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WELFARE OF FARMED DEER – PRACTICAL ASPECTS

***Paweł Janiszewski*[1], *Marek Bogdaszewski*[2], *Daria Murawska*[3], *Katarzyna Tajchman*[4]**

[1] Department of Fur-Bearing Animal Breeding and Game Management
University of Warmia and Mazury in Olsztyn
[2] Institute of Parasitology of the Polish Academy of Sciences,
Research Station in Kosewo Górne, Poland
[3] Department of Commodity Science and Animal Improvement
University of Warmia and Mazury in Olsztyn
[4] Department of Companion and Wildlife Animals
University of Life Sciences in Lublin

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Abstract

In the 20th century, members of the family *Cervidae*, in particular the red deer (*Cervus elaphus*), the fallow deer (*Dama dama*) and the sika deer (*Cervus nippon*), became relatively popular farm animals. Deer farming continues to develop, albeit at different rates, in Europe and worldwide. In deer farms, the fulfillment of the Five Freedoms listed in the Codes of Recommendations for the Welfare of Livestock (FAWC 2014) may involve somewhat different measures in comparison with other livestock animals due to the specific biological requirements, behavioral patterns and low levels of domestication in cervids.

Numerous requirements have to be fulfilled to achieve high levels of welfare in animal farms, including deer farms. They include an adequate diet that meets the animals' nutritional needs, the use of appropriate materials and solutions for building farm equipment and devices, selection of adequate personnel and appropriate animal handling procedures. In deer farms, several fundamental conditions have to be met to guarantee minimum welfare levels. Additional requirements that improve the welfare of farmed red deer and fallow deer have been formulated based on many years of observation, experience and scientific research.

Address: Paweł Janiszewski, University of Warmia and Mazury, ul. M. Oczapowskiego 5, 10-718 Olsztyn, Poland, phone: +48 (89) 523 44 42, e-mail: janisz@uwm.edu.pl

DOBROSTAN FERMOWYCH JELENIOWATYCH – ASPEKTY PRAKTYCZNE

***Paweł Janiszewski*[1], *Marek Bogdaszewski*[2], *Daria Murawska*[3], *Katarzyna Tajchman*[4]**

[1] Katedra Hodowli Zwierząt Futerkowych i Łowiectwa
Uniwersytet Warmińsko-Mazurski w Olsztynie
[2] Instytut Parazytologii Polskiej Akademii Nauk, Stacja Badawcza w Kosewie Górnym
[3] Katedra Towaroznawstwa Ogólnego i Doświadczalnictwa
Uniwersytet Warmińsko-Mazurski w Olsztynie
[4] Katedra Hodowli Zwierząt Towarzyszących i Dzikich
Uniwersytet Przyrodniczy w Lublinie

Słowa kluczowe: *Cervus elaphus*, *Dama dama,* wyposażenie, obsługa, żywienie, stres.

Abstrakt

W XX wieku niektóre gatunki z rodziny jeleniowatych, zwłaszcza jeleń europejski (*Cervus elaphus*), daniel (*Dama dama*) i jeleń sika (*Cervus nippon*), stały się dość popularnymi zwierzętami gospodarskimi. Hodowla jeleniowatych rozwija się, choć w różnym tempie, w Europie i na świecie. W ich utrzymaniu fermowym powinno być spełnionych pięć zaleceń dotyczących wolności, wymienionych w Kodeksie dobrostanu zwierząt gospodarskich (FAWC 2014). Ze względu na specyficzne wymagania biologiczne, brak wzorców zachowań i niski poziom udomowienia jeleniowatych może wiązać się to z zastosowaniem odmiennych wskaźników, w porównaniu z innymi zwierzętami gospodarskimi.

Wiele wymagań musi być spełnionych, aby osiągnąć wysoki poziom dobrostanu zwierząt gospodarskich, w tym jeleni. Należą do nich odpowiednia dieta, która zaspokaja potrzeby żywieniowe zwierzęcia, stosowanie odpowiednich materiałów i rozwiązań do budowy sprzętu i urządzeń, wybór odpowiedniego personelu i odpowiednich procedur obsługi zwierząt. W hodowli jeleniowatych musi być spełnionych kilka podstawowych warunków, aby zagwarantować minimalny poziom dobrostanu. W pracy przedstawiono wymagania sformułowane na podstawie wieloletnich obserwacji, doświadczeń i badań naukowych, które po zastosowaniu poprawiają dobrostan hodowanych jeleni i danieli.

Introduction

Man has been using animals to satisfy own needs for millennia. Human attitudes towards animals evolved throughout history, from early primitive hunting, through domestication to industrial livestock production. A positive change in man's attitude towards animals was observed in the late 20th century (PHILIPS 2009). This period witnessed the birth of the Animal Welferism movement which relies on the basic premise that humans have the right to use animals as long as the animals' biological needs, including access to food, water, protection, shelter, medical care, freedom from pain and suffering, are met (PHILIPS 2009, GODDART 1998, ETIM et al. 2013). In 1965, those needs were outlined as the Five Freedoms in the Codes of Recommendations for the Welfare of Livestock developed by the Farm Animals Welfare Council (FAWC 2014):

1. Freedom from hunger and thirst – ready access to water and diet to maintain health and vigor.
2. Freedom from discomfort – provision of comfortable resting space, shelter and an appropriate environment.
3. Freedom from pain, injury and disease – prevention or rapid diagnosis and treatment.
4. Freedom from fear and stress – provision of conditions and treatment which eliminate mental suffering.
5. Freedom to express normal behavior – provision of sufficient space, proper facilities and appropriate company of the animal's own kind.

The above welfare requirements constitute the basic principles for animal handling, and they should not be debatable in a civilized society. The objective of research and husbandry measures should be to develop breeding methods which ensure that profits are increased by fully catering to the animals' biological needs rather than through ruthless exploitation (PIASENTIER et al. 2005).

In deer farms, the fulfillment of the Five Freedoms listed in the Codes of Recommendations for the Welfare of Livestock (FAWC 2014) could involve somewhat different measures in comparison with other livestock animals due to the specific biological requirements, behavioral patterns and low levels of domestication in cervids.

This paper discusses the key welfare requirements for deer farms, including the optimal environment for females and their offspring during the breeding season.

Welfare of farmed deer – discussion

Designing, building and equipping deer farms

Deer farms can be established on various types of land, including areas where other types of agricultural production are not profitable, provided that grasslands are available. The quality of pastures can be improved and maintained through various farming operations, including fertilization, mowing left-over vegetation and reseeding pastures with valuable species of grasses and legumes. The size of the land for building a deer farm is determined by various factors, including the farmed species or breed, topography of the site, availability and quality of pastures, cost and availability of supplementary feed, distance from markets/processors, and enterprise structure (TUCKWELL 2003).

A farm should be an integral site to guarantee full functionality for animals and the staff. Pens, shelters and all farm facilities should be connected to a handling facility joined by a raceway for herding deer. Different layouts can be used, depending on the shape, surface and size of the land plot, production intensity and enterprise structure. A rectangular layout with a centrally positioned raceway is the most popular solution. The raceway runs adjacent to all pens, joining them with one another and with the handling facility. In this layout, animals can be moved in all directions. This solution can be modified by connecting selected pens with the largest paddock via a narrowing raceway or a small raceway with a handling shed. The layout of a deer farm should ensure problem-free movement of animals between paddocks and from/to the raceway and the handling facility. According to HAIGH et al. (2005), injuries sustained during herding, catching and transport of animals are the most common causes of death in white-tailed deer (*Odocoileus virginianus*) farms. For this reason, the farm and the handling facility should be designed with utmost care. Deer are more likely to pace up than down the fence, they change direction at an angle of less than 90° from the fence and bypass obstacles from a distance. This knowledge should be used to plan gates and mark strategic locations with planks and poles. Gates should be positioned in corners for practical reasons. A centrally located gate is a "hole in the wall", and deer may be unwilling to cross it. Corner gates allow for the use of long and uninterrupted stretches of fencing mesh that can be fixed and joined without complications. This solution also facilitates the movement of animals between opposing pens. According to TUCKWELL (2003), „V" gates as well as three-way and four-way gates best serve the purpose. All three solutions deliver numerous possibilities and are highly practical. Gates should be at least 3.5 m wide to create access for machinery. Raceways, entrances and suboptimally located gates should be shuttered to make them more visible for animals and to prevent deer from jumping over them. Raceway walls should be tightly shuttered to prevent injury, and they should be higher than netting (more than 2 m). Fallow deer can clear fences 2 m tall, therefore, fences in fallow deer farms should be even higher (DEFRA 1989). Raceways should not turn at right angles, which can lead to crowding and the risk of stampede with disastrous consequences (MATIELLO 2009). Raceway width should be adjusted to the animals' specific needs.

Mesh fencing is a crucial part of a deer farm, and next to stock purchase, it constitutes one of the highest initial expenses. The proper deer netting has fixed knots, it is highly resistant and acts as a shock absorber, therefore, animals that hit against the fence are not seriously injured and do not damage the fence. Young animals are particularly prone to hitting the fence, and the resulting mortality is much higher in farms that do not use flexible netting. Shock-absorbing netting keeps deer safe from predators (dogs and foxes can

kill up to 50% of calves/fawns) because mesh openings are smaller at the bottom. Netting should be bedded in the ground to prevent predators from digging under the fence and entering the farm. A typical fence should have the height of 1.8 to 2 m. High voltage electrified wire on outriggers may be used on the outside of the fence to protect deer from feral dogs. GODDARD et al (2001) studied behavioral responses of red deer to fences of five different designs. They reported the best results (animals did not pace the fence) for a conventional fence (netting with the height of 1.9 m) and a fence with an inverted "L" shape (with the height of 90 cm and horizontal mesh with the width of 80 cm at the top). Deer frequently paced the remaining types of fences: a low fence (90 cm) with offset electric wire, a low (90 cm) double fence (two rows of mesh separated by a distance of 1 m), and a tall fence (1.9 m) with four webbing tapes above.

Every deer farm should provide the animals with appropriate shelter to guarantee high welfare standards (MAF 2007, DEFRA 1989, DEFRA 2013, MATIELLO 2009). The hair coat does not protect deer perfectly against adverse weather and every farm should offer quarters that shelter the animals from wind, rain and snow. Shelter and shade can be provided in a variety of ways by relying on natural features (valleys, indentations), groups of large trees and shrubs, hedges or man-made objects such as buildings, haystacks and straw bales (MAF 2007). Farms situated in open areas could benefit from planting trees. Young trees should be encased with shutters, metal grids or mesh to protect them from browsing, and larger trees should be adequately secured to prevent stags/bucks from chewing the bark and rubbing their antlers on tree stems. Farmers in New Zealand (MAF 2007) and the United Kingdom (DEFRA 2013) are also advised to provide the animals with resting spaces on dry ground, in particular if the farm is situated in a damp or waterlogged area, by spreading large amounts of straw on raised ground. Shelter (visual isolation) also minimizes aggressive behavior in animals. Artificial shelters and visual barriers built with the use of fabric and plastic sheeting in pens for red deer hinds reduced aggressive behavior by 60% in comparison with hinds kept in an open paddock (WHITTINGTON and CHAMOVE 1995). Pregnant females should be provided with shelter in the perinatal period and for minimum two weeks postpartum even in the absence of extreme weather events (MAF 2007, DEFRA 1989, MATIELLO 2009).

The topography of the farm site is a very important consideration. Trees, shrubs, roads, ponds, hills and valleys are the key elements of the local landscape. Trees provide shelter and shade, and indentations and valleys can serve a similar purpose. Hilly terrain promotes physical exercise and contributes to animal welfare. According to the recommendations of the New Zealand Deer Code of Welfare, females should be kept in hilly paddocks before mating

because regular exercise improves their physical condition (elimination of excessive fat), contributes to reproductive success (fertilization efficiency) and lowers the risk of complications during parturition (MAF 2007). A deer farm does not have to incorporate a forest which is not an attractive pasture area and is costly to fence in. A forest offers shelter from the wind, in particular in winter, and provides visual isolation, but in order to serve this purpose, it is enough if a forest is situated in the vicinity of a deer farm. Laneways should be wide enough to enable farming machines to supply feed, water, hay and straw to all facilities or to mow grass. If possible, calving/fawning paddocks should be situated far from roads. Cervids have a preference for natural bodies of water over artificial water reservoirs. A farm should not be set up on large swamps because deer eagerly hide in such areas, and they are difficult to chase out, which increases the risk of the animals going wild. Ponds and marshes are potential sources of parasites and their indirect hosts (snails). For this reason, an absence of natural ponds in pens could be a certain advantage because artificial reservoirs (concrete rings, plastic containers, troughs) contain clean water and can be used to administer vitamins, micronutrients and medication. Despite the above, ponds and water-logged territories enable deer to express their natural behavior and wallow in mud. The animals roll around in mud to get rid of external parasites, cool off during hot weather and to mark the ground with their scent in the mating season (CLUTTON-BROCK et al. 1982, MATIELLO 2009). Water facilities should be designed to minimize fouling and wastage. Demand for water increases during spells of hot weather. Stags/bucks need more water during the rut, hinds/does – during lactation, and calves/fawns – in the first 10 days after weaning (MAF 2007). According to Animal Welfare Guidelines for deer farms in Tasmania, fallow deer does need around 10 liters of water per day (DEPI 2008).

Handling facilities

Every deer farm requires a handling yard where animals can be safely divided into groups, prepared for transport and subjected to various health and maintenance procedures, including deworming, tagging, antler cutting and pregnancy diagnosis. Handling facilities should be designed and built with utmost care in view of the needs of the farmed species and herd size. Special attention should be paid to the entrance to a handling facility, the type of materials used and the construction method. A conventional handling yard is designed on a rectangular plot, and it features several smaller pens for separating the animals, a utility shed and a loading ramp. The handling pen can also be circular with a utility shed and crush in the center and holding pens

along the perimeter. The design and construction of deer handling facilities are described in detail in *Safe Practical Deer Yards, a New Zealand guidebook* by CUDBY (2004). Handling facilities should be designed to minimize the risk of injury (absence of protruding elements, no spaces between shutter planks, solid and smooth walls, non-slippery flooring or no flooring) and stress (gates that do not produce noise, problem-free movement of animals, darkened sheds) and increase operating efficiency (at least some facilities should be roofed, the utility shed should have electric power and running water, handling facilities should be sufficiently lit to examine the animals and diagnose any signs of disease or injury). Cervids, in particular fallow deer, settle much more easily in darkened premises or in complete dark, and they are more eager to move from darker to lighter facilities. The above observations should be taken into account when designing handling yards to facilitate handling operations and minimize stress resulting from movement and immobilization (MAF 2007, MATIELLO 2009). Deer should be handled quietly with care and patience. The operators should speak in a soft voice to calm the animals down, get them accustomed to human scent and send the message about the operator's presence in a dimly lit shed. All operations should be performed quietly, quickly, efficiently and according to the same routine. Cervids are herd animals, and individuals should not be isolated from the group. If an individual has to be quarantined or separated from the group for health reasons, it should have visual contact with other animals. Cervids should not be handled in periods of adverse weather, including thunder and hailstorms, strong winds or excessive heat (MAF 2007).

Every handling facility should be equipped with a crush to immobilize deer, perform grooming operations, administer medical treatment and slaughter animals. The choice of an appropriate crush should be dictated by the farmed species, the size of the herd and how tame the animals are. Crushes are generally divided into two categories: mechanical and hydraulic. Mechanical crushes include box-type pens and crushes where the animal is restrained between two walls. In the latter type, an animal enters the crush, and it is suspended by its shoulders between two skewed walls, with its feet off the floor. The animal is released when one of the sides is moved away from the other. Those types of crushes are suitable for red deer and fallow deer, but due to their small size and lack of a head restraining mechanism, they are not highly effective for immobilizing stags/bucks, in particular those with hard antlers. This restraint method is relatively stressful for animals, but provides safe and direct access to the animal and is relatively inexpensive. Box-type pens are made of two parts which, when closed, immobilize the animal and leave access to head. They are suitable for fallow deer, and they facilitate blood sampling, tagging, medical tests and slaughter. Hydraulic crushes offer the

greatest comfort and enable the operator to access the animal from all sides. Animals are restrained between hydraulically controlled, padded walls. Hydraulic crushes have one or two moving sides. Upon entering the crush, the animal is immobilized together with the head. A hydraulic crush is easily adjusted to the animal's size, which minimizes the risk of injury, increases safety and facilitates various operations, including antler cutting. The greatest disadvantage of a hydraulic crush is its high price. Blood, hair and bird droppings should be regularly removed from a crush. Handling facilities should also be kept clean and free of animal feces (MAF 2007).

Deer should be familiarized with handling facilities and management routines from an early age to reduce apprehension and assist handling (MAF 2007).

Nutrition

Quality pastures are the key to healthy nutrition in a deer farm. For best results, animals should graze in a rotation system where the height of grass cover reaches 10–12 cm, and when it is reduced to 5–6 cm, they are moved to a different pasture. In this approach, animals eat young leaves with the highest nutritional value. Under suboptimal conditions (drought, poor soils and low quality sward), a pasture should be stocked with 5–10 red deer hinds or 10–20 fallow deer does with offspring per hectare. If forage growth is insufficient, animals should be provided with supplementary feed. The nutritional requirements of cervids change on a seasonal basis. Physiological processes and behaviors, such as molting, antler growth, appetite, reproduction, lactation are strongly correlated with day length. The most energy consuming processes, including lactation and antler growth, take place in periods characterized by the highest availability of food sources. Winter feeding should rely on high-quality feed with high energy content to satisfy the maintenance requirements of animals, prevent weight loss and minimize mortality. The energy demands of deer increase by 20–30% if the animals are not adequately sheltered from wind and snow. Nutrition levels and feed utilization are also influenced by the animals' age, sex, size, body condition, health status, level of activity and exercise, weather conditions and provision of shelter (MAF 2007). Young animals, stags/bucks that are growing antlers, hinds/does in the last trimester of pregnancy and lactating females have higher energy requirements which should be met by administering high quality feed. All animals should have free access to feed to minimize aggressive interactions and to cover the nutrient requirements of subordinate individuals (MATIELLO 2009). In winter or in large commercial farms where pastures are not the main source of nutrition,

animals should be provided with high quality hay, barley straw or silage to increase dietary fiber intake. Poisonous plants, plastic waste, strings, wire and other man-made objects that can be ingested by deer should be removed from pastures. Changes in diet should be introduced gradually to enable ruminal flora to adjust to new food and to prevent digestive problems (MAF 2007, DEPI 2001). Good nutrition is an important tool for animal stress management. When an animal is improperly fed, stress has even greater negative impact on his health. The period of stress for deer is the time when the content of proteins in the fodder is low. Deer demand on the crude protein (CP) is minimally 6–7% to proper functioning rumen. However, the diet containing less than 10% CP results in inferior antler growth and muscle development. Optimal protein amount for the proper development of bones and muscles in the daily feeding of deer is 12–16%. In addition to this component in the diet of deer you cannot be missed the calcium and phosphorus (PERKINS 1991). Detailed information about the nutrient requirements of farmed deer, feed types, daily rations and energy demand subject to the animal's sex, age and physiological state can be found in the literature (ASHER et al. 1996, ASHER et al. 2005, LANDETE-CASTILLEJOS et al. 2002).

Handling stress and its influence on animal welfare

Cervids which have not developed positive contact with humans, excluding individuals that were raised by humans, are difficult to race, catch and handle. The stress of restraint can also significantly compromise welfare (RUSHEN et al 1999).

In a study of red deer calves, MATIELLO (2009) demonstrated that regular contact with humans during management routines decreases the percentage of heart rate peaks associated with human presence in the pen. Grigor et al. (1998) examined the responses of one-year-old red deer hinds to five procedures: transport, immobilization in a crush, human presence, visual isolation from the herd, and escape. Stress responses were measured by the speed with which animals entered the raceway leading to a handling facility. Hinds were most stressed after 5 minutes of immobilization in a crush and after 5 minutes of transport. Animals that were not subjected to additional stressors were the first to enter the raceway. POLLARD and LITTLEJOHN (1996) evaluated the influence of pen size on the behavior of red deer stags in various seasons. In large paddocks, aggression levels and behavioral signs of stress (fence pacing, vertical head movements) were lower regardless of season than in small pens, but the observed trends were more highly expressed in summer. If several individuals have to be temporarily separated from the herd, males should be

provided with adequate space, in particular in summer months preceding the rut, to maintain acceptable welfare standards. CARRAGHER et al. (1997) used automatic blood sampling kits and heart rate monitors to demonstrate that isolation, human contact and restraint cause stress responses. Immobilization in a crush was the greatest stressor. It has been shown that by taking blood from the animal deprived physically of the possibility of movement hematological and biochemical parameters indicated less stress, unlike in the animals which were treated with sedative pharmacological or shot gun. It was observed slightly (P>0.05) elevated parameter values such as: AST (aspartate aminotransferase), ALT (alanine aminotransferase), GGT (gamma-glutamyl), GLDH (glutamate dehydrogenase), the amount of albumin and WBC (total leukocyte count) in blood from animals immobilized physically, and a lower amount of Hb (hemoglobin), RBC (red blood cell count) and PVC (total volume of blood elements). Higher WBC in blood of deer that were deprived physically of the possibility of movement as compared to chemical methods, may be the result of shrinkage of the spleen and isolated by a catecholamine, other parameters may be caused myopathy. The amount of glucose in the blood was increased regardless of the manner of collecting the blood, and may be caused by stress, which activates the sympathetic nervous system and thus increases the secretion of adrenaline. However, high glucose levels in the animals chemically deprived of movement may be due to the use xylazine that in ruminants causes hyperglycemia and, consequently, weaken the immune mechanism (VENGUST at al. 2006). There were no significant differences between chemical appeasing and shooting the animal. It seems, therefore, that the fleeting stress caused by physical anchorage is less intrusive than administration of pharmacological agents. The hypothalamic-pituitary-adrenal axis was activated during each stress response, but the measured parameters quickly returned to norm when the animal was reunited with the herd. The above results could suggest that handling procedures do not significantly compromise deer welfare, but it should be remembered that stress and fear that accompany management routines can lead to injury or even death.

RECARTE et al. (1998) investigated the ways in which fallow deer, kept in a park, responded to human presence. The distance to which the animals moved away from humans was determined by the sense of security offered by the environment (paddock design) and the degree to which deer were familiarized with humans. Does with offspring were much more likely to run away from humans that other groups of fallow deer, which could be attributed to the female instinct of protecting the young from potential aggressors. POLLARD and LITTLEJOHN (1995) and CHAYA et al. (2006) observed that red deer have highly individual responses to human contact and handling procedures. According to CHAYA et al. (2006), temperament plays an important role during

selective breeding. They reported that calves obtained by crossbreeding red deer and wapiti were calmer during catching and administration of medicine. Timidity and fear of humans are traits that are partially inherited from parents, but they can be alleviated by breeders through adequate handling and by culling the most problematic individuals.

According to MANTEUFFEL et al. (2009), rewarding farm animals for displaying certain types of behavior can improve animal welfare, minimize fear of humans and facilitate handling. Such behaviors include responding to specific cues (visual or auditory), regular and frequent calling of individuals to a feeding facility, calling cow groups to milking parlors or presenting horses with visual patterns on a screen which indicate access to oats. The above authors postulated that cognitive enrichment based on instrumental behaviors and positive responses to specific situations can minimize stress levels associated with changes in housing environment or handling. Auditory cues are used to stimulate feeding behaviors in a large open space moose farm in Kostroma, Russia (MINAEV et al. 1984). A similar approach could be used in deer farms.

Segregation and stocking density

European fallow deer and red deer are highly social animals that inhabit large areas in sexually segregated groups during anestrus season and in mixed-sex groups during the rut. Even under intensive management conditions, deer tend to maintain sexual segregation, in particular during the birth season. Mixed-sex groups are the most common type of social aggregation when space is limited, in particular during feeding activity (MATIELLO et al. 1997). Breeders should allow deer to engage in natural behaviors and when needed maintain sexually segregated groups by providing animals with appropriately designed pens, managing and stocking the herd in accordance with high welfare standards. A herd should be divided into groups. It is determined by the size of the farm and the handling facility. Males and females should be segregated for the most part of the year, and they can be additionally divided into age groups (1- and 2-year olds and older). Spike bucks rub off the velvet on their antlers more quickly than older bucks, and segregation can prevent aggressive young bucks from attacking mature males. The segregation of hinds/does into age groups can improve the overall condition of the youngest females and fertilization rates. Calves/fawns which are weaned in winter should be segregated into sex groups in spring. This approach promotes early cutting of single spikes and separation of selected calves/fawns for sale or slaughter. Segregation also supports feed optimization to accommodate the

specific needs of a given group. Individuals of the same age group consume similar amounts of feed, which would not be the case if they were kept together with older and more dominant animals. Segregation also reduces losses associated with overfeeding dominant group members. Members of sex- and age-segregated groups, including pregnant hinds/does, weaned calves/fawns and stags/bucks, can be fed different diets that are adapted to their specific nutritional needs.

Pasture stocking rates determine individual weight gains, natural behaviors and stress levels, and they influence animal welfare. BLANC and THÉRIEZ (1998) analyzed the effect of stocking density on social behaviors, daily activity levels and weight gains in one-year-old red deer hinds kept in a pasture. The herd was divided into two experimental groups: a low density group (LD, 37 animals/ha) and a high density group (HD, 150 animals/ha). Aggressive behaviors such as kicking, biting, head hitting and threatening poses were much more frequently noted in group HD. Total grazing time did not differ significantly between groups and group HD females grazed more often but for shorter periods of time than LD group females. Simultaneous grazing was also lower in group HD. LD group hinds grew at a faster rate. Stocking density was more likely to influence the growth rates and grazing behavior of subordinate individuals than dominant animals. The cited authors concluded that high stocking density causes stress during social contact, which influences grazing activity and growth rates, in particular in subordinate individuals. The frequency of antagonistic behaviors displayed by red deer calves increased with stocking density (MATIELLO 2009). POLLARD and LITTLEJOHN (1996) also observed that aggression levels in red deer stags increased with a reduction in pen size and individual space.

In their natural habitats, red deer and fallow deer females leave the herd in the perinatal period and return 1–2 weeks later (CHAPMAN and CHAPMAN 1975, CLUTTON-BROCK et al. 1982). In the farm environment, small pen size, high stocking density, synchronized calving/fawning and shortage of shelters can prevent deer from expressing their natural behaviors, thus disrupting the natural cycle. As a result, many hinds/does give birth at the same time in constrained space, which can discourage females from bonding with their offspring. In farms, hinds/does assist other females in bringing up their offspring or raise foreign offspring. Human presence is a source of additional complications, and animals are stressed even when the observer remains in hiding (WASS et al. 2004). Research indicates that hinds which are unable to bond with their young often abandon their offspring, which is never observed in wild deer populations (ASHER et al. 1996). In crowded calving paddocks, newborns hidden in grass are accidentally trodden on by other animals, calves are "stolen" by females that have never calved or have miscarried, the

offspring of hinds that are unable to find an isolated place for delivery may be stillborn, and hinds pace and clear the fence in an attempt to find appropriate shelter. In deer farms, rapid fence pacing could be a sign that a female will shortly go into labor (POLLARD et al. 1998, WASS et al. 2003, ASHER et al. 2007, ASHER et al. 2014). Fence pacing intensifies when humans are present in the vicinity of the calving paddock (POLLARD et al. 1998) and in smaller and overcrowded paddocks (ASHER et al. 2007). Fence pacing is a stress response, and breeders should provide pregnant females with sufficient space to minimize unwanted behaviors. Stress during delivery can lead to complications, stillbirths and abandonment of offspring. Hinds that go into delivery near the fence will be disturbed by other animals which can accidentally tread on the newborn. Calves can also attempt to cross the fence, often with lethal consequences. Pregnant hinds should also have access to isolated shelters where they can hide from other members of the group. In their natural habitat, hinds give birth in areas overgrown with shrubs, reeds, nettles and ferns where newborns spend the first few days of their lives (POLLARD and STEVENS 2003). Calving/fawning paddocks should be provided with an adequate number of sheltered sites where the young will spend the first few weeks of their lives. In deer farms, the design and construction of breeding areas where calves/fawns are born and reared should be well planned to ensure the success of breeding operations and high levels of animal welfare.

Designing and building calving/fawning paddocks

Deer should be provided with a sufficient number of sheltered sites during delivery and offspring rearing. Natural shelters, such as shrubs, nettles, ferns and tall grass, are preferred, but if not available on the site, they should be replaced with man-made facilities. Calving/fawning paddocks are crucial in every farm. A shortage of secluded facilities where hinds can give birth away from other members of the group raises stress levels, increases the risk of complications and calf mortality (WASS et al. 2003). If suitable calving/fawning areas are overcrowded, females can choose to give birth in suboptimal locations, such as under the fence or in an open area, thus exposing the newborns to excessive solar radiation (MATIELLO 2009). HODGETTS et al (2002) reported that the availability of secluded areas contributes to animal welfare. They also observed that the type (natural or man-made) and shape of shelters are important. Natural shelters (nettles, ferns) were more frequently used than artificial structures. Calving/fawning paddocks should be situated far from busy roads and noisy sites (MATIELLO et al. 1997, POLLARD and STEVENS 2003).

In densely stocked paddocks with an insufficient number of hiding places, calves/fawns can be licked, sniffed, pushed or kicked by other females. Disturbed calves/fawns may begin to pace the fence, where they can be trodden on by other individuals. Young deer can sustain injuries in contact with aggressive females, and some calves/fawns attempt to cross the fence in search for a better hiding place, often with lethal consequences. For this reason, calving/fawning paddocks should be spacious, stocking rates should be kept low and adequate to the number of available shelters (WASS et al. 2004). The New Zealand Deer Production Guide (BEATSON et al. 2000) proposes a test for evaluating calving/fawning paddocks. Shelters receive points for fulfilling specific criteria that contribute to animal welfare in the perinatal period and during offspring rearing. The following factors are evaluated: size of the calving/fawning paddock, distance from roads and other disturbing sites, topography of the site (percentage of flat and undulating areas), presence of hills, trees, tree trunks, rocks, ponds, rivers, protective green belts around the paddock, percentage of shaded area, type of fence netting, type of pasture, plant species and plant height, stocking density in the paddock.

AUDIGÉ et al. (2000) analyzed factors that influence the survival of fallow deer fawns between birth and weaning. The experiment was performed on hinds which were diagnosed as pregnant 50–70 days after the rut. The offspring of 17% of primiparous hinds and 9.2% multiparous hinds did not survive until weaning. Most deaths occurred in the perinatal period or several weeks after birth. The cited authors concluded that reproductive success is determined by individual traits as well as by herd management during birth and in later periods. The body condition scores (BCS) of hinds significantly influenced the survival of offspring and were positively correlated with the body weights of hinds in winter. The administration of high quality feed to females already in early stages of pregnancy can considerably contribute to reproductive success. The discussed study revealed that stocking density influences the survival rates of offspring. According to the cited authors, high stocking density does not pose a threat in itself, but it can have highly negative consequences when combined with other factors, such as malnutrition or shortage of safe areas where hinds can give birth or hide their offspring. In the above study, tagging at birth did not influence the survival rates of calves. Weather was an important consideration, and moderate temperatures without extreme weather events were most conducive to healthy growth and development. Drought and high temperatures contributed to the risk of dehydration and hyperthermia, whereas overcast weather and rainfall could lead to hypothermia. Immediately after a thunderstorm, dead calves were found in paddocks with a limited number of sheltered sites. The presence of mature stags in the calving paddock also had a negative impact on offspring survival. The number of calves that survived until weaning increased when caretakers

regularly visited breeding areas to examine the health condition of mothers. Breeders who take good care of their herds are familiar with the animals' needs and respond quickly to any problems. According to the cited authors, the following requirements should be met to maximize breeding success: hinds should be in good health before the rut, females should not lose weight in winter, the number of early conceiving hinds should be increased, adult hinds and stags should be managed separately during calving and rearing.

The New Zealand Animal (Deer) Code of Welfare (MAF 2007) recommends the following best practices for handling pregnant and lactating hinds/does:

1. Hinds/does should be provided with appropriate feed during pregnancy and lactation to ensure that their BCS is in the range of 3–4 (on a 0–5 scale).
2. Stress, especially through overcrowding, should be minimized during calving/fawning to reduce losses in newborn calves/fawns. The provision of feed, water and shelter should be planned appropriately to minimize disturbance.
3. During calving/fawning, mothers and their offspring should not be disturbed or exposed to unfamiliar events that disrupt their routines.
4. Hinds/does with calving/fawning difficulties should be given assistance.
5. Stocking density in calving/fawning paddocks should be reduced already before calving/fawning to provide hinds/does with adequate space, safe shelters for delivering their offspring and avoid disturbance to other calving hinds/fawning does, which could lead to the loss of calves/fawns.
6. Females should be placed in calving/fawning paddocks at last 7–10 days before the anticipated start of calving/fawning.
7. Regular exercise reduces the risk of parturition problems, therefore, hinds/does should be kept in paddocks with steep hills in the prenatal period.
8. Unfamiliar deer should not be placed in calving/fawning paddocks.
9. Primiparous females should be segregated from adult hinds/does.

Conclusions

The issues related to deer farming, addressed in this paper, indicate that deer farm management is a highly complex process. Both successful deer farming and the welfare of farmed deer are determined by biological and behavioral factors on the one hand, and by the breeder's knowledge, skills and ability to adequately respond to animals' needs on the other. Many important aspects of deer farming technology remain insufficiently explored, and the findings regarding livestock (cattle, sheep) farming cannot be directly extrapolated to deer farming.

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