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Optimum Weaning Time for Fallow Deer in Southern Australia

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Foreword

In southern Australia, deer fawn in December and January. Most deer farmers allow fawns to remain with the does until natural weaning occurs. However, some farmers wean fawns in May-June while other farmers wean in March. Farmers need to decide whether they should wean deer early or late given the low availability of feed in autumn and winter and surplus of green feed in spring.

This project was undertaken to determine the optimum weaning time of deer. Initially deer weaned early in March had heavier body weight compared to those weaned in May. However by the end of the growing period there was no clear trend showing early weaning was better than late weaning.

This project was funded from industry revenue, which is matched by funds provided by the Federal Government and is an addition to RIRDC's diverse range of over 1200 research publications. It forms part of our Deer Production Systems which aim to improve production efficiency of deer farming that have diversity, flexibility, and robustness to be resilient Australian Agriculture.

Most of our publications are available for viewing, downloading or purchasing online through our website:

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Contents

Executive Summary

In November 2003, 320 pregnant does with an average weight of 45.8kg were selected for a trial conducted at the Bilby deer farm in the South East of South Australia. All selected deer were weighed and randomly allocated into 4 groups. Each group was identified with a coloured ear tag (blue 46.5±3.83 kg, green 45.7±3.67 kg, red 46.0±4.93 kg and orange 45.7±3.50 kg mean and SD). The four groups were allocated to different paddocks for fawning. The same feeding strategy normally used at the Bilby Deer Farm was used for each group. At the end of March, two groups (blue and green) were weaned. The other two groups (red and orange) were weaned at the end of June 2004. To ensure that all treatment and control groups received the same quality and quantity of supplementary feed, all deer were fed a pelleted diet (supplied by SARDI). The feed allowance was 1.2 kg/day/head to ensure all animals obtained adequate nutrients based on Mulley and Flesch (2001) recommendations. Each deer had adequate trough feeding space to ensure all obtained their daily allocation and to minimise the impact of social ranking on individual feed intake. Does and weaners were weighed every two months from the end of March 2004. Fawns were weaned early in March and their weight compared with fawns, which were weaned later in June 2004.

In March body weights of does in the early weaned treatment were about 4 kg heavier than does in the late weaned treatment but by May this difference was only 0.7 kg. In September 2004 there was no differences observed in the weight of does on the early and late weaned treatments. Early weaned fawns were 4-5 kg heavier in March and 2 kg heavier in May compared to the late weaned fawns. However in September 2004 there was no difference in the weight of fawns whether they were weaned earlier or later in the year. The body weights of does were similar at the start of the experiment. At the conclusion of the trial there was no difference in body weight of does whether their fawns had been weaned early or not. This may because there were dry conditions during the experimental period or due to the effect of stress (herding, weighing and handling) on body weight. In the trail the farm manager, Ian Rasmussen (per. comm.) observed that deer weighed every 8 weeks had lower weight gain (average 10 kg less) compared to the deer those were not weighed. This is probably because each time deer were put through the handling yards to be weighed or tagged, they suffered undue stress and consequently affected their gain.

Introduction

In southern Australian, most fallow deer fawn in December and January. Mating occurs in April and May. This means that does are lactating during the hot and dry summer when the pasture quality and quantity are factors limiting the recovery of body condition of does before mating. Under the current practice, most farmers do not wean their fawns, and a few farmers wean their fawns after mating. This potentially further delays the build-up of body condition of does due to the nutrient demands for milk production. Thus farmers continue to question whether they should wean their deer later during May or June to reduce the stress during weaning and to improve performance during the grazing season. Alternatively should they wean in March to allow the does to recover their body conditions for the next reproduction cycle. While there is limited information on the impact of weaning time on reproduction performance of fallow deer in southern Australia, research conducted in UK and New Zealand shows that weaning time influences the body weight of hinds at rut (Blaxter and Hamilton, 1980a, Audige *et al*., 1999a). The latter is related to the fertility of the hind with a general relationship of $p=1-\exp(-0.085(W-52))$, where P is the probability that a hind will calve and W is her weight in kg at the time of rut. The separation of calves from hinds at rut has no effect on fertility (Hamilton and Blaxter, 1980). More importantly, the mortality data for calves is equally related to the weight of their dams at the time of the rut (Blaxter and Hamilton, 1980a) and body condition score pre-mating is one of the major risk factors influencing conception (Audige *et al.*, 1999a).

Research conducted in UK also demonstrated that if the calves are weaned from the hinds pre-rut, the breeding herds will calve earlier next year and will wean heavier calves. The heavier hinds calve earlier. For example, Hamilton and Blaxter (1980) found that increasing the body weight by 10 kg pre-rut advanced calving date by 2.2 days for all classes of red deer. Similar results were reported by Friedel and Hudson (1994) and Marchant (1998). These results might have a significant impact on deer production in southern Australia. From the current deer production calendar, the advance in fawning date will potentially reduce the number of deer born during extremely hot summer conditions in January, reducing the mortality of fawns. However, more research work is required to explore advantages of early weaning.

Weaning time also has effect on growth performance of calves. While deer can be weaned naturally at 4-6 months of age, having a mixture of a herd of hinds and calves is not easy to manage. Some farmers believe that leaving calves with hinds will reduce the stress associated with weaning and hinds can teach calves to forage under grazing conditions (Audige *et al*., 1999). However, it is well recognised that birth weight is related to the weight of the hind at rut which can be increased by early weaning as discussed in above section (Blaxter and Hamilton, 1980). Friedel and Hudson (1994) reported that growth rate and weaning weight were positively influenced by hind pre-rut weight. A 10g/day improvement in gain with a 10 kg increase in hind weight was also found by Moore *et al*. (1988). Blaxter and Hamilton (1980) found a positive relationship between birth weight of calves and daily weight gain of calves from birth to weaning in red deer.

Asher and Adam (1985) and Asher and Langridge (1992) monitored a number of deer farms in New Zealand. They found that for both red and fallow deer, calf birth weights were positively related to birth date and dam liveweight pre rut was influenced by weaning time. Weaning weights and liveweight gains were positively related to birth weight, weaning age and dam liveweight pre-rut. For each additional 1 kg in birth weight, weaning weight increased by 1.4 kg in red and 1.1 kg in fallow deer. Equally for every week weaning was delayed in March, weaning weights were apparently increased by 2.1 kg in red and 1.4 kg in fallow deer (Asher and Adam 1985). However, little information on the relationship between weaning time and growth rate of fallow weaners is available under southern Australian conditions. This project was focused on weaning strategies for fallow deer in southern Australia with a typical Mediterranean environment and attempted to develop an optimum weaning time to improve farm profitability through improving performance of weaners and avoid carrying over weaners to the following season.

Literature Review

SUMMARY: Current growth in the deer industry is 20% per annum as the demand increases for venison in Europe, including the increased use of antlers in Asia as a natural medicine by humans. The deer industry in Australia has developed rapidly, but farm profitability has fluctuated markedly. The knowledge on deer farming has largely been adopted from New Zealand (NZ) and the United Kingdom (UK) although the environmental conditions in these deer growing countries differ markedly from Australia. The practice used for weaning is one of the key factors influencing the profitability of the industry. However, a wide range of weaning dates are practised by farmers leading to the question of whether deer should be weaned after mating to reduce the stress during weaning or should they be weaned in the pre-rut period to allow does to recover their body condition for the next reproduction cycle. This review examines the effect of weaning time on the performance of does and hinds and the subsequent growth rate of the fawns and calves. Gaps in knowledge of weaning procedures and nutritional management for early weaned deer are identified.

INTRODUCTION

The world deer industry is growing about 20% annually with about five million deer currently being farmed (Hudson, 1999). In 2002, the estimated national deer numbers in NZ was 2.25 million (24,400 tonnes of venison) with 90% venison being exported to Europe, mainly to Germany (Ministry of Agriculture and Forestry, NZ, 2003). China has the second largest farmed deer population in the world (500,000, mainly Sika deer). Australia has about 200,000 animals on around 1,200 farms, and red deer and fallow deer form the great majority of the herd (Shapiro, 1998). Other countries, such as UK, Denmark and United States of America (USA), also have a significant number of deer.

The main products produced from deer are venison and velvet antler. Venison is low in calories, fat and cholesterol but high in protein and iron, making it suitable for low fat diets. The major consumer of venison in the world is Germany with 40-50,000 tonnes of venison consumed annually. NZ is the world's largest producer and exporter of farmed venison. Australia produces 1,000 tonnes of venison annually, 80% being exported (Shapiro, 1998). Velvet antler is mainly used in Asian market as an ingredient of traditional medicine (Miao *et al*., 2001). China has increased its capacity to produce over 400 tons of antler per year but quantities available vary from year to year (Deer trade, internet, 2003).

Worldwide, deer are raised under a variety of circumstances. They are hand-fed throughout East Asia, grazed on improved pastures in Europe and NZ, and ranched on native ranges in Russia. In North America, deer farming has tended to follow the NZ model but is constrained by seasonal availability of pastures and the need for winter feeding (Hudson, 1993). In East Asia, especially in China, the calves are tamed from birth and bottle-reared or fed concentrate. Farming systems are almost entirely focused on the production of velvet antler for the local medicine trade with demand also increasing for venison. The velvet yields are about 2.5 kg/stag/year from Sika-type stags and over 7.0 kg/stag/year from Wapiti-type stags. Very high levels of protein are frequently fed to stags in late winter to accelerate the process of hard antler casting and initiation of the new season's growth (Drew, 1998). In NZ and Australia, mature red stags can yield 3 kg or more of antler and fallow deer can yield 1 kg per year (Tuckwell, 1998). Deer are slaughtered at 12-24 months of age with carcass weights ranging from 22-32 kg for fallow, 48-65 kg for red deer and higher for wapiti hybrids (Miao *et al*., 2001)

Although there is an increasing demand for venison and antlers, the profitability fluctuates between farms and countries. Many factors contribute to this, including marketing and on-farm management. Weaning practice is one of these on-farm management factors that affect the profitability of the industry. In most countries, especially in Australia, there is a wide range of weaning dates between farms. The decision on weaning date is often motivated by the desire to minimise the stress suffered by calves associated with weaning, thus minimising the risk of losses through injuries or temporary reduction of food intake (Audige *et al.*, 1999a). In UK and North America, most farmers wean their calves prior to joining hinds with sire stags in mid-March, although some are weaned after the rut, i.e., in late August or early September. In southern Australia, most farmers do not wean their fawns/calves, while a few farmers wean their fawns after mating. This may delay the build-up of body condition of does due to the nutrient demands for milk production. Farmers continue to question whether they should wean their deer later during May and June (after mating) or in March (before mating). Weaning after mating could reduce the stress during weaning, and improve performance during the grazing season. Weaning before mating could allow does to recover their body condition for the next reproduction cycle. This review summarises the literature on the effect of weaning on deer production and identify gaps in knowledge of weaning procedures and nutritional management for early-weaned deer.

WEANING TIME AND PERFORMANCE OF DOES AND HINDS

Hormones

Weaning time seems to affect the release of luteinizing hormone (LH) and stimulates early postpartum oestrus of does and hinds although very limited evidence is available. Some research demonstrates that early weaning has no effect on the onset of oestrus in fallow deer and Awassi ewes. Weaning did not show a significant effect on serum LH release (Mulley *et al.*, 1994; Hamadeh, 2001). Research conducted with sheep on the effect of early weaning on the stimulation of early postpartum oestrus also gave conflicting results. Some researchers reported that lactation delays the onset of postpartum behavioural oestrus while others found no significant differences between early and late weaned ewes (Sefidbakht and Farid, 1977). However, Stagg *et al.* (1998) studied the effect of calf isolation on follicular wave and hormone changes, and clearly demonstrated that the suckling effect in beef cows was the major factor affecting the duration of the postpartum on oestrous interval. The removal of the suckling resulted in a 2-fold increase in LH pulse frequency which is the key endocrine factor determining whether or not a dominant follicle ovulates. Whether this occurs in deer is not clear.

Oestrus and conceiving date

The reasons for early weaning include improved flexibility and management of the calves and their dams. However, the widespread belief that hinds which have had their calves removed before mating conceive earlier has not been clarified. Some reports demonstrated that weaning brought forward average calving by a week (Blaxter *et al.*, 1980a; Friedel and Hudson, 1994; Pollard, 2002). This leads to larger stronger calves and hinds calving before they have had time to get too fat and suffer calving difficulties. Experience with other ruminants would also suggest that a better conception rate could be achieved (Marchaant, 1998). For example, Audige (1999b) pointed out that if farmers pre-rut wean calves from adult hinds, the breeding herd will calve earlier in the next season and will wean heavier calves. Wilson (1984) suggests that lactating hinds come into oestrus some days later than non-lactating hinds. Frequency and intensity of suckling affects onset of oestrus and these are likely to be higher in dry years when lactation is decreased. In North America, producers that wean before the rut in September produce calves about 5 days earlier than those that separated wapiti calves and hinds after the rut. This depended on the age of deer. Older wapiti hinds whose calves were pre-rut weaned subsequently calved an average of 8 days earlier than hinds that were bred with their calf at foot. Two year-old hinds calved 5.6 days later when they were weaned as calves before the rut (Friedel and Hudson, 1994). In a two-year experiment, Pollard *et al.*, (2002) found that mean conception dates occurred sooner in the early weaned hinds compared with the late-weaned hinds (by 12 days in 1999 and 7 days in 2000, Table 1). However, Mulley *et al.* (1994) and Hamadeh (2001) reported that early weaning had no effect on the onset of oestrus in fallow deer and Awassi ewes with no major effect of weaning on conception dates of hinds.

Table 1. Mean conception dates (relative to January1) and February/March and May/June condition scores for each weaning date treatment, on each farm, plus SED (standard error difference**)** between farms (Pollard *et al.*, 2002)

Weaning treatment	Farm No.	Day of conception	Feb/March condition score∴	May/June condition score
Early	1	-	3.1	3.4
	2	98	3.2	3.4
	3	89	3.9	4.4
	4	82	3.3	4.4
	5	82	3.5	4.0
	6	90	3.2	3.8
				3.4
Late	1	-	3.2	3.2
	2	110	3.3	2.8
	3	101	3.9	3.8
	4	99	3.5	3.9
	5	98	3.4	3.1
	6	97	3.2	3.1
SED		5.0	0.21	0.11
Sig.1		***	ns	***
Sig.2		***	***	***
Sig.3		***	ns	***

The level of significance of differences between treatments (Sig.1), farms (Sig.2) and interaction between treatment and farm (Sig.3) is indicated (ns. not significant, ***P<0.01). ∴ Deer with high condition scores are in better body conditions.

Body condition

Traditionally, pre-mating target live weights in yearling hinds and body condition score in adult hinds have been considered to be the critical factor affecting calving dates (Mitchell *et al.*, 1976; Kelly and Moore, 1977; Hamilton and Blaxter, 1980a; Moore *et al.*, 1985; Audige *et al.*, 1999b). In New Zealand, the pre-calving body condition score recorded in September appear to be an important risk factor and is positively related to the weight gain during winter. Thus a suitable weaning time is a major factor of nutritional management of adult hinds during early pregnancy and is critical for reproductive success (Audige *et al.*, 2000). To achieve a high pregnancy rate early in the mating season, farmers should wean calves early, exclude hinds with a body condition score ≤2.0 at mating. This is because the hind's body weight is related to the fertility of the hind with a general relationship of $p=1-\exp(-0.085(W-52))$, where P is the probability that a hind will calve and W is her weight in kg at the time of rut. From this equation, a 52 kg hind will not calve at all. The probability of a 60 kg hind calving is 0.49, a 80 kg hind is 0.91. Blaxter and Hamilton (1980a) also reported that for each 10 kg increase in pre-mating body weight, calving date of red hinds was advanced by two days.

While there is limited information on the impact of weaning time on body weight of fallow deer, research conducted in UK and New Zealand shows that weaning time influences the body weight of hinds at rut. It is believed that the later the hinds are weaned, the less likely they are to have a body condition score > 2 (Blaxter and Hamilton 1980a; Audige *et al.*, 1999a). Data in Table 1 clearly shows that the hinds weaned early were in better condition than those weaned late, probably due to the mobilisation of body reserves for milk producing. While Loudon *et al.* (1984) showed no significant weight changes during lactation, Landete *et al.* (2000) found a slight but significant trend for hinds to lose body weight during lactation. The hinds that produced less milk were those that suffered the greatest body losses, but this might be caused by the calving date. The late calving hinds produced less milk, yet suffered greater losses in body weight (Loudon *et al.*, 1984; Adam and Moir, 1987).

Birth weight

Birth weight of fawns and calves was related to the weight of the hind and does at rut, and so too was the subsequent daily rate of gain of the calf from birth to weaning (Table 2.). Usually the improvement in weaning weight of 3.5 kg can be achieved for each 1 kg increase in birth weight (Mulley, 1984). Also the mortality data for calves was equally related to the weight of their dams at rut (Blaxter and Hamilton, 1980b; Table 3). Kay and Staines (1981) and Mulley *et al.* (1990) also thought fawn birth weights generally approximated 10% of their mother. Considering the relationship between the weaning time and the body weight of hinds or does, weaning time will consequently influence the birth weight of fawns and calves. However, Landete *et al.* (2001) reported that the weight of the hind did not influence the weight of calf at birth, suggesting the supply of nutrients in the early stage of lactation appears to be more crucial for growth.

Table 2. Birth weight, weaning weight and growth rate of fawns over two fawning seasons (Mulley, 1984)

Fawning season		N	Mean birth weight (kg)	S.D.	N	Mean weaning weight (kg)	S.D.	Growth rate (birth to weaning) (g/day)	S.D.
1982/83	Total	52	4.0	0.70	57	18.4	2.8	123.3	23.8
	Males	33	4.0	0.74	35	18.6	3.15	128.0	24.1
	Females	19	4.0	0.67	22	18.1	2.23	115.5	21.8
1983/84	Total	66	4.6	0.58	11	21.5	2.9	182.0	26.0
	Males	36	4.9	0.57	6	24.0	3.4	210.4	20.7
	Females	30	4.3	0.45	5	20.0	1.5	165.0	5.0
Combined	Total	118	4.3	0.63	68	18.9	2.8	133.6	24.2
	Males	69	4.5	0.60	41	19.4	3.2	140.7	23.6
	Female	49	4.2	0.60	27	18.5	2.1	125.8	18.3

S. D., standard deviation. N, numbers

Table 3. Computed mortality of calves born to hinds at different body weights (Blaxter and Hamilton, 1980b)

Weight of hind (kg)	Predicted mean weight of calf (kg)		Weight related mortality (ratio)		Total mortality (ratio)	
	Stags	Hinds	Stags	Hinds	Stags	Hinds
55	6.0	5.6	0.149	0.220	0.166	0.237
60	6.3	5.9	0.123	0.176	0.140	0.193
65	6.5	6.1	0.105	0.142	0.122	0.159
70	6.8	6.3	0.095	0.119	0.112	0.136
75	7.0	6.6	0.092	0.103	0.109	0.120
80	7.3	6.9	0.094	0.092	0.111	0.109
85	7.5	7.1	0.100	0.088	0.117	0.105

Weaning rate

The separation of calves from hinds at rut has no effect on fertility, but the mortality of calves is related to the weight of their dams at the time of the rut (Blaxter and Hamilton, 1980b). There was a significant interaction between age class of the hind and the practice of weaning (Friedel and Hudson, 1994). Weaning improved calf-rearing success for adult Wapiti hinds by 2.6% and for 2 year-old Wapiti hinds by 13.4% (Figure 1). Weaning rate of adult hinds was 18% higher than 2 year-old hinds (Table 4).

Table 4. Reproductive performance of hinds in the survey (Friedel and Hudson, 1994)

	2year- old (n=208)	Adult (n=876)	Herd (n=1084)
Calf rate (%)	81.3	96.2	93.4
Calf mortality (%)	9.5	4.4	5.2
Weaning rate (%)	73.6	91.4	88.0
Open (%)*	18.8	4.3	7.1

* Open: no pregnant.

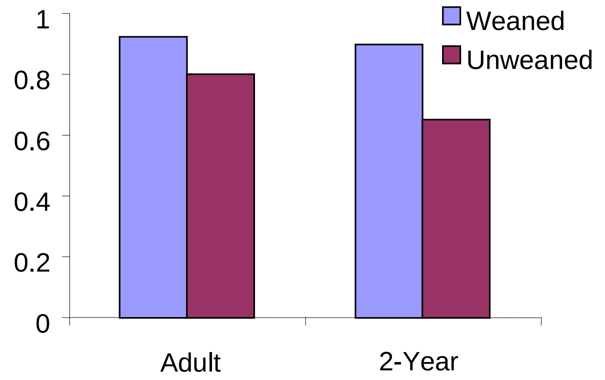


Figure 1. Effect of pre-rut weaning on the subsequent weaning rates of 2 year-old and adult hinds (after Friedel and Hudson, 1994)

Lactation

Usually deer have two types of lactation curves. Type I is the typical mammal curve with a peak during week 2 – 4 while type II is a decreasing curve that is attributed to a poorer diet (Garcia *et al.*, 1999). Loudon *et al.* (1984) compared the performance of red deer calf milk consumption when the hinds and their calves grazed either a sward of hill pasture (sward A) or a sward of improved grass (sward C). The peak milk consumption of the calves on sward A occurred at day 20 of lactation and earlier than those on sward C (day 40) but milk intakes of calves on sward A were 20% lower than those for calves on sward C. The decline in milk intake relative to calf requirements stimulates the young animals to ingest food characteristic of the adult diet (Robbins, 1983). In a study of wild red deer, Clutton-Brock (1985) reported that hinds were so depleted of body reserves as a result of heavy lactation, especially when the hinds graze poor quality pasture, that they either failed to conceive in the following breeding season, or didn't conceive as early as might normally occur (Mulley *et al.*, 1990). It was reported that 1 kg decrease in body weight would result in a 0.3-day average delay in calving. These research outcomes suggest that red calves should be weaned early to enable the hinds to build up their body condition for the next reproduction cycle. Research by Loudon *et al.* (1984) clearly demonstrated that weaning of red calves was feasible from 60 days and they noted that growth was not improved by giving milk for 100 days or more. More importantly, the advance in fawning date by early weaning will potentially reduce the number of deer born during extremely hot summer conditions in southern Australia, reducing the mortality of fawns. However, more research work is required to further demonstrate the advantages of early weaning under a Mediterranean environment where pasture supply is limited during the lactation and weaning periods.

EFFECT OF WEANING TIME ON THE PERFORMANCE OF FAWNS AND CALVES

Digestive capacity

Usually deer calves begin to consume solids from about 2 weeks-of-age. Good quality pasture, meal or other palatable concentrates should be provided from an early age to develop their digestive system (Wilson, 1984). Red deer and sambar calves begin nibbling forage at 20 days-of-age and ruminating at 32 days and 35 days, respectively (Dryden, 2002). Similar results were reported for black-tailed deer. For example, Seip *et al.* (1982) reported the black-tailed deer fawns had a functional rumen at a young age and appeared as efficient at digesting solid foods as older animals. Young fawns consumed little solid food until 25-28 days but by 60 days, solid food comprised the major part of the diet. This period corresponded to a period of rapid rumen growth (Table 5). It was clear that the rumen was small in fawns 21 days-of-age, but the relative weight of the rumen increased 4-fold by 109 days-of-age and reached adult proportions.

Table 5. Stomach measurements and digestibilities with increasing age of black-tailed deer fawns (Seip *et al.*, 1982)

Age of fawn (days)	Body weight (kg)	Weight of empty stomach (g)	Rumen weight (g)	Relative rumen weight (g/kg body weight)	Stomach volume (cm^3)	Rumen volume (cm^3)
21	7.5	80	34	4.5	260	150
41	8.6	144	92	10.7	590	500
60	14.5	249	155	10.7	1,600	1,400
71	18.5	380	265	14.3	1,200	1,050
109	32.8	746	560	17.1	2,150	1,700
144	35.9	747	549	15.3	3,400	3,000

When the young ruminant is weaned, volatile fatty acids become the main energy source instead of sugars and fats. The weaned ruminant must produce glucose in the body from propionic acid. Propionic and butyric acids and 1,2-propanediol have been stimulants for rumen mucosal growth, suggesting the growth of fore-stomachs, and especially rumen mucosa, relative to body weight is stimulated only in feeding periods of solid foods (Hamada *et al.*, 1975). Dry feed consumption increases rapidly and rumen fermentation develops quickly in the calves weaned at 3 weeks compared to those weaned at 5 and 7 weeks (Winter, 1985). This indicates that early weaning does not retard the development of digestive system of young calves.

Growth rate

Under current practices, the NZ deer industry has the potential to reach the target carcass weight of 50-65 kg by one year-of-age or less for red calves, to meet the spring export market. Because the growth of calves is related to milk intake for the first 90 d after birth (Arman, 1974), calves weaned early gained less weight than the late-weaned calves (Pollard, 2002; Table 6.). For fallow deer, the recommended minimum weight for an animal at weaning is 15 kg (English, 1984a). Weaning generally takes place between 14 and 21 weeks (Mulley *et al.*, 1990) at an average weight of 18 to 21 kg.

There is a clear relationship between weaning weights, live weight gains to weaning and birth weight, weaning age and dam live weight pre-rut. Weight at weaning for Javan rusal deer is correlated to weight at birth. An increase of 100 g at birth gives an increase of 110 g in weight at the time of weaning (4 months) for fallow deer (Asher and Adam, 1985; Asher, 1993) and a 140 g increase for red deer (Asher and Adam, 1985). However, there is limited information on the performance of red deer calves weaned at very early age and the performance as yearlings that have been exposed to a harsher than normal environment during their weaning life. Flesch *et al.* (1999) reported that there was no overall difference in growth rates between the various weaning strategies for fallow deer (Table 7). The deer weaned straight on to pasture at the beginning of the trial suffered an initial growth check for 1-2 weeks due to the stress of weaning. The deer given concentrate feed in individual pens did not gain weight either due to the stress of weaning although they did not lose weight for the first week of weaning. The deer that were unweaned at the beginning of the trial also experienced a one-week period of negative growth when they were weaned from their mothers on the 4th May. The effect of weaning does from their fawns in the pen trial could be seen for the first three weeks of the trial, before the pattern of energy intake stabilised between approximately 10-11 MJ ME/day. The feed intake of fallow weaner deer at 16 weeks-of-age was shown to be equivalent to that of adult fallow does. This research suggested that farmers could choose the technique most suited to their management program.

In recent years an emphasis has been placed on the ability of young animals to grow to meet body mass and body dimensional set points and to undergo compensatory growth. Provided the plane of nutrition is high, young animals under compensatory growth in spring follow a low growth period in summer and winter (White, 1992). Thus it is suggested that fawns weighing 15 kg be weaned if good feed is available (English, 1984a). Dryden (2001) examined the early weaning strategy for rusa deer in Queensland, Australia. He compared growth rates of calves weaned at 7 weeks with those weaned at 9 weeks. He found that food intake and growth rate were less in the 7 week weaned calves than in those weaned at 9 weeks. However, dry matter intake was not different when adjusted for metabolic size (Dryden, 2001).

Table 6. No. of calves in each weaning date treatment and mean growth rates for each farm between February/March and September, plus SED (standard error of difference) between farms (Pollard, 2002)*

Weaning treatment	Farm no.	No. calves	Growth rate (g/day)		
			February/March-June	May/June-September	March-September
Early	1	51	126	52	84
	2	62	177	88	135
	3	59	202	27	120
	4	20	237	108	170
	5	58	23	42	34
	6	34	134	50	91
Late	1	48	229	46	128
	2	54	176	103	143
	3	56	289	-4	151
	4	18	293	107	195
	5	53	129	5	65
	6	38	184	34	105
SED			10.9	12.4	8.1
Sig.1			***	***	***
Sig.2			***	***	***
Sig.3			***	***	***

*The level of significance of differences between treatments (Sig.1), farms (Sig.2), and interaction between treatment and farm (Sig.3) is indicated (***P<0.001)

Table 7. Mean (±s.e.m) weight and growth rates, of doe and buck fallow deer fawns from 12 to 25 weeks-age, weaned onto high energy concentrate feed (group1), weaned on to pasture (group 2) and unweaned and fed on pasture (group3) (Flesch, 1999)

Treatment group	Sex	n	Weight at 12 weeks of age (kg)	Weight at 25 weeks of age (kg)	Growth rate 12-25 weeks (g/day)
	Does	6	20.4 (0.8)	25.2 (0.9)	77 (3.0)*
1	Bucks	3	23.2 (1.5)	27.5 (1.7)	89 (5.1)*
	Group	9	21.3 (1.4)	25.9 (1.4)	82 (7.2)*
	Does	6	18.3 (1.5)	25.3(1.5)	77 (4.5)
2	Bucks	2	21.5 (0.8)	28.0 (1.2)	73 (2.8)
	Group	8	19.1 (1.6)	25.9 (1.6)	76 (2.8)
	Does	5	20.8 (1.1)	27.3 (1.2)	72 (4.0)
3	Bucks	4	22.6 (1.3)	30.3 (1.2)	85 (2.3)
	Group	9	21.6 (1.3)	28.6 (28.6)	78 (3.7)
	Does	17	19.8 (1.4)	25.8 (1.4)	75 (3.8)[a]
All groups	Bucks	9	22.6 (1.3)	28.8 (1.5)	84 (4.1)[b]
	Total group	26	20.8 (1.5)	26.9 (1.6)	79 (4.0)

a,b Indicates significantly different growth rate(p<0.05) between does and bucks.
* Growth rate for group one was calculated over eight weeks only.

Both red deer and fallow deer have a capacity for compensatory growth, i.e. after a period of restricted feeding or retarded growth, they grow faster in a subsequent period on *ad libitum* feeding (red deer- Suttie *et al.*, 1983; Adam and Moir, 1985; Milne *et al.*, 1987 and Webster *et al.*, 1997; fallow deer-Vigh-Larsen, 1991). However, the compensatory growth is incomplete, depending on pasture quality (Table 8). Data from Table 8 clearly shows that the maximum level of compensatory growth achieved is approximately 40%. Only two of the restricted groups reached the same live weight at the end of the study as the non-restricted groups because the pasture tends to deteriorate towards the end of summer (Vigh-Larsen and Davies, 1998).

Table 8. Compensatory growth during summer after restricted feeding during winter (Vigh-Larsen and Davies, 1998)

Winter feeding period								Summer grazing period			
Species		Ad lib.			Restricted				Ad lib	Restricted	
	No. days	MJME/Days	DLG g/day	MJME/kg gain	MJME/day, %	DLG %	MJME/kg gain,%	No. of days	DLG g/day	DLG %	Reference
Red deer	195	16.3	210	78	54	52	104	109	220	136	Suttie *et al.*, 1983
Red deer	116	21.7	176	123	45	-14	4	139	156	138	Aam *et al.*, 1985
Red deer	116	21.7	176	123	84	54	156	139	156	109	Adam *et al.*, 1985
Red deer	148	17.3	140	124	54	28	192	103	120	141	Milne *et al.*, 1987
Red deer	148	17.3	140	124	74	75	98	103	120	139	Milne *et al.*, 1987
Red deer	92	16.7	196	85	53	14	383	212	223	122	Webster *et al.*, 1997
Fallow deer	180	12.3	117	105	68	32	212	119	100	138	Vigh-Larsen, 1991
Fallow deer	180	12.3	117	105	79	61	130	119	100	114	Vigh-Larsen, 1991
Fallow deer	202	12.8	146	88	73	56	130	110	62	140	Vigh-Larsen, 1991
Fallow deer	202	12.8	146	88	88	68	128	110	62	124	Vigh-Larsen, 1991

DLG: daily live weight gain; ME: metabolizable energy

ADVANTAGES AND DISADVANTAGES OF EARLY WEANING

Advantages

The nutrient requirements of a weaned hind is about half that of a lactating hind. The body condition of early-weaned hind and does recovers before mating, which ensures high pregnancy rates (greater than 80%) in the first 18-day cycle. Breeding females need 4 weeks to recover any lactational loss of body weight before joining. For high conception rates, adults does should be greater than 42 kg at joining, with 16 month-old does between 35-38 kg (Pearce, 1996; English, 1984b).

Early weaning may have a positive effect on oestrus synchrony and early conception. The suckling of a calf stimulates release of prolactin, a hormone that has a negative effect on the release of hormones governing the oestrus cycle. Removal of the calf may stimulate earlier cycling and breeding activity. Pollard (2002) pointed out that weaning early is expected to have a positive effect on hind conception date and winter hind condition.

Early weaning provides an opportunity to start a simple animal health program for weaners without worrying about handling big groups, giving young stock time to accustom to being managed before winter. Disease control in the weaning group is easier to manage than in mixed groups. Weight change can be monitored in weaning groups so that consistent weight gain can be achieved and problem of yearling does not reaching puberty weight by 16 months-of-age can be therefore avoided (Mulley, 1984)

Early weaning allows time to sell or cull surplus breeding hinds, and to select individuals for special breeding programs and test them for tuberculosis if necessary.

Favourable weather improves forage availability and reduces the competition for food. Early weaning helps calves to recover quickly from the stress of separation and to continue their high autumn growth rates.

Friedel and Hudson (1994) reported that the practice of pre-rut weaning in wapiti increased calving rates, decreased calf mortalities, increased weaning rates, advanced the calving season and resulted in larger calves at 200 days.

Early weaned fawns and calves may be brought in regularly for drenching, vaccination and parasite control.

Disadvantages

Early weaning accentuates the stress of separation. Research with dairy cows suggested that both cows and calves pace, call out to each other, and generally remain unsettled for several days following separation.

Post weaning losses can also occur with early-weaned fawns, due to stress and adverse weather conditions (Christie, 1993).

Early weaning requires increased care during handling and yarding because of the weight difference between the calf and dam.

Changing to new feeds, especially concentrates, can be risky at this time. Two weeks before weaning, it is necessary to introduce grains or deer pellets to hinds and their calves.

Pollard (2002) concluded that weaning early could have a negative effect on calf growth rate but management could override negative effects of early weaning. In New Zealand, some farmers believe that young deer survive harsh winter climates better when not weaned.

FACTORS INFLUENCING WEANING PRACTICES

Pasture availability

In New Zealand, the rye grass/white clover pastures commence growth in spring; peak production occurs in late spring and is followed by reduced summer growth and a decline in feed quality. A small increase in pasture growth occurs in autumn, followed by a reduction/cessation of growth during winter. Patterns of pasture production such as this suit the sheep and cattle industries, which coincide with lambing and calving with the spring onset of pasture growth. Unfortunately this is not possible with temperate deer such as red deer and fallow deer because they calve during summer, when ryegrass-based pastures are at their lowest nutritive value and deer feed requirements are at their highest during lactation (Barry *et al.*, 1998).

The Mediterranean environment in Australia is characterised by wet, cold winters and hot, dry summers (Ru *et al.*, 2003). Annual pastures emerge in later autumn and reach peak production in spring. The quality and quantity of pasture are the key factors limiting animal production in summer and autumn. Therefore, fawns are often weaned at a time of rapidly decreasing pasture quality, or are weaned naturally by their mothers in early winter when live weight gain is of paramount importance in achieving target live weights. Although weaner deer will undergo a period of compensatory spring growth, growth rates from weaning to spring are still vitally important if slaughter and breeding target weights are to be achieved (Mulley *et al.*, 2001). In other words, low pasture quantity and/or quality result in post-weaning nutritional stress and unsatisfactory weight gains by weaners. Thus nutritional supplementation is crucial for weaners to reach a suitable market weight by summer (Revell *et al.*, 2001)

Handling of deer

The most common problems encountered in newly weaned calves are injuries due to poor handling. It is essential to keep handling facilities in good working order and for farmers to be prepared to handle smaller animals. Without a satisfactory yarding facility (weaning yard with adequate space, feed racks and water), it is difficult to practice early weaning. Lack of a weaning facility limits the chance of practicing early weaning. However, establishment of a quiet nucleus in the paddock-either a couple of calm dry hinds or an early weaned group which has settled down can facilitate weaning if it is not possible to keep them in the yards for a few days. Even with good facilities, weaning imposes stress on both the hind and her fawn and both should be treated with considerable care at this time (Yerex *et al.*, 1990)

Weather

Both fallow deer and red deer are tolerant of a wide range of environmental conditions within temperate zones, but weather can be a factor influencing the date of weaning on any given farm. It is understood that weaning should be avoided when the weather forecast suggests cool, rainy or windy weather. Calves have low fat reserves, and their baby coats do not provide good insulation until the winter coat grows. The stress of weaning predisposes calves to diseases, and this is magnified by poor weather. Moderate weather conditions increase the probability of survival to weaning. Weaning calves survive better in sunny areas but their chance of survival appears to decrease under warmer condition. Dry and warm conditions expose calves to dehydration while less-sunny weather might expose calves to hypothermia. When facilitated with the shelter and protected from the wind, the weaning calves are more likely to gain body weight (Audige *et al.*, 2000)

MANAGING EARLY WEANED DEER

Nutrition of earl weaned deer

There is limited information on the nutrition of early weaned fawns and calves. As a general guideline, fawns or calves should be weaned onto good pasture with *ad libitum* supplementary feed for optimum growth (English, 1984a). When fawns or calves are weaned pre-rut, they are deprived of an important source of nutrition, namely milk. The red deer hind, in common with the females of other cervids, produces rich milk (Table 9; Arman *et al.*, 1974). It contains about three times as much fat, twice as much protein, but the same concentration of lactose as cow milk. A well-fed hind produces some 1.7 litres of milk daily for the first four weeks after which her calf begins to eat substantial amounts of solid food. An undernourished hind produces little milk and may abandon her calf (Kay and Saines, 1981).

Table 9. The organic and mineral constituents of red deer milk (g/kg milk) at different stages of lactation (Arman *et al.*, 1974)

Stage of lactation (days)	Total solids	Fat	Crude protein	Lactose	Gross energy (kJ/kg)	Ca	P	Mg	Na	K
3 to 30	211	85	71	44	5440	2.2	2.2	0.18	0.33	1.2
31to 100	235	103	76	44	6530	2.2	1.8	0.18	0.37	1.3
Over 100	271	131	86	45	7740	2.5	1.9	0.22	0.35	1.2

In nature, the young ruminant continues to suck its dam while it learns and develops its ability to digest solid food, the milk by-passing the rumen and so supplying protein additional to that synthesised in the rumen. If a calf is weaned before the microbial product can fully meet its requirements, its growth will suffer unless enough dietary protein reaches the intestine (Kay and Staines, 1981). However, while the digestive capability of fawns or calves are developing, fawns of white-tailed deer show an increasing ability between 4 and 14 months-of-age to digest, metabolize and retain the energy of a diet (16.8% crude protein in dry matter) fed to appetite (Thompson *et al.*, 1973). Simpson *et al.* (1978) found no improvement with age (5-13 months old) in the digestive ability of red deer calves. No information on their development of digestive capacity is available for fallow deer. For the development of supplementary feeding strategy, it is essential to understand the nutrient requirement of weaner deer.

Red deer

A number of experiments were conducted in New Zealand to define the nutrient requirement of red deer. English (1984b) summarised these research outcomes (Table 10) and most Australian farmers are using these values as guidelines for feeding their weaner deer although some data may not be valid under Australian conditions, especially southern Australia. Dryden (2001) also found that the young calves consumed amounts of dry food similar to those expected of mature red deer.

Table 10. Metabolisable energy requirements (MJ ME/day) of red deer (English, 1984b)

		Autumn	Winter	Spring	Summer	Annual stock units
Stags	3-15 month	16	19	27	26	1.4
	15-27 month	24	28	31	30	1.8
	Older stags	19	35	42	38	2.2
Hinds	3-15 months	15	18	22	21	1.2
	Older hinds	23	22	24	47	1.9
Ewe	Rearing 1.1 lambs to weaning (standard s.u)	13	10	28	11	1.0

* One stock unit (SU) requires about 540 kg pasture (dry matter basis) per year.

Studies of nitrogen metabolism in red deer and sheep (Maloiy *et al.*, 1970) indicate that these species have similar ability to convert dietary nitrogen and endogenous urea to digestible microbial protein. On high protein diets (16.5%), the apparent digestibility of nitrogen was similar for red deer (75%) and sheep (73%) whereas on the low protein diet (5.25%), the apparent nitrogen digestibility was higher for sheep (39%) than for red deer (27%). For red deer on pelleted concentrates, grass hays and pasture, protein digestibility is directly related to the crude protein content of the diet, ranging from 56% for grass hay to 78% for concentrate pellets (Denholm, 1984). Estimates of dietary crude protein requirements for optimal growth vary within the range of 13% to 25% (Denholm, 1984). French *et al.* (1956) concluded that young male fawns (White-tailed deer) required 13% to 16% crude protein. Ullrey *et al.* (1967) obtained maximal growth on diets of 13% crude protein for female fawns and 20% for male fawns (White-tailed deer).

Fallow deer

The nutrient requirement of fallow weaner deer has only been recently defined. The seasonal energy requirements for fallow deer have been published in NZ by Milligan (1984) and Asher (1992) based on interpolations from red deer data (Fennessy *et al.*, 1981). The energy requirements for weaners on a seasonal basis are 11.0,11.8,14.2 and 13 MJ metabolisable energy (ME)/day for autumn, winter, spring and summer respectively, or between 1.0 and 1.3 kg dry matter (DM) per day of high quality feed. However, there have been limited experiments conducted to measure the energy requirement of weaner fallow deer during the grazing season.

Mulley *et al.* (2001) conducted a preliminary study on the nutrient requirement and growth rate of fallow weaner deer, with three groups comprising; 1) individually penned weaned fawns with a high energy concentrate diet containing 14 MJ ME/kg DM and 14 % crude protein (CP); 2) pasture-fed weaned fawns grazed in quarter hectare paddocks containing mixes of either oat/ryegrass or kikuyu with ME value between 9.7 and 13.8 MJ ME/kg DM and 3) pasture-fed unweaned fawns. There were no significant differences in growth rates between two weaning strategies, indicating that early weaning did not influence fawn's weight gain. Fawns in the unweaned treatment also experienced negative growth when weaned at the completion of the study. Concentrate-fed fawns in this study offered a ration containing 14 MJ ME/kg DM consumed up to 850 g/head/day to fulfil their daily energy requirements of approximately 11.5 MJ ME. Mulley *et al.*, (2001) suggested that a high level of crude protein (approximately 16%) is advantageous for fallow fawns to achieve their target live weights.

Ru *et al.* (2003) studied the energy and protein requirements of grazing fallow weaners. The study used 60 fallow weaners, including 30 males and 30 females. Deer were randomly divided into three groups with balanced sex in each group. Three groups were randomly allocated into the three paddocks and supplemented with a diet including 2% minerals, 30% lupin and 68% barley. The diet contained 13.0 MJ DE/kg and 168.8 g/kg protein. Group 1 was fed *ad libitum* and group 2 was fed 400g/day while group 3 was fed 200 g/day. Supplementation ceased at the end of July. Forage intake was estimated using plant alkane as a marker. Due to the difficulty of the weaning process in April, this study only determined the nutrient intake, energy and protein requirements from May. The outcomes of this study clearly demonstrated that fallow weaner deer obtained a very limited amount of protein and energy in May and June due to the low availability of herbage in southern Australia at this time of year. The level of supplementation influenced the forage intake in May and June (Table 11). The digestible energy and crude protein intake were strongly correlated with body weight gain. The energy requirement per kg $W^{0.75}$ for maintenance, estimated using regression analysis, was highest in July. If the ratio of 0.82 (digestible energy/metabolisable energy) suggested by ARC (1980) is used to convert digestible energy to metabolisable energy (ME), the predicted ME requirement for fallow weaner deer is 6.7, 7.5, 9.6 MJ ME/day in May, June, July, respectively, at a growth rate of 50 g/day (Table 12). The crude protein requirement determined from this study is relatively high, but it should be noted that the protein requirement in this study is expressed as crude protein and the values can vary with the quality of feed. While it is ideal to express the protein requirement as degradable and undegradable crude protein, it is impossible to determine the degradability of protein in this study due to the limited resources (Table 13, Ru *et al.*, 2003).

Table 11. Daily nutrient intake from pastures by grazing fallow deer during the season (Ru *et al.*, 2003)

Treatment	Nutritional component					
	DM (kg/day)		DE (MJ/day)		CP (g/day)	
	Means	SE	Means	SE	Means	SE
			May			
H	0.148a	0.025	1.95a	0.30	44.2a	7.3
M	0.199a	0.021	2.62a	0.26	57.5a	5.9
L	0.300b	0.022	3.05b	0.26	83.5b	6.2
P	**		**		**	
			June			
H	0.137a	0.015	1.75a	0.30	37.7a	4.0
M	0.185a	0.016	2.45a	0.31	49.6b	4.2
L	0.304b	0.018	3.61b	0.35	76.5c	4.7
P	**		**		**	
			July			
H	0.504a	0.037	8.09a	0.57	137.3a	10.3
M	0.297b	0.035	4.29b	0.54	82.9b	9.9
L	0.534a	0.035	8.06a	0.54	157.3a	9.9
P	**		**		**	

∴∴ Values are significantly different between treatments in each month at p<0.01.
H, *ad libitum* group; M, 400 g/day group; L, 200g/day group; DM, dry matter; DE, digestible energy; CP, crude protein; SE, standard error.

Table 12. Energy requirement of grazing fallow deer for different growth rates during the season estimated using the relationship between energy intake and growth rate (Ru *et al.*, 2003)

Date	Liveweight (kg)	Gain (g/day)	DE		ME	
			MJ/day	MJ/W $^{0.75}$	MJ/day	MJ/W $^{0.75}$
		0	7.25	0.65	5.95	0.54
May	24.8	50	8.20	0.74	6.73	0.61
		100	9.15	0.82	7.50	0.68
		0	8.22	0.70	6.74	0.57
June	26.9	50	9.12	0.77	7.48	0.63
		100	10.02	0.85	8.22	0.70
		0	10.25	0.86	8.40	0.70
July	27.4	50	11.70	0.98	9.59	0.80
		100	13.15	1.10	10.78	0.90

DE, digestible energy; ME, metabolisable energy.

Table 13. Crude protein requirement of grazing fallow deer at different growth rates estimated using the relationship between protein intake and growth rate (Ru *et al.*, 2003)

Date	Liveweight (kg)	Gain (g/day)	Crude protein	
			g/day	g/W $^{0.75}$
		0	135.49	12.19
May	24.8	50	150.09	13.51
		100	164.69	14.82
		0	148.62	12.58
June	26.9	50	161.72	13.69
		100	174.82	14.80
		0	180.22	15.04
July	27.4	50	207.87	17.35
		100	235.52	19.66

Feed conversion efficiency

It has often been assumed that deer are more effective converters of food to live weight gain than cattle or sheep but this is not correct. The production of 1 kg carcass and lean meat required 125 and 193 MJ ME respectively for Holstein Friesian-bull caves on *ad libitum*. The production of 1 kg carcass and lean meat for red deer calves required 169 MJ ME and 238 MJ ME, respectively (Vigh-Larsen *et al.*, 1998). However, during the post-weaning growth phase, food conversion was 2.7-3.8 kg dry matter intake for 1 kg carcass gain on a barley concentrate plus 10% roughage diet for deer and beef required approximately 5-6 kg dry matter intake for 1 kg carcass gain (Wilson, 1979). This further suggests that the period of post-weaning is crucial for economic venison production.

Managing early weaning

It is an advantage to return calves to familiar pasture, with the hinds separated and kept some alternatively distance away. If possible a small nucleus group can be weaned first, and then added to, or a small group of five or six calm dry hinds can be held with weaners for herd control and a calming influence. Opinions vary on whether weaners should be held in yards or returned directly to pasture, but there is some preference for holding overnight for 2 to 3 days, with mothers separated and returned to the pasture immediately. Weaners, whether yarded or on pasture, should have access to fresh clean water and good quality hay or pasture. Supplements should be used only if the calves are already accustomed to them.

There are two early-weaning processes. One is fence-line weaning. In this procedure, the calves are separated and returned to adjacent pastures, with only a fence-line between them. This allows socialisation behaviour to continue, including vocalization, nose-to-nose contact, and lying together. The second alternative is soft weaning, which involves the removal of about ten percent of hinds or does each day for ten days. This allows a gradual change to the social structure of the group, and allows access to the comforting presence of the herd. No mater which procedure is followed, there is always stress associated with weaning. To minimise the stress, start feeding supplements to the calves and fawns before weaning. Oats and specially formulated pellets or cubes are a good choice. Prepare a pasture for the calves by seeding and fertilising to produce a lush growth, and rest the pasture from grazing for the month of weaning. Weaning should not be carried out when the weather forecast suggests cool, rainy or windy weather.

CONCLUSION

There is no clear guideline on the weaning time of red and fallow deer. There is still debate amongst farmers about pre and post rut weaning although it is believed that post rut weaning has the disadvantage that calves are not drenched for lungworm control over autumn and the stress of separation occurs when weather conditions are likely to be poorer in early winter. Later weaning has the advantage that hinds can teach their calves to eat winter supplements before weaning. Due to the advantages of early weaning discussed in the previous section, weaning pre-rut is practiced by most farmers in NZ.

NZ weaning practice may not be applicable in Australia and other countries where there are different environmental conditions. In NZ, winters are mild, summers temperate, the rainfall abundant and herbage growth quite spectacular (Short, 1985). Perennial pastures such as ryegrass and white clover are common deer pastures in northern region where most deer research was conducted. Metabolisable energy and protein content of perennial ryegrass/white clover pastures in summer are 11.1 MJ/kg and 21.5%, respectively. During lactation deer can grow 331-399 g/day when grazing on perennial ryegrass/white clover pasture. From weaning to slaughter, the growth of young deer grazing perennial ryegrass and white clover was approximately 200 g in autumn and 300 g during spring. During winter the average growth rate was 110 g/day, but varied from 75 to 160 g/day between years (Barry *et al.*, 1999). Under such feeding conditions, pre-rut weaning is preferred because early-weaned calves can be preferentially fed the best quality pasture available (Wilson, 1984; Christie, 1993). However, in southern Australia, at 3 months-of-age, fawns are exposed to very dry, hot summers with no green pasture supply. Nutritive value of dry mature pastures is very poor. For example, metabolisable energy content for lucerne hay and medic hay is < 9 MJ/kg and protein content ranges from 14-16%. Under most situations, deer are grazing crop stubbles or a mixed pasture of legume and grass which have much poorer quality than legume hays. Farmers also believe hinds can teach calves to take supplements and survive harsh summer climates better when not weaned.

Dryden (2002) studied the early weaning of small numbers of red deer housed indoors in Queensland. The weaning age were 7 and 9 weeks, which could serve as an emergency weaning strategy. The results cannot be applied to fallow deer in southern Australia due to the difference in species and environmental conditions. It is also believed that fallow deer cannot be weaned at 7 weeks of age due to the stress associated with weaning and weathers, and the inability of fawns to consume adequate nutrients from supplementary feed under grazing conditions. Therefore, critical trials are needed to establish the production effects of both pre and post rut weaning and validate NZ weaning strategies of red deer and fallow deer grazed under southern Australian or other regions with similar environmental conditions.

Methodology

Experimental location

The research was conducted on the Bilby Deer farm in the South-East of South Australia. Experiments were conducted under Dr J. Flesch's supervision.

Experimental Design

Forty acres paddocks were used in this experiment. Stocking rate was 2 deer/acre. The natural pasture species were rye grass, shaftel and phalaris. After weaning, fawns were put into fresh paddocks that were previously sown with oats and clover. To increase the statistical power of the experiment the following experimental design was adopted using the Biometric SA recommendations as follows. The detailed procedures were;

- In Nov. 2003, 320 pregnant does were selected. The does were;
    - Similar genotype;
    - Similar body conditions (average score);
    - Similar body weight;
    - Pregnant (ultrasonography test)

All selected deer were weighed and randomly allocated into 4 groups (80 does/group). Each group was identified with a different coloured ear tag. Four groups were located into different paddocks (10 acres for each paddock) for fawning with the same feeding strategy normally used on the Bilby Deer Farm.

- From Jan. 1 to Mar 31 2004, all deer were checked to ensure that adequate feed was available. If necessary, hay was supplemented.

- At the end of March, two groups were weaned. The other two groups were weaned at the end of June 2004. To ensure that all treatments and control groups receive the same quality and quantity of supplementary feed, all deer were fed a pelleted diet (supplied by SARDI). Does and fawns were fed 1kg of silage per day up until weaning then fawns were put into fresh paddocks that were previously sown with oats and clove. Each deer had a feeding space of at least 0.5 m trough feeding space to ensure that all deer obtain their daily allocation and to minimise the impact of social ranking on individual deer feed intake.

Measurement

From March to September (does) and to November 2004 (weaners), all deer (weaners and does) were weighed every two months. Weights of does and weaners were recorded to the nearest 0.5kg. The procedure involved shifting deer from paddocks into a lane-way system which bought them into the handling yards which were enclosed in a 60' x 50' shed. There were no dark rooms in the shed and all rooms had 8' wooden walls. Deer to be weighed were brought in from the main round room into a small holding pen with a weight platform.

1996).

Photo 1. Bilby deer farm

Photo 2. Paddock

Photo 3. Deer in weighing shed (a)

Photo 4. Deer in weighing shed (b)

Photo 5. Deer released to paddocks

Photo 6. Recording data

Statistical analysis

The experiment was a randomised block design. Weaning time was the main treatment factor. The treatment effects were assessed with ANOVA in Systat software (Wilkinson 1996).

Results and Discussion

Bilby deer farm

During the trial the Bilby deer farm was put on the market for sale. Some of the does and fawns were sold during the experimental period reducing the numbers in each treatment. This may have had some influence on the statistical power of the experiment, but it was considered that the results obtained were a true reflection of the treatments imposed.

Doe performance

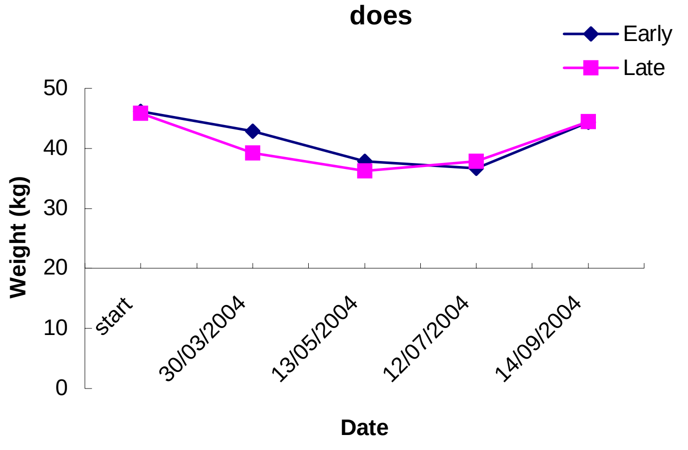
There was no significant difference in body weight of does at beginning of the experiment. However, early weaned does had heavier body weight (42.85 vs 39.18 kg) by 30 March 2004 compared to the late weaned does. Early weaned does lost more weight from May to July. However their weight gradually increased and by the end of the experiment there was no significant difference in body weight between early and late weaned does (Table 14 and Fig.2).

Table 14. Body weights (kg) of does that had fawns weaned early or late

Treatment	Wt.* start	Wt. 30/3/04	Wt. 13/5/04	Wt. 12/7/04	Wt. 14/9/04	Wt. difference (period 1)	Wt. difference (period 2)	Wt. difference (period 3)	Wt. difference (Total)
Early	46.14	42.85	37.80	36.72	44.39	-3.19	-8.57	-9.95	-0.39
Late	45.85	39.18	36.29	37.86	44.50	-6.70	-9.52	-7.34	0.61
P value	***0.512***	***0.000***	***0.027***	***0.051***	***0.902***	***0.000***	***0.175***	***0.002***	***0.577***
SEM	***0.220***	***0.297***	***0.333***	***0.286***	***0.421***	***0.308***	***0.34***	***0.418***	***0.840***

Please note: During the experiment some deer lost ear tags. Other deer were sold by the farm during the trial. * Wt=weight.

Figure 2. The liveweight of early or late weaned does



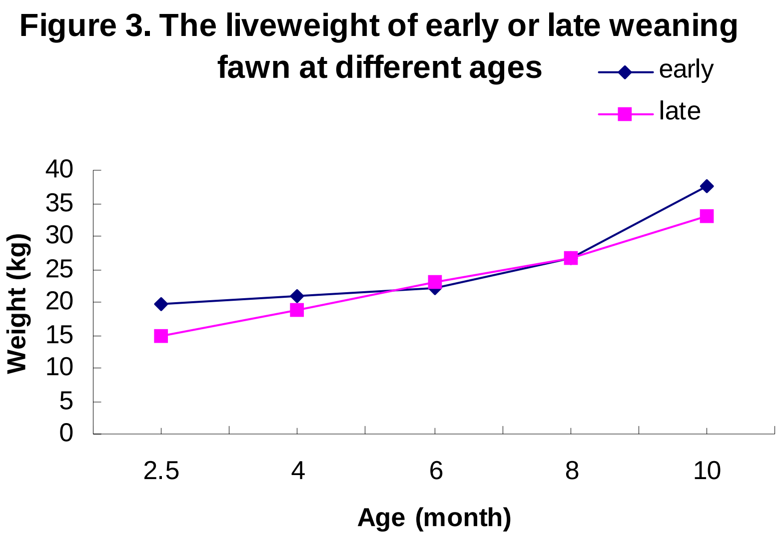
Weaner performance

Fawns weaned early had heavier body weight at 29, March 2004 and grew more by the end of the experiment (17, November, 2004) compared to fawns that had been weaned late. Late weaned fawns grew more between 29, March 2004 and 14, September 2004 (Table 15 and Fig. 3).

Table 15. Body weights (kg) of fawns that had been weaned early or late

Treatment	Wt.* 29/3/04	Wt. 13/5/04	Wt. 12/7/04	Wt. 14/9/04	Wt. 17/11/04	Wt. difference (period 1)	Wt. difference (period 2)	Wt. difference (period 3)	Wt. difference (total)
Early	19.68	20.77	22.24	26.58	37.46	0.79	2.32	6.53	17.41
Late	14.81	18.77	23.17	26.61	33.01	3.78	8.10	11.98	18.38
P value	***0.000***	***0.000***	***0.130***	***0.954***	***0.000***	***0.000***	***0.000***	***0.000***	***0.297***
SEM	***0.277***	***0.280***	***0.307***	***0.289***	***0.449***	***0.178***	***0.408***	***0.424***	***0.462***

Please note: During the experiment some deer lost ear tags. Other deer were sold by the farm during the trial.
* Wt=weight.



Note: Age of fawns was based on the assumption that all fawns were born in mid January.

Discussion

The body weight of does was similar at the start of the experiment and after the experiment had been completed their body weight was also similar. No clear trend emerged showing that early weaning was better than late weaning for doe body weight recovery. This result was different from that reported by Pollard *et al.* (2002), who stated that the hinds weaned early were in better condition (3.9 vs 3.3 condition score) than those weaned late, probably due to the mobilisation of body reserves for milk producing. The doe body weight from both early and late weaning treatments was close to the body weights of pregnant does (November, 2003). This may because there was dry conditions during the experimental period or the weight was influenced by the stress of herding, weighing and handling. When the trial was set up, deer not involved in the trial were placed in separate paddocks on the farm. The farmer manager, Ian Rasmussen (per. comm.) observed that deer weighed every 8 weeks had lower weight gain (average 10kg less) compared to the deer that were not weighed. This was probably because each time deer were put through the handling yards to be weighed they suffered undue stress, which affected their gain.

Early weaned fawns had significantly heavier body weight by 29, March 2004 and 17, November 2004 compared to late weaned fawns. This indicated that the growth rate of early weaned fawns was superior in the early stages compared to late weaning fawns (if it is assumed the birth weight of early and late weaned fawns were similar). This may indicate that the early weaning did not affect the development of the digestive system of young fawns. Winter (1985) reported that dry feed consumption increases rapidly and rumen fermentation develops quickly in the calves weaned at 3 weeks compared to those weaned at 5 and 7 weeks. In this study, late weaned fawns grew faster (7.84 vs 5.81kg) from March to September 2004, while early weaned fawns grew faster (10.88 vs 6.40kg) than late weaners from September to November. This may be because of the weaning stress. Flesh (1999) reported that the deer weaned straight onto pastures at the beginning of the trail suffered an initial growth check for 1-2 weeks due to the stress of weaning. The deer given concentrate feed in individual pens did not gain weight due to stress of weaning. Overall early weaning fawns were significant heavier that the late weaning fawns. This result was different from Flesch (1999), who reported that there was no overall difference in growth rates between the various weaning strategies (weaned onto high energy concentrate feed, weaned onto pasture and unweaned and fed on pasture).

Anecdotal reports from the Bilby deer farm

While the trial was being conducted not all the fawns that were weaned early or late were included in the experiment. These deer were kept in separate groups on the farm and not subjected to the experimental regime. The farm manager reported that the early weaned dear were heavier toward the end of the growing season than the late weaned deer. The manager considered that the stress of herding and weighing deer throughout the project probably contributed to all deer having similar weight at the end of the trial. In other words the stress of herding, weighing and handling reduced the body weight such that it represented a stress treatment for both the early and late weaned group. A control group that was not handled during the experiment should be considered in any follow up experiments.

Conclusion

There was no clear trend showing early weaning was better for does and fawns in body weights than late weaning in this experiment. This may because the weather condition was dry during the experiment period or due to the persistent stress of handling. Deer were grazing crop stubbles or a mixed pasture of legumes and grass, which had poor nutritive value during experimental period. In the future, balanced diets and minimal handling may be needed to determine the difference between the early or late weaning strategy.

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Implications

The advantages of early weaning were apparent early in the season. However by the end of the season there appeared to be no benefits from early weaning.

Recommendations

It is suggested that deer farmers undertake a small trial on their owns farms to determine if early weaning is beneficial or not, ensuring that handling is kept to a minimum.

Publications

Y. M. Bao*, Y. J. Ru, P. C. Glatz and Z. H. Miao. (2004) The influence of weaning time on deer performance. Asian-Aust. J. Anim. Sci. 17:569-581.

Communications Strategy

Publish the results in the Deer Industry newsletter
Publish paper in an applied scientific journal