NUTRITION

NUTRITION

Physiology

Like sheep, cattle, goats and other ruminants, deer have a four-compartment stomach system that allows them to digest large volumes of fibrous feed. In adult animals, food is mixed with saliva in the mouth, passes down the oesophagus and collects in the rumen (1st stomach compartment). In the rumen rhythmic movements break up the feed into small particles and mix them before allowing them to flow on to the reticulum (2nd stomach compartment). More fibrous material may be returned to the mouth for further chewing (cud).

The rumen is in fact a large fermentation container where colonies of highly specialised micro organisms (bacteria and protozoa) break down the food. After fermentation in the rumen, food gradually continues down the digestive tract where further digestion and absorption takes place. Different types of micro organisms digest different feeds and it takes time for new colonies of micro organisms to build up when deer eat different feeds. For this reason it is important when feeding deer that they be given time to adjust to any changes in diet.

The digestibility of feed ingredients for deer are commonly considered to be similar to those for sheep. However, Ru et al [75] found that digestibility data for sheep cannot be applied to deer for all ingredients. Difference in digestibility can be influenced by factors including rate of passage of food through the digestive tract, structure of the digestive tract and chemical composition of feed.

Ageing Deer from their Teeth

While it is easy to estimate the age of most commercially managed ruminant livestock (sheep, goats and cattle) by examining their incisor teeth, the same cannot be said for deer.

Sheep, goats and cattle have four pairs of 'milk teeth' incisors at birth and permanent incisors gradually replace the 'milk teeth' over about four years at known ages. By observing the number of permanent incisors and the degree of wear of the incisors on the lower jaw of a live animal it is easy to estimate the animal's age.

Deer have four pairs of incisor teeth like other ruminants but all of the 'milk teeth' incisors are replaced by permanent incisor teeth by about eleven months of age although the central pair is usually replaced by 6 to 7 months of age [94].

Although it is possible for experienced people to age deer by examining their premolars and molars, the examination of these teeth in live deer is extremely difficult. Most accounts report the need to open the mouth of a dead animal further than is possible in live deer to allow a clear view of the teeth.

Information from deer hunters describes how to age deer by examination of the teeth in the lower jaw and observing:

- The number of premolars and molars
- The degree of wear seen on the premolars and molars
- The colour of the premolars and molars

In summary after about 11 months any estimate of the age of age made by examination of their incisor teeth should be considered unreliable and further examination of molar teeth is not practical in live (farmed) deer.

Deer Digestion

Hoffmann [45] classified the world's ruminants as concentrate selectors (browsers), roughage feeders (grazers) and intermediate feeders (those that both browse and graze). He differentiated species according to typical structures of the digestive tract and feed selection.

Browsers

- Rely on browse (foliage in summer; twigs in winter)
- Have large salivary glands that produce a relatively large volume of saliva that aids digestion of complex tannins
- Have small rumen and reticulum (1st and 2nd stomach compartments) relative to the digestive tract
- The opening between the reticulum and omasum (2nd and 3rd stomach compartments) is relatively large and allows passage of large forage particles
- Have a well developed caecum
- Rapidly ferment ingested material
- Rapidly excrete difficult to digest particles of forage to prevent distension of gut

Grazers

- Are adapted to grass and sedges that grow during all seasons
- Generally have a broad muzzle and flat incisors allowing grazing of short pastures
- Have relatively small salivary glands
- Saliva and rumen digestion of complex tannins less efficient
- When full, the combined rumen and reticulum (1st and 2nd stomach compartments) weight may be up to 25% of live weight

- Have an opening between the reticulum and omasum (2nd and 3rd stomach compartments) which is relatively small so movement of large particles is delayed until particles are broken down into smaller pieces
- Digestion provides slow but complete fermentation of all food consumed

Deer used for farming in Australia are predominantly intermediate feeders which means they generally use each feed type less well but benefit from greater nutritional flexibility.

Important Components of Nutrition

Energy

Measurement

Energy principally results from the biochemical breakdown of food that contains carbohydrates, fats, oils and proteins. Energy content of feed is measured in megajoules of metabolisable energy per kilogram of dry matter (either MJ/kg DM or MJ ME/kg DM).

For practical purposes energy requirements of stock are usually described as megajoules of metabolisable energy per day (MJ ME/day).[2]

Older energy measurements can be converted to megajoules using the conversion factors in Table 3.

Unit Given	Unit required	Conversion factor	
Calorie (Cal)	Megajoule (MJ)	Multiply by	0.000004184
Kilo Calorie (Kcal)	Megajoule (MJ)	Multiply by	0.004184
Mega Calorie (M cal)	Megajoule (MJ)	Multiply by	4.184
Joule (J)	Megajoule (MJ)	Multiply by	0.000001
Kilo Joule (KJ)	Megajoule (MJ)	Multiply by	0.001

Table 3: Guide Conversion Factors for Energy Values

[2] Energy requirements of grazing livestock are scientifically determined on a metabolic weight basis. Metabolic weight is calculated using the formula $W^{0.75}$ that can be calculated using the extended formula $\sqrt{\sqrt{W^3}}$ (determine W^3 (W x W x W) then determine the square root of W^3 then determine square root of that result). Scientifically stock requirements are usually expressed as megajoules of metabolisable energy per kilogram of metabolic live weight (MJ ME/$Kg^{0.75}$)

Maintenance Requirements

The fasting metabolic rate, often called the physiological maintenance requirement, of an animal is the minimum energy required to allow it to support essential physiological activities (i.e. heart beat and breathing).

Normal maintenance requirements as they relate to animal production include allowance for activities associated with normal living including, searching for food (walking), selecting food, standing, eating, ruminating and regulating body temperature. This increased allowance (activity increase) usually represents an increase of about 30% above physiological maintenance requirements.

Generally maintenance requirements described for stock include activity requirements but during times of extreme food shortage (drought), while animals are restricted to relatively small areas, they can be maintained on diets that provide less energy for activity - see the chapter on drought feeding.

Metabolisable Energy

ME is the amount of energy available to an animal after losses associated with digestion itself (used by rumen micro-organisms) and those associated with urine, dung and methane are removed.

All animals have a different ability to extract the energy within feed (efficiency of digestion). This means the energy rating of any feed may be different for different types and classes of stock.

The rate at which feed passes through a ruminant animal's digestive system depends on the rate of microbial digestion and fermentation in the rumen. The composition of food that enters the rumen determines the speed of microbial digestion and fermentation in the rumen and generally, fibrous feeds are slow to break down while young leafy and succulent food breaks down (is digested) quickly. The rate at which a food is broken down is commonly referred to as the digestibility of the feed.

Digestibility

The digestibility of an individual feed (see feed quality in the pasture chapter) is usually expressed as a percentage and provides an estimate of the proportion of feed consumed that is used by the animal. Digestibility of a pasture is directly and positively related to the energy content of pasture [72] and energy content of feed is measured as MJ ME/kg DM (MJ = Mega Joules, ME = Metabolisable Energy, DM = Dry Matter).

Digestibility %	Energy Content of Feed (MJ ME/kg DM)
40	4.8
50	5.7
60	8.2
70	9.9
80	11.6

(© Prograze Manual 1996)

Table 4: Guide estimates of Energy content of feed relative to digestibility value

Energy Density (MD)

The digestibility of a ration that may comprise one or more feeds is generally described as the energy density (MD) of the ration (MD = Energy Density measured as MJ ME/Kg DM).

The MD measure is an indicator of feed quality that:

- Indicates how much of the feed can be eaten
- Measures how much of the feed is available to the animal
- Affects how much of the available energy can be retained as body tissue

Animals with access to a diet with a low MD (maybe less than MD 8.0) must consume much more of the diet dry matter to obtain the energy they require. Animals grazing diets with a very low MD may not have the rumen capacity to consume the volume of food required to obtain the energy they need and so need a high energy supplement.

Small changes in the diet MD may influence the ability of an animal to maintain its weight or supply needs of pregnancy, lactation or growth from the available feed.

Protein

Protein (including amino acids) is required for normal growth and reproduction. Each animal's requirements vary throughout the year and are closely correlated to its stage of production. Animals that are growing, pregnant, lactating and producing velvet antler have high protein requirements relative to maintenance requirements.

Deficiencies result in poor growth rates, depressed reproductive performance of adults, increased susceptibility to disease and poor feed use efficiency. However, feeding of protein that is in excess to requirements provides little

positive outcomes and several negative outcomes. Excess protein is commonly converted into metabolites that are excreted or converted into body fat. As protein is generally expensive, money spent on excess protein is usually wasted.

Digestibility

The protein content of a feed relative to the fibre or dry matter content also affects digestibility. Bacteria and other microorganisms in the rumen responsible for initial digestion and fermentation of the feed rely on protein in feed for their own growth. If protein in feed is limiting growth of these microorganisms, the digestion and fermentation they control is significantly slowed.

Minerals and Vitamins

Deer have similar requirements for most minerals and vitamins as sheep and cattle so deer that are managed in areas known to be deficient in minerals and vitamins should be regularly monitored (see the chapter on Health). Copper is the exception and most researchers suggest that Red deer and Wapiti/Elk:

- Have a high requirement for copper
- Have a greater tolerance than sheep and cattle of high copper levels
- Have a limited ability to absorb dietary copper
- Either do not have the ability to store copper or they rapidly excrete it from the liver

Dry Matter

Within limits deer, like other grazing animals, can compensate for poor diet quality by consuming more of the feed available. Although there is some evidence that the capacity of the rumen increases when diet quality is poor [38] intake of poor quality feed is limited by the size of the rumen.

The dry matter component of a feed is simply the feed material without the water component (i.e. the feed is dried).

Fibre

While not a nutrient in itself, fibre is an important component of all ruminant diets that is needed to maintain stable ruminant function.

Recommended minimum modified acid detergent fibre (MAD) concentrations for sheep and cattle [73] are provided in Table 5.

Level of Production	Sheep	Cattle
Maintenance	100	120
Growth	120	150
Pregnancy	130	160
Lactation	150	180

Table 5: Recommended minimum fibre concentrations (gm MAD/kg DM) for sheep and cattle diets

Little specific information on dietary fibre requirements for deer exist although some anecdotes suggest that fibre content of deer diets should be about 13 to 15% of the dry matter (DM) or 130 to 150 grams of fibre/kg DM.

Until more detailed information is available, it is reasonable to use the fibre requirements for sheep as a guide to the fibre requirements for Fallow deer and cattle requirements as a guide to the fibre requirements for Red deer and Wapiti/Elk.

Dry Sheep Equivalents (DSE)

The Dry Sheep Equivalent (DSE) is a standard unit used to compare feed requirements of different classes of stock or assess the carrying capacity of grazing land (DSE per winter grazed hectare). Relative profitability of different livestock enterprises may also be expressed as $ per DSE.

DSE's are only guide estimates of the feed requirements of grazing animals. As the basis used to describe a DSE may vary, it is important to quote the basis of a standard DSE when comparing different species of stock or different classes of the same species.

In this book a standard Dry Sheep Equivalent (DSE) unit is the standard generally used in Australia and refers to the amount of energy required to maintain a 45 kg merino wether in body condition score of 2.0 to 2.5. From the Agricultural Research Council [3] the average daily energy requirement of merino wether with a body condition score of 2.0 to 2.5 and a live weight of 45 kg is 5.8 megajoules of metabolisable energy per day.

NZ Stock Units (SU)

In New Zealand a similar method of comparing feed requirements of different classes and species of stock is used. The standard unit is described as a Stock Unit (SU) and the standard unit refers to the average daily energy requirement of a 55 kg breeding ewe producing 1.1 lambs annually.

The average daily energy requirement, from [3], of a 55 kg breeding ewe producing 1.1 lambs annually is 10.6 megajoules of metabolisable energy per day (assuming a feed energy density of 10 megajoules/kg of dry matter).

In comparison, the metabolisable energy requirement of one New Zealand SU is equivalent to the metabolisable energy requirement of 1.8 DSE's described above.

Seasonal Periods

Temperate species of deer (Red deer, Fallow deer and Wapiti/Elk) show a marked decrease in appetite during winter months that is principally controlled by photoperiod (day length). Although growth slows considerably during this time, the effect on mature deer with good body condition (BCS 3 or better) prior to winter is minimal. During this period of 'winter inappetence' animals meet their energy requirements by metabolising their fat reserves. However, when their fat reserves are exhausted they metabolise body protein (muscle) to meet their energy needs.

This phenomenon leads to substantial weight losses during winter, particularly in mature male deer regardless of feed availability. Both Red and Fallow deer males may lose up to 20% of their summer bodyweight during winter but show a pronounced appetite increase and associated compensatory growth during spring and early summer that allows them to quickly regain weight.

Weight loss also occurs in females but it is usually much less pronounced. Winter inappetence is less obvious in tropical species of deer and any appetite depression that occurs generally is considered to be influenced by temperature and feed availability rather than photoperiod effects. Maintenance energy requirements of well-managed Rusa deer increase by about 7% during the rut [27].

Management implications of seasonal effects include the need to match the seasonal variation in appetite to the availability of feed (may include provision of supplementary feed).

Risks of not ensuring animals are in appropriate condition at the beginning of winter include:

- Death of deer in winter (winter death syndrome)
- Poor conception rates
- High neonatal losses due to low birth weights and low growth rates

Seasonal periods for deer in Southern Australia used when developing estimate energy requirements provided in this publication are defined as:

- Autumn - 10 weeks from 1 April to 9 June. It runs from the onset of the rut to the start of winter
- Winter - 14 weeks from 10 June to 15 September. It is the period of winter rain and cooler temperatures
- Spring - 10 weeks from 16 September to 24 November. It is characterised by increasing temperatures, increasing humidity and the flush of green vegetation
- Summer - 18 weeks from 25 November to 31 March. It is characterised by high temperatures and very low rainfall and extends from calving to the rut

Energy Requirements of Breeding Females

Energy requirements of deer have been determined by research in New Zealand, Australia, Canada, Scotland and other countries. Guide energy requirements for breeding females are provided below. However it is important to understand that the energy requirement for the mother drops immediately after parturition (birth) for about 7 to 10 days before it rapidly grows to meet demands of lactation.

After about the first month of lactation the combined energy requirement of a mother and her unweaned offspring increase significantly. The increased energy requirement occurs as the offspring begins to consume increasing quantities of pasture to meet its requirements for rapid growth.

Guide energy requirements provided below for Red deer and Wapiti/Elk assume that the annual maintenance requirements of Red deer in managed out doors in Australia are 25% lower than the reported requirement in New Zealand [86]. The provision of shelter along with adequate nutrition to assure that deer are in very good condition before the end of autumn is essential to ensure high conception rates and the best chances of survival during the following months of decreased appetite.

Red Deer Hinds

Daily energy requirements of Red deer hinds managed out doors (not housed) in Southern Australia can be estimated assuming:

- The maintenance energy requirement determined for housed Red deer hinds [82]
- Formulae for estimating energy requirements of pregnancy and lactation [46]
- Season lengths as described above
- Average weight changes between seasons adapted [29]

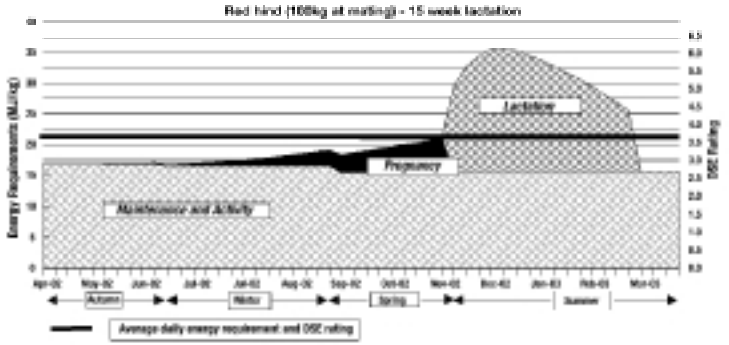
- Joining occurs in mid April
- Gestation length is 233 days and birth occurs in late November to early December
- Lactation length is 15 weeks and calves are weaned at the end of February

A graph of estimated energy requirements developed for 100 kg live weight Red deer hind that are successfully joined at the beginning of autumn (late April) is provided in Graph 1.

The average daily energy requirement for the hinds is 21.9 MJ/day and the average daily maintenance requirement is 16.1 MJ/day. This energy requirement indicates that the average daily energy requirements of a 450 kg beef cow are similar to the average daily requirements of about 2.9 Red deer hinds that are 100 kgs at mating.

In other words a farmer could reasonably expect to replace one beef cow that is 450 kg at mating in autumn with 2.9 Red deer hinds that are 100 kgs at mating. By calculation, an average daily DSE rating for a 100 kg Red deer hind in Southern Australia should be considered to be about 3.8.

Energy requirements and target live weights are likely to change for well-managed strains of Red deer hinds and stags that have a mature live weight in excess of 100kgs and 220 kgs respectively. However the patterns of energy requirement will be similar to the patterns shown below.



Graph 1: Estimated energy requirements for a Red hind - 100 kg at mating

Fallow Does

Daily energy requirements of Fallow does (not housed) in Southern Australia can be estimated assuming:

- The maintenance, gestation and lactation energy requirements determined for Fallow deer does [64] and [63]
- Mature live weight for a Fallow doe of 45 Kgs
- Season lengths as described above
- Average weight changes between seasons adapted from [64] and [63]
- Joining occurs in mid April
- Gestation length is 233 days and birth occurs in late November to early December
- Lactation length is 15 weeks and fawns are weaned in early March

A graph of estimated energy requirements developed for 45 kg live weight Fallow does that are successfully joined at the beginning of autumn (April) is provided in Graph 2.

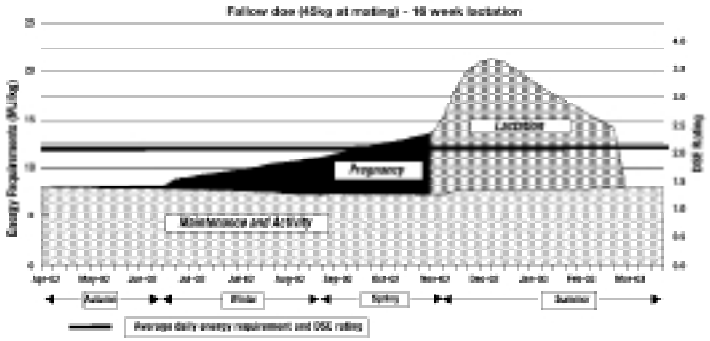
The average daily energy requirement for the does is 12.6 MJ/day and the average daily maintenance requirement is 8.0 MJ per day. This energy requirement indicates that the average daily energy requirements of a 450 kg beef cow are similar to the average daily requirements of about 5.0 Fallow does that are 45 kgs at mating.

In other words a farmer could reasonably expect to replace one beef cow that is 450 kg at mating in autumn with 5.0 Fallow does that are 45 kgs at mating.

The estimated increase in requirements for gestation and lactation are similar to the estimates provided by Flesch [63] who reported that daily energy requirements for gestation almost double maintenance requirements near the end of gestation and peak requirements for lactation increase energy requirements by more than 2.5 times maintenance requirements.

By calculation, an average daily DSE rating for a 45 kg Fallow doe in Southern Australia should be considered to be about 2.1.

Energy requirements and target live weights are likely to change for well-managed strains of Fallow deer does and bucks that have a mature live weight in excess of 45 kgs and 100 kgs respectively. However the patterns of energy requirement will be similar to the patterns shown below.



Graph 2: Estimated energy requirements for a Fallow doe - 45 kg at mating

Wapiti/Elk Hinds

Daily energy requirements of Wapiti/Elk hinds managed out doors (not housed) in Southern Australia can be estimated assuming:

- The maintenance energy requirement determined for Wapiti/Elk hinds [46]
- Mature live weight for a Wapiti/Elk hind in Australia of 240 Kgs
- Formulae for estimating energy requirements of pregnancy and lactation [46]
- Season lengths as described above
- Average weight changes between seasons adapted from [46]
- Joining occurs during mid March
- Gestation length is 252 days and birth occurs in mid November
- Lactation length is 15 weeks and calves are weaned at the end of February

A graph of estimated energy requirements developed for 240 kg live weight Wapiti/Elk hinds that are successfully joined at the beginning of autumn (April) is provided in Graph 3.

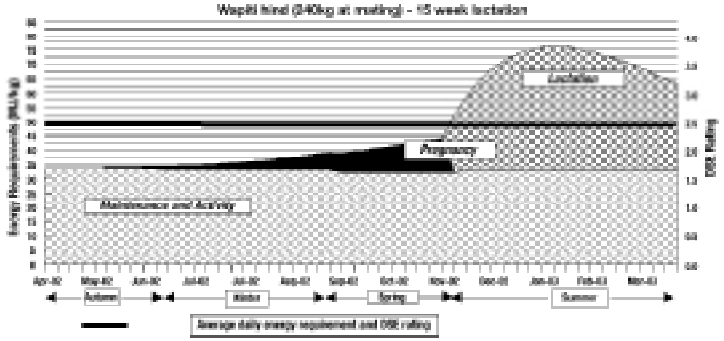
The average daily energy requirement for the hinds is 48.8 MJ/day and the average daily maintenance requirement is 33.2 MJ/day. This energy requirement indicates that the average daily energy requirements of a 450 kg beef cow are similar to the average daily requirements of about 1.3 Wapiti/Elk hinds that are 240 kgs at mating.

In other words a farmer could reasonably expect to replace one beef cow that is 450 kg at mating in autumn with 1.3 Wapiti/Elk hinds that are 240 kgs at mating.

The estimated increase in requirements for gestation and lactation are similar to the estimates provided by Hudson (2001) who reported that daily energy requirements for gestation increase by about 12 MJ/day above maintenance requirements near the end of gestation and peak requirements for lactation increase energy requirements by about 40 MJ/day above maintenance requirements (about double the maintenance energy requirement).

By calculation, an average daily DSE rating for a 240 kg Wapiti/Elk hind in Southern Australia should be considered to be about 8.4.

Energy requirements and target live weights are likely to change for well-managed strains of Wapiti/Elk hinds and stags that have a mature live weight in excess of 240 kgs and 420 kgs respectively. However the patterns of energy requirement will be similar to the patterns shown below.



Graph 3: Estimated energy requirements for a Wapiti/Elk hind - 240 kg at mating

Rusa Deer Hinds

Daily energy requirements of Rusa deer hinds in tropical and sub tropical areas of Australia can be estimated assuming:

- The maintenance, gestation and lactation energy requirements determined for Rusa Deer hinds [26]
- Mature live weight for a Javan Rusa hind of 90 Kgs
- Stags are removed from breeder herds between late October and January and the predominant calving period is spring
- Average weight changes between seasons adapted from [39]
- Joining occurs during late June

- Gestation length is 252 days and birth occurs at the beginning of March
- Lactation length is 15 weeks and calves are weaned at the end of May

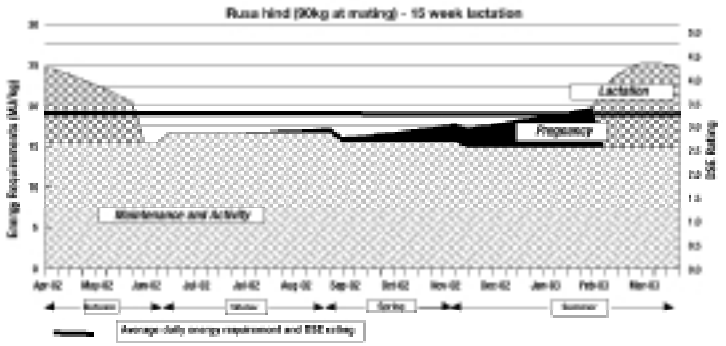
A graph of estimated energy requirements developed for 90 kg live weight Rusa hinds that are successfully joined in late June is provided in Graph 4.

The average daily energy requirement for the hinds is 18.7 MJ/day and the average daily maintenance requirement is 14.9 MJ/day. This energy requirement indicates that the average daily energy requirements of a 450 kg beef cow are similar to the average daily requirements of about 3.4 Rusa hinds that are 90 kgs at mating.

In other words a farmer could reasonably expect to replace one beef cow that is 450 kg at mating in autumn with 3.4 Rusa hinds that are 90 kgs at mating.

The estimated increase in requirements for gestation and lactation are similar to the estimates provided by Dryden [26] who reported that daily energy requirements for maintenance and growth are similar to those of Sambar deer but about 10% less than requirement for Red deer hinds of the same weight.

By calculation, an average daily DSE rating for a 90 kg Rusa in subtropical and tropical Australia should be considered to be about 3.2.



Graph 4: Estimated energy requirements for a Rusa hind - 90 kg at mating

Energy Requirements for Growth

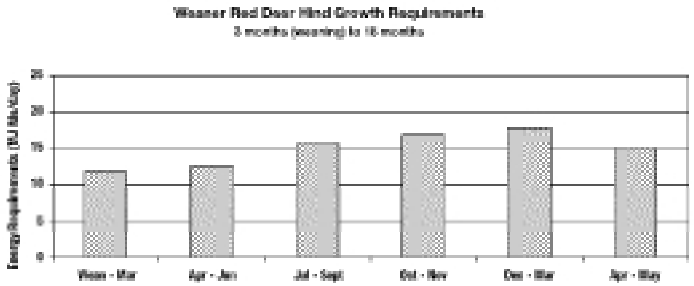
Red Deer

Data on the energy requirements for growth of Red deer is adapted from [29], [38] and [86]. Patterns of growth reflect the influence of season and the relatively extended time to reach mature weight, particularly for the stags, when compared to other species. The suggested target live weight of Red deer hinds and stags in Australia is 100 kgs and 220 kgs respectively, based on average size of Red deer hinds in existing well-managed herds in Australia.

Hybrid animals are likely to have greater energy requirements and achieve higher weight gains than purebred Red deer. However the patterns of energy requirement will be similar to the patterns shown below.

Feed requirements of offspring begin to increase after about a month of lactation when they begin consuming small amounts of pasture and increase significantly at about three months after birth.

Graphs 5 and 6 provide guides to average seasonal energy requirements of Red deer hinds and stags from four months (weaning) until eighteen months of age. The graphs reflect the influence of age and by inference live weight, and season on energy requirement.



Graph 5: Guide Energy Requirements for Red Hind Growth

Graph 6: Guide Energy Requirements for Red Stag Growth

Fallow Deer

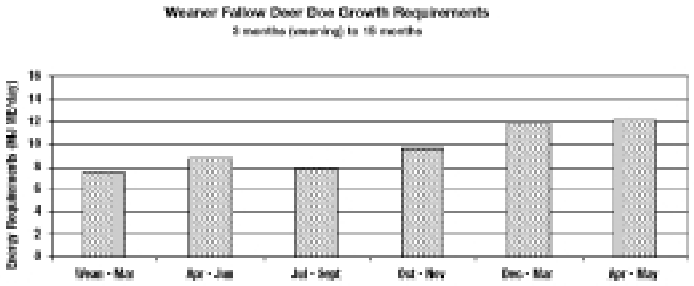
Mulley [64] determined the energy requirements for growth of Fallow deer.

Patterns of growth are similar to those observed for Red deer and Wapiti/Elk and importantly the feed requirements of offspring begin to increase after about four weeks of lactation when they begin consuming small amounts of pasture. At about 16 weeks after birth the energy requirements of rapidly growing fawns are similar to their mother's requirements.

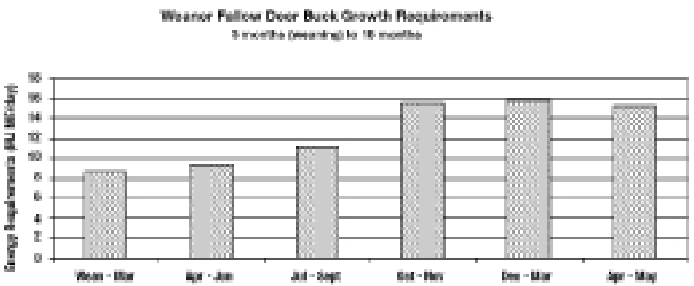
The suggested target live weight for mature European Fallow deer does and bucks in Australia is 45 to 50 kgs and 100 kgs respectively, based on average size of Fallow deer does and bucks in existing well-managed herds in Australia.

Hybrid animals are likely to have greater energy requirements and achieve higher weight gains than purebred European Fallow deer. However the patterns of energy requirement will be similar to the patterns shown below.

Graphs 7 and 8 provide guides to average seasonal energy requirements of Fallow does and bucks from four months (weaning) until eighteen months of age. The graphs reflect the influence of age and by inference live weight, and season on energy requirement.



Graph 7: Guide Energy Requirements for Fallow Doe Growth



Graph 8: Guide Energy Requirements for Fallow Buck Growth

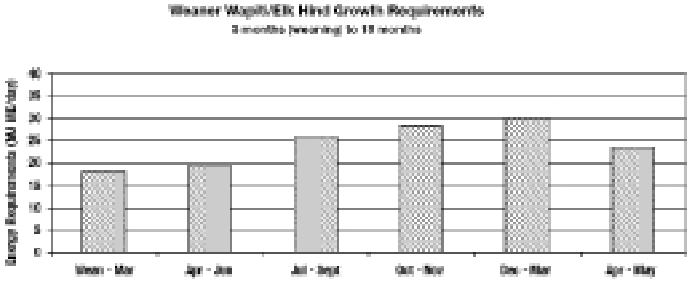
Wapiti/Elk

Data on the energy requirements for growth of Wapiti/Elk deer is adapted from [38]. Patterns of growth reflect the influence of season and the relatively extended time to reach mature weight, particularly for the stags, when compared to other species. The suggested target live weight for mature Wapiti/Elk hinds and stags in Australia is 240 kgs and 420 kgs respectively, based on expectations of existing elite Wapiti/Elk breeding herds in Australia.

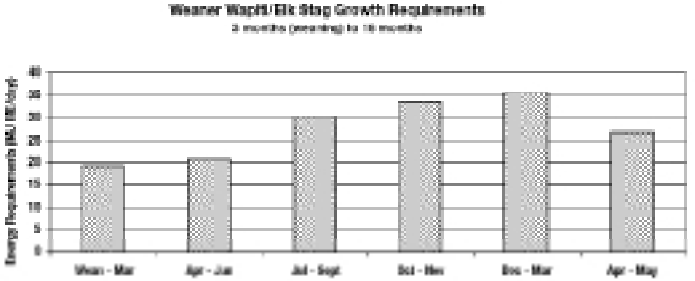
Hybrid animals are likely to have greater energy requirements and achieve higher weight gains than purebred Wapiti/Elk. However the patterns of energy requirement will be similar to the patterns shown below.

Feed requirements of offspring begin to increase after about a month of lactation when they begin consuming small amounts of pasture and increase significantly at about three months after birth.

Graphs 9 and 10 provide guides to average seasonal energy requirements of Wapiti/Elk hinds and stags from four months (weaning) until eighteen months of age. The graphs reflect the influence of age and by inference live weight, and season on energy requirement.



Graph 9: Guide Energy Requirements for Wapiti/Elk Hind Growth

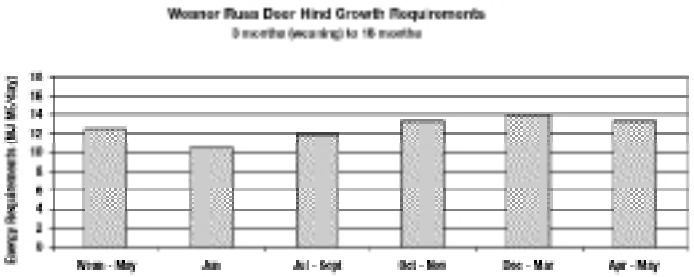


Graph 10: Guide Energy Requirements for Wapiti/Elk Stag Growth

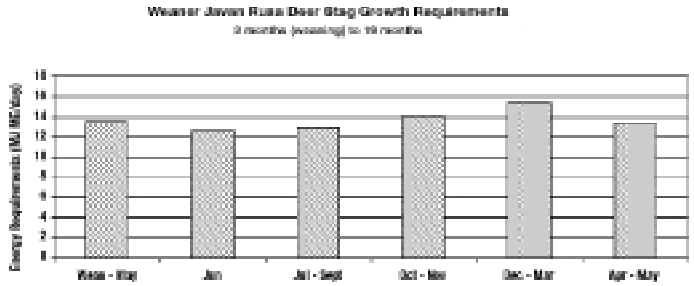
Rusa Deer

Data on the energy requirements for growth of Rusa deer is adapted from [26] and [38]. Patterns of growth reflect the influence of season and are similar to other deer species. Hybrid animals are likely to have greater energy requirements and achieve higher weight gains than purebred Javan Rusa deer. However the patterns of energy requirement will be similar to the patterns shown below.

Feed requirements of offspring begin to increase after about a month of lactation when they begin consuming small amounts of pasture and increase significantly at about three months after birth. Graphs 11 and 12 provide guides to average seasonal energy requirements of Rusa deer hinds and stags from four months (weaning) until eighteen months of age. The graphs reflect the influence of age and by inference live weight, and season on energy requirement.



Graph 11: Guide Energy Requirements for Rusa Hind Growth



Graph 12: Guide Energy Requirements for Rusa Stag Growth

Energy Requirements for Mature Breeding/Velveting Males

Nutrition of mature male deer is important for two reasons. The first is to ensure sires recover from weight loss that began the previous rutting season and continued throughout the winter. The second important consideration of mature male nutrition relates to the production of velvet antler, particularly for Red deer and Wapiti/Elk breeds.

Although spring and summer nutritional demands to recover weight lost during mating and winter and allow for growth are relatively high, energy requirements for antler growth are only a small fraction of the daily energy intake of mature males (0.5 MJ/day for Red deer and 1.0 MJ/day for Wapiti/Elk - [45]).

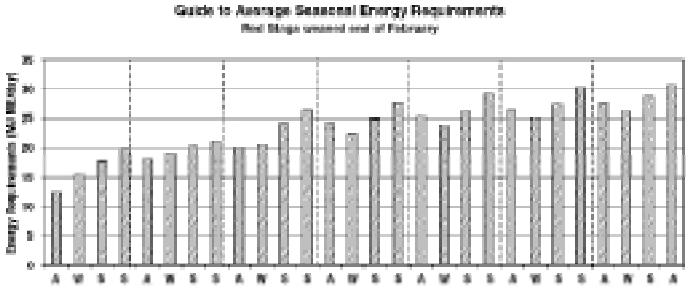
Sires in poor condition at the beginning of mating are likely to be less fertile than animals in ideal condition and subsequent herd reproductive performance is likely to be less than could otherwise have been possible.

The pre-rut weight of males, specifically frame size is the factor that most influences velvet weights. Each 10 kg increase in pre-rut body size brings forward the date of casting by 3 to 4 days and increases velvet weights by 0.12 kgs - [45].

Most observers suggest that winter feed restriction does not affect antler size provided unrestricted feed is available during spring and summer. Mineral requirements for velvet production are similar to those of lactation. Twenty to forty percent of the mineral required for antler growth comes from mobilising skeletal reserves, as the best diet can only provide 60 to 80% of what is required [81].

Red Deer Stags

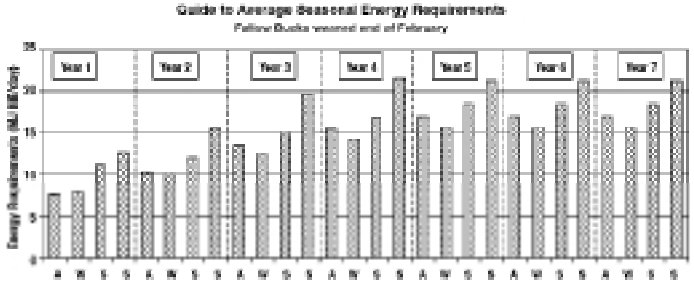
The guide average seasonal energy requirements provided for Red deer males after weaning assume the target live weights shown in the chapter on target live weights. Energy requirements for pure bred Red deer males or hybrid males that have a mature live weight in excess of 220 kgs and different annual target live weights are likely to be different than those shown below. However the patterns of energy requirement will be similar to the patterns shown below. Graph 13 is developed from [29], [38] and [86].



Graph 13: Guide Red Stag Energy Requirements

Fallow Deer Bucks

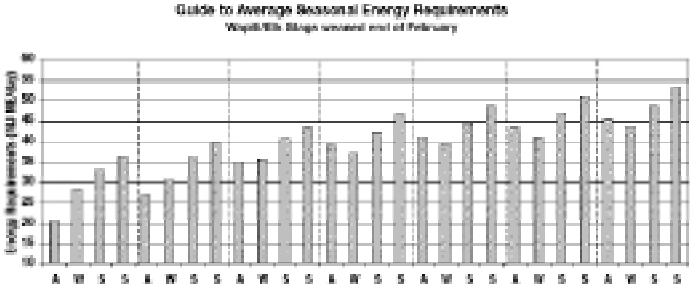
The guide average seasonal energy requirements provided for Fallow deer males after weaning assume the target live weights shown in the chapter on target live weights. Energy requirements for pure bred Fallow deer males or hybrid males that have a mature live weight in excess of 100 kgs and different annual target live weights are likely to be different than those shown below. However the patterns of energy requirement will be similar to the patterns shown below. Graph 14 is developed from [66] and [2].



Graph 14: Guide Fallow Buck Requirements

Wapiti/Elk Stags

The guide average seasonal energy requirements provided for Wapiti/Elk males after weaning assume the target live weights shown in the chapter on target live weights. Energy requirements for purebred Wapiti/Elk males or hybrid males that have a mature live weight in excess of 420 kgs and different annual target live weights are likely to be different than those shown below. However the patterns of energy requirement will be similar to the patterns shown below. Graph 15 is developed from [38].



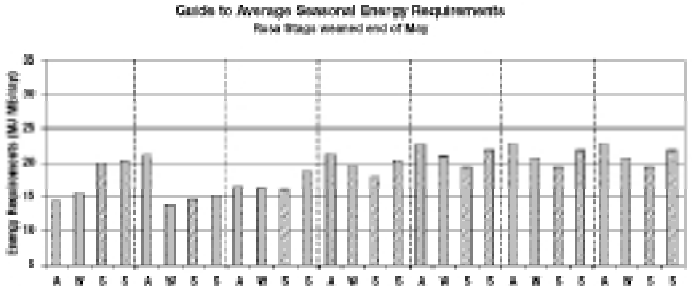
Graph 15: Guide Wapiti/Elk Stag Requirements

Rusa Stags

The guide to average seasonal energy requirements provided for Rusa deer males after weaning assume the target live weights shown in the chapter on target live weights.

Target weights and energy requirements are estimated from data provided by Dryden [25] and include interpolations from data for Red deer and Wapiti/Elk provided by Fennessy [29] and Hudson [45]. The information is also based on an assumption that pattern of growth for Rusa stags is similar to that for Red deer and Wapiti/Elk but that peak seasonal body weight for Rusa stags occurs in May/June (beginning of the rut) rather than in March.

Energy requirements for purebred Javan Rusa stags or hybrid stags that have a mature live weight greater or less than 140 kgs and different annual target live weights, are likely to be different than those shown below. However the patterns of energy requirement will be similar.



Graph 16: Guide Rusa Stag Requirements

Protein Requirements

Protein is needed for maintenance, muscle and bone growth, and tissue repair. Deer that are growing rapidly or lactating and males recovering from the rut have higher than maintenance protein needs.

Increased protein requirements can, to some extent be met by increased intake however, the protein percentage in diets designed for these high protein requirement animals usually needs to be increased as well.

Although protein requirements for deer have not been as clearly defined as energy requirements, some guide requirements can be provided.

A manager's aim should be to meet an animal's requirement for protein without feeding excess that can contribute to the difficulties described above.

Available data, [38], [98] and [83] suggest guide dietary protein requirements of:

- Maintenance 6 to 10%
- Growth 14 to 16%
- Lactation 14 to 16%

Dry Matter Requirements

This guide to the maximum dry matter intakes for Red and Fallow deer was developed from [52], [98] and [64].

Class of Animal	Autumn		Winter		Spring		Summer	
	Red	Fallow	Red	Fallow	Red	Fallow	Red	Fallow
Males								
3-15 mths	1.5	1.0	1.8	1.0	2.4	1.2	2.6	1.3
15-27 mths	2.2	1.3	2.5	1.2	2.8	1.4	2.9	1.5
Older	1.7	1.1	3.1	1.6	3.9	1.9	3.8	1.9
Females								
3-15 mths	1.5	0.9	1.8	0.9	2.5	0.9	2.6	1.1
Older	2.2	1.2	2.9	1.2	3.4	1.3	4.2	2.1

Table 6: Guide maximum dry matter (Kg of DM/head/day) intakes for Red and Fallow deer

Effect of Live Weight on Energy Requirement

As discussed earlier, energy requirements and target live weights are likely to be different for deer of the same species that have different mature live weights. However the patterns of live weight gain will be similar to those shown above.

A guide comparison of the average daily energy (MJ of ME) and dry matter (DM) requirements for each season for breeding females that have a different live weight at mating is provided in the Tables below.

The DM requirements shown assume the continual availability of good quality (70% digestibility - 9.9 MJ ME/kg DM) pasture throughout the year (see Table 28 in the chapter on pasture assessment). In reality the quality of available pasture will change during the year and may have different energy content to the guide values provided, so the actual pasture dry matter requirement will change.

Any change in pasture DM quality will influence the quantity of pasture DM that must be consumed to provide energy requirements and whether supplements are needed (see 'Supplementing Existing Pasture' in the chapter on feeding).

Live weight At Mating (kgs)		Season - No. days *Autumn* 70	*Winter* 98	*Spring* 70	*Summer* 127	Annual Total	Average
MJ ME		14.0	13.3	15.3	28.2	6935	19.0
Kg DM	**80**	**1.4**	**1.3**	**1.6**	**2.8**	**701**	**1.9**
MJ ME		15.3	14.4	16.7	29.7	7427	20.3
Kg DM	**90**	**1.5**	**1.5**	**1.7**	**3.0**	**750**	**2.1**
MJ ME		16.6	15.6	17.9	31.2	7908	21.7
Kg DM	**100**	**1.7**	**1.6**	**1.8**	**3.2**	**799**	**2.2**
MJ ME		17.9	16.7	19.2	32.6	8378	23.0
Kg DM	**110**	**1.8**	**1.7**	**1.9**	**3.3**	**846**	**2.3**
MJ ME		19.2	17.8	20.4	34.1	8841	24.2
Kg DM	**120**	**1.9**	**1.8**	**2.1**	**3.4**	**893**	**2.4**

Table 7: Guide average daily ME and DM requirements of Red deer hinds grazing pasture with MD 9.9 (digestibility of 70%)

Live weight At Mating (kgs)		Season - No. days *Autumn* 70	*Winter* 98	*Spring* 70	*Summer* 127	Annual Total	Average
MJ ME		7.2	9.0	10.9	14.0	3926	10.8
Kg DM	**37**	**0.7**	**0.9**	**1.1**	**1.4**	**397**	**1.1**
MJ ME		7.9	9.9	12.0	15.4	4318	11.8
Kg DM	**42**	**0.8**	**1.0**	**1.2**	**1.6**	**436**	**1.2**
MJ ME		8.6	10.7	13.1	16.7	4698	12.9
Kg DM	**47**	**0.9**	**1.1**	**1.3**	**1.7**	**475**	**1.3**
MJ ME		9.3	11.6	14.1	18.0	5068	13.9
Kg DM	**52**	**0.9**	**1.2**	**1.4**	**1.8**	**512**	**1.4**
MJ ME		10.0	12.4	15.1	19.3	5429	14.9
Kg DM	**57**	**1.0**	**1.3**	**1.5**	**2.0**	**548**	**1.5**

Table 8: Guide average daily ME and DM requirements of Fallow deer does grazing pasture with MD 9.9 (digestibility of 70%)

Live weight At Mating (kgs)		Season - No. days *Autumn* 98	*Winter* 70	*Spring* 127	*Summer* 127	Annual Total	Average
MJ ME		28.9	28.1	34.9	66.9	15714	43.1
Kg DM	**200**	**2.9**	**2.8**	**3.5**	**6.8**	**1587**	**4.3**
MJ ME		31.2	30.1	37.4	69.1	16540	45.3
Kg DM	**220**	**3.2**	**3.0**	**3.8**	**7.0**	**1671**	**4.6**
MJ ME		33.5	32.1	39.9	71.4	17350	47.5
Kg DM	**240**	**3.4**	**3.2**	**4.0**	**7.2**	**1753**	**4.8**
MJ ME		35.7	34.0	42.4	73.6	18146	49.7
Kg DM	**260**	**3.6**	**3.4**	**4.3**	**7.4**	**1833**	**5.0**
MJ ME		37.9	35.9	44.9	75.7	18930	51.9
Kg DM	**280**	**3.8**	**3.6**	**4.5**	**7.7**	**1912**	**5.2**

Table 9: Guide average daily ME and DM requirements of Wapiti/Elk hinds grazing pasture with MD 9.9 (digestibility of 70%)

Live weight At Mating (kgs)		Season - No. days *Autumn* 70	*Winter* 98	*Spring* 70	*Summer* 127	Annual Total	Average
MJ ME		19.9	12.9	13.0	18.2	5873	16.1
Kg DM	**70**	**2.0**	**1.3**	**1.3**	**1.8**	**593**	**1.6**
MJ ME		21.2	14.2	14.3	19.6	6366	17.4
Kg DM	**80**	**2.1**	**1.4**	**1.4**	**2.0**	**643**	**1.8**
MJ ME		22.4	15.5	15.7	20.9	6844	18.7
Kg DM	**90**	**2.3**	**1.6**	**1.6**	**2.1**	**691**	**1.9**
MJ ME		23.6	16.8	16.9	22.3	7309	20.0
Kg DM	**100**	**2.4**	**1.7**	**1.7**	**2.2**	**738**	**2.0**
MJ ME		24.7	18.0	18.2	23.5	7762	21.3
Kg DM	**110**	**2.5**	**1.8**	**1.8**	**2.4**	**784**	**2.2**

Table 10: Guide average daily ME and DM requirements of Rusa deer hinds grazing pasture with MD 9.9 (digestibility of 70%)

DSE Comparison

This guide comparison is based on the standard DSE energy requirement generally used in Australia and refers to amount of energy required to maintain a 45 kg merino wether in body condition score of 2.0 to 2.5. The average daily energy requirement of merino wether with a body condition score of 2.0 to 2.5 and a live weight of 45 kg is 5.8 megajoules of metabolisable energy per day.

Class of Stock	Live weight (kgs)	Description	Average daily energy requirement (MJ ME/day)	Average daily DSE rating
Beef Cattle				
Beef Bull	800		78.5	13.5
Beef Cow	450	150 day lactation, 30 kg calf	63.3	10.9
Beef Steer	300	Weight Gain 0.25 kg/day	45.9	7.9
Weaned Male Calf	160 at weaning	Weight Gain 0.25 kg/day	26.9	4.6
Weaned Female Calf	140 at weaning	Weight Gain 0.25 kg/day	24.2	4.2
Dairy Cow				
Friesian Dairy Cow	600	300 day lactation	153.8	26.5
Sheep				
Merino Wether	45		5.8	1.0
Merino Ewe	55	Avge 1 lamb/year-120 day lactation	10.5	1.8
Crossbred Ewe	60	Avge of 1.1 lambs/year-120 day lactation	11.4	2.0
Deer				
Red Deer Hind	100	15 week lactation	21.8	3.8
Fallow Doe	45	15 week lactation	12.6	2.2
Wapiti/Elk Hind	240	15 week lactation	33.2	5.7
Rusa Hind	90	15 week lactation	18.7	3.2
Red Velvet Stags	220	Mature body weight	28.4	4.9
Fallow Buck	100	Mature body weight	18.0	3.1
Wapiti/Elk Velvet Stags	420	Mature body weight	47.7	8.2
Weaner Red Hinds	48 at weaning	Avge Weight Gain 0.870 kg/day - *March to April*	14.2	2.4
Weaner Fallow Does	20 at weaning	Avge Weight Gain 0.055 kg/day - *March to December*	8.3	1.4
Weaner Wapiti/Elk Hinds	78 at weaning	Avge Weight Gain 0.161 kg/day - *March to December*	23.0	4.0
Weaner Rusa Hinds	29 at weaning	Avge Weight Gain 0.108 kg/day - *May to February*	12.0	2.1
Weaner Red Stags	54 at weaning	Avge Weight Gain 0.130 kg/day - *March to December*	18.0	3.0
Weaner Fallow Bucks	23 at weaning	Avge Weight Gain 0.082 kg/day - *March to December*	11.2	1.9
Weaner Wapiti/Elk Stags	86 at weaning	Avge Weight Gain 0.234 kg/day - *March to December*	25.9	4.5
Weaner Rusa Stags	34 at weaning	Avge Weight Gain 0.149 kg/day - *May to February*	13.3	2.3

Table 11: Guide DSE Ratings of Different Classes of Stock