are you housing per winter?

8. What size groups do you have the deer in over the winter.

9. How do you group your deer over the winter?

   Mixed sex, single sex, Mixed age, size/weight, age, mobs from outside, other.

10. What stocking rate do you house your stock for each cohort?

    Sq.m/per deer (total including outside space if any.)

    Calves,

    Hinds

    Other

11. Stocking rate of animals inside only per sq/m.

    Calves

    Hinds

    Other

12. Are your winter areas designed specifically for deer?

    Yes/No

13. Can the deer see out freely?

    Yes/No

14. How much activity/people presence do the deer see through the day?

    None, Very little, some, lots, constant activity

15. Why do you bring deer in?

16. Which Month do you normally bring in your deer inside? (each cohort Calves, Hinds Yearlings?)

    Hinds:

    Calves:

    Other:

17. How long do you normally house your stock for? (each cohort, Calves, Hinds, Other.)

    Hinds:

    Calves:

    Other:

18. What do you bed your stock on?

    Straw, wood chip, sand, other

19. How often do you bed your stock down?

    Daily, every other day, weekly, other

20. How do you bed your stock down?

    Hand, straw chopper, tractor/loader, other

21. Are the stock still in the area when bedded down ?

    Yes/No

22. What do you generally or mostly feed your deer on over the winter? (multi choice)

    Grass silage, maize silage, barley, concentrate, Hay, bi-products, beet, other

23. Do you feed clamp silage or bale silage?

    Clamp/Bales

24. How do you feed your deer?

    Twice a day, daily, every other day, weekly, other

25. Is there any time your stock would be without feed? (e.g between feeds)

    1-3 hours, 3-6 hours, 8 hours +

26. What % of stock can feed at any one time?

27. Do you mix deer from different mobs at housing?

    Yes/ No

28. Do you put any enrichment in for your deer?

    Yes/No

29. If yes, what enrichment do you put in?

30. Do you change said enrichment and how regularly do you change it.

31. Do you have lights on in your sheds over night?

32. Are your lights standard lights?

33. If not standard please explain.

34. Is the whole shed lit, some or dully light through the night?

35. Are your lights coloured, if so which colour?

36. Do you see/experience bullying in your housed deer?

    Yes /No

APPENDIX 2: READER'S QUESTIONNAIRE

Bullying Expanded:

I would very much like to hear from as many of you as possible with regards bullying of deer inside over the winter. If you have any spare time or would like to become part of my further study, I would very much appreciate it if you could fill out the further questions. If you would like to take part in my study which will involve some basic observations of your deer over the winter a monitor farm, please get in touch.

When did your deer come into the sheds this year? Calves, Hinds, etc.

When do you normally turn animals back outside?

How long after housing was the first bullying seen for each cohort?

What animal/s where first bullied? (size, small, big, age, sex)

Any reasons (injury, from another group, scanned dry etc)

Do you see bullying in a certain shed or group?

Do you see bullying in a particular line of your deer?

If yes, what line and age of deer are they?

Type of bullying? E.g. kicking, biting, chased by multi animals, weight loss?

Which animals are doing the bullying?

Does the bullying result in you removing the animal from the group?

What do you do with the bullied animals?

Do you find the bullying continues all winter?

Do you do anything to help combat the bullying?

Do you have any thoughts on bullying and ways to prevent it or make it worse?

Dan DeBaerdemaecker

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