Hybridization and Species/Strains in the New Zealand Deer Industry.

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Abstract

Traditional crossbreeding of elk wapiti sires with a base NZ red deer continues, aimed primarily at improving venison production patterns. There are increasingly highly selected strains of European deer available that are making a substantial contribution to improving and changing the genetic balance of the NZ herd. Principles of crossbreeding that advance biological and economic efficiency are reviewed in terms of efficiency, flexibility and production cost.

The need for objective breeding and recording systems to better advance these programmes is highlighted.

Père David x red hybrids have been the subject of intensive study as a role model to define genetic based quantitative trait linkages as a DNA based selection tool of the future.

Keywords: Breed strains, crossbreeding, efficiency, flexibility, production cost, quantitative trait linkage.

Introduction

The great diversity of the Cervid species, as expressed by size differences and a spectrum of antler growth is well documented in herds and strains throughout the world.

Within the NZ deer farming industry cross breeding between many of these diverse strains is a common commercial feature, aimed primarily at improving the profitability and flexibility of venison production. Commonly used genetic bases are of recently introduced European red deer and the base NZ red deer hind, and also with the principal strains of North American elk

Essentially commercial and market demands of the venison industry have remained unchanged for the last decade and are expressed as a relatively narrow carcase range of 50-70 kg with a peak return in the New Zealand spring. Demand for a continual supply is broadly paralleled by declining schedule price in phase with the natural farm production patterns through summer and autumn. There are real financial incentives to either utilise genetic advantage in growth via interstrain breeding or crossbreeding, or to develop cost effective on-farm feeding systems to maintain young stock through a second winter of low or nil growth to meet the peak schedule in the following spring.

It is fair comment to observe that in spite of the dramatic progress in production reported by the acknowledged leading stud herds and well managed commercial farms, there are few formal breeding objectives in place. The breeding industry also lacks rigorous genetic evaluations to provide breeding values, heritability estimates of economic traits and consistent mechanisms of selection criteria to identify elite stock on an industry basis. However, there have been great gains since a good antler head was ~5.0 kg at maturity in the 1980's with reports of 8 - 10 kg red deer heads now produced commonly.

Table 1 presents a purely subjective review of current farmed deer production, as expressed by velvet antler weights seen at the major national and international velvet antler competitions - as a reflection of progress, and arguably between strain differences.

If nothing else it reflects change in weight by age possible in velvet antler production and perhaps presents a yardstick by which on-farm production of strains and interstrain crossbreeds can be measured. Data from year to year and between competitions is unduly influenced by changing grading standards, huge environmental differences and certainly does not represent all the leading strains, stud farms and individuals.

Table 1a. Velvet antler (kg) – from National Velvet Antler Competitions 1994-97, showing trends in weight

	Kg weight				
Competition Heads	**1994**	**1995**	**1996**	**1997**	
NZ Red (Mature)	6 164	6 101	6 359	6 896	combined
Imported Red (Mature)	7 334	7 613	7 013		
Red 3 yo	4 08	4 089	4 160	4 313	
Red 2 yo (Nelson*)				3 45	
Wapiti Supreme (Mature)	10 345	12 530	12 355	11 277	
Wapiti/Elk EW$_1$ class	9 13	7 853	8 283	7 830	
Wapiti Elk 3 yo	5 425	5 916	6 360	5 190	

Table 1b. North American Elk Velvet Antler Production (kg), 1997 season.(600 antler pairs/regional competition averages) compared with New Zealand data

Age	Average Antler Weight	Elite (Top 3 per region)	NZ Elk/Wapiti* (EWS competition)	Red Deer (National Averages)
2 yo	5 30	5 93	4 08	3 18
3 yo	7 83	9 60	5 33	4 31
4 yo	9 89	11 71	7 41	-
5 yo	11 47	12 86	8 37	-
6 yo	11 86	13 47	-	-
Mature	14 18	16 60	9 95	6 896

If nothing else these figures confirm the advantages of starting any breeding programme with the animals, or sons of animals that are in the top 3% of production albeit subject to environmental influences. The marked differences between elk and red deer are clearly preserved with age and broadly reflect the established trends that antler weight increases at a relatively greater rate than liveweight increases.

The across *vs* within breed strain debate can be fiercely protective and subjectively biased, notwithstanding the emerging production advances that are real. The industry continues to want for hard information on relative carcase yields, production indices related to farm costs and returns and a well defined series of breeding objectives to match market requirements and the reality of on-farm production costs.

With dual product streams, (velvet antler and venison) the utilisation of breed/strain variation is further complicated as the emphasis on early growth rate for better timed slaughter contrasts with evaluation for velvet antler production at a later age. If velvet antler weight for age is the selection criteria 2 yo. velvet weight remains the best selection index although recent work (SNODFA project) is showing some promise evaluating spike beam when cut at an ideal commercial stage (SP1). As breeding objectives evolve the value of integration of breed and strain characteristics via within strain selection of individuals, or crossbreeding between strains will inevitably develop a unique and derived NZ farmed deer most adapted for NZ farming conditions and the markets the deer industry serves.

It is useful to revisit the well established principles of hybridisation or cross breeding in that light i.e. efficiency, flexibility and production costs.

Efficiency

The dynamics of hybridization allow single rapid genetic gains in selected characters that are expressed at their maximum the further apart genetically the parents are. In deer the important commercial features are:

- Growth rate improvement (at a young age).
- Mature weight.
- Antler growth (weight and grade for age).
- Gestation length or timing of mating and calving.

Any major change in these features will have significant benefits, but not without cost or implication on farm management systems. These factors must be considered as part of the efficiency of production equation that ultimately impacts on profitability.

For example, the gains in growth possible by cross breeding elk with red deer have huge potential but inadequate feeding through lactation and in the critical post weaning autumn growth period have significant implications for the hind in next seasons successful breeding and timing, as well as limiting ultimate growth of the offspring.

Recent work at Lincoln University by Glen Judson (1995) suggest that differences in growth rate between red deer and wapiti hybrids are at their maximum during spring and autumn growth periods and at an equivalent or parallel low during the winter growth depression. Enhanced growth during the favourable periods requires attention to high quality feeding supply and management. Black Forest Park (Currie pers. comm.) report, however, significant earlier mating patterns with East European sires and no extended gestation length allowing them, in South Otago, to begin calving ~ 20th October with some groups being 60-70% completed by the first week in November. This adds considerably to ultimate weaning weight through better lactation and summer pasture management.

Gains in efficiency of feed maintenance for larger mature animals are only achieved at maturity at three years of age and greater (early work at Invermay suggested that wapiti bulls of twice the body weight of red stags required only 68% of feed relative to the body weight difference) but there are significant behavioural and management implications that impact on stocking rate and production that can reduce that efficiency. This can in effect reduce the practical stocking rate of mature hybrids or larger crossbreeds compared with base NZ red deer but may not affect the economic outcome because of the greater overall product return.

Similarly increased gestation lengths in hybridisation systems have a major influence on timing and management of weaning, mating and calving that require adjustment in feeding and stock and pasture management.

Efficiency of hybridisation is generally expressed as the net result of product out/food eaten. In venison production, this is best seen as the terminal sire concept where a large highly selected sire from a divergent strain type is mated to the smallest practically sized breeding hind. Limitations are basically confined to any adverse impact to biologic, and therefore economic efficiency on reproductive rate, either via reduced pregnancy rates, (failure to conceive) or due to increased calving difficulties and losses via dystocia or mismothering, desertion or starvation. There is little objective industry information on the extent or reality of this potential loss. Lawrence (1986) in survey of calving difficulties related to breed crosses in comparison to within breed dystocia's reported only 9% of dystocia could be attributable to between breed differences. Anecdotally many of the common perceptions of reproduction rate depression in hybridisation systems can be attributed to mismanagement of breeding sires, or poor calving management that is unfairly attributed to the breed cross rather than the farm operation. However, some significant mating failures between elk/wapiti and red deer have been reported under good management (54-60%) without any real reason being identified.

Bringans (pers comm.) has had extensive experience in the production of "Silks" - crossbreeding North American elk with sika deer (~75-80kg) in AI programmes to produce a hybrid sire with growth characteristics of elk and superbly adapted to Texas heat and pasture conditions that prove more successful that an equivalent sized red deer in that climate. Good conception rates and lack of birthing difficulties were noted as a strong feature of this extreme cross.

In terms of efficiency a 10% improvement in herd weaning rate grants a 6% biological increase in production efficiency, and on current prices an estimated 19% economic advantage. Conversely a reduction of this level will have at least that cost if not more if there is also loss of hind due to calving, or further impact of breeding ability in the following season (Fennessy 1987).

Reproductive failure in hybridisation systems can well be very costly and not compensated for by gains in growth efficiency.

It is relevant to reprint Fennessy's table of factors that can affect efficiency of venison production in both biologic and economic terms.

Features:

Table 2. Factors affecting efficiency of meat production in a herd of red deer, the expected response in biological efficiency or economic (gross margins) efficiency to changes in the factor, and the possible means of changing the factor (Fennessy 1982 and Fennessy unpublished).

Change in the factor		% Change in Efficiency		Means of changing the factor
		Biological	Economic	
10%	in weight for age of the whole herd	2	9	Selection for weight within a herd or strain, change of strain/sub-species (eg Red deer to wapiti)
10%	in weight of slaughter stock only, with no change in age at slaughter	5	15	Hybridisation (eg Wapiti x red deer females), selection, management-altering calving season
10%	units in herd weaning rate (calves weaned per 100 hinds to stag)	6	19	Management-nutrition, survival, selection for twinning, management to increase twinning
1%	units in herd death rate	2	-	Management and disease control, selection, hybridisation

The implication is that hybridisation must be planned and managed accordingly irrespective of the choice of strain type or size with gains entirely consistent with risk and the need for appropriate management.

Flexibility and Production

Primarily, crossbreeding allows production of prime carcass weights at an earlier age on what continues to be a premium contracted or schedule market. Practical advantages in having the productive ability to meet earlier slaughter dates allow for differentiation of a venison production system to set liveweight targets for spread disposal of venison stock, freeing up the deer farm pasture for improved lactation management, or feed diversion into female and smaller stock.

Ideally a crossbreeding system seeks to dispose of all females within the 15 month cycle, although some producers find these effective animals to carry into mid-winter and peak schedule prices with some small weight gain and no management difficulties during the rut.

With a commercial emphasis on an early time of slaughter, ie. a younger age for inter-strain and cross-strain hybrids, there has been considerable debate, but regrettably sparse objective data on venison yield, both in carcass to liveweight ratio (dressing %) and the meat/fat/bone yields of strain types and hybrids.

Some exporters vigorously suggested that elk - at carcass weights of 55-60kg or 100-110kg liveweight at 4-5 months of age were an inappropriate choice of animal for venison production. The Elk and Wapiti Society similarly equally vigorously challenged that by suggesting that it was almost unheard of that farmers would offer young elk in April/May post-weaning for venison production and a venison veal type market was not supported.

Hybrid yields have been touted as at least equal to that of similar weights of red deer, with a 2-3 month time advantage but there is a strong suggestion that these animals must be well fed prior to the slaughter at weights desired, rather than just presented at a target weight achieved by virtue of size.

Most plant managers report very favourable yield data from cross-strain breeding (25-50% crosses) but there has been no concerted and controlled trial work completed in this area.

Recent comparative data has been added to previous work by Drew et al (1992). The salient points of Table 3 are:

1. "Red Deer" (NZ type strain) show that with increasing age, lean yield decreases, fat yields increase dramatically and % bone decreases.
2. Eleven-month-old F1 (elk x red) show every high lean yield, very low fat yield with bone yield approximately the same as in two year old red deer. Significantly this cross is extremely high in primal saddle lean yield.
3. Commercial wapiti cross (2 and 3 year old) yield approximately the same killing-out percentage as 26 month average reds, but are approximately 10kg heavier (32% elk genes as assessed by ***Genomnz***).
4. All genotypes and ages show a very similar hind leg meat/bone/fat yields.

Table 3. Average Red and hybrid carcase composition

	Red Deer				Elk x Red cross (50 50)	
	15 month		*26 Month*		*11 Month*	
Liveweight (kg)	104		130		116	
Hot carcase weight (kg)	58 2		74 1		68 4	
Cold carcase weight (kg)	56 4		72 3		66 6	
Dressing percentage	56		57		59	
Typical yields	Kg	(%CW)	Kg	(%CW)	Kg	(%CW)
Saddle	8 4	(14 5)	10 9	(15)	11 8	(18)
Hind legs	21 7	(38 5)	28 1	(39)	26 6	(40)
Shoulder	11 5	(21)	13 7	(19)	12 9	(20)
Neck	8 5	(15)	11 6	(16)	9 3	(14)
Ribs	5 7	(10)	8 0	(11)	5 5	(8)
GR (tissue depth 11/12th ribs) - fatness indicator	6 mm		10 mm		4 7 mm	

Table 4. Yield by primal cut (lean, fat, bone) of 15-month Red deer and 11-month hybrids. Lean, fat and bone content of primal cuts (tissue as percentage of primal cuts)

Primal Cuts	Lean %		Fat %		Bone %	
	Red	*Elk/Red*	*Red*	*Elk/Red*	*Red*	*Elk/Red*
Saddle	69	74	7 3	3 9	24	22
Shoulder	74	76	6 2	4 6	16	16
Hind leg	77	79	5 2	3 5	21	21
Neck	67	70	6 8	5 7	26	24
Ribs	68	75	12 3	5 5	20	19
Total yield	72 7	76	7 0	4 7	20	19

Table 5. **Percentage of saleable carcase - commercial yield**

Comparison of 11-month Wapiti hybrids and 12 - 15 month Red deer - boning room floor yields * (Martin, Otago Venison pers. comm.).

	Hybrid Wapiti yields %	12-15 month Red deer yields - typical commercial expectation (%) *
B/L shoulder	16.9	15-16
Leg	37.5	35-39
Neck (trimmed)	2.5	2.5
Tenderloin	1.5	1.2
Striploin yield - not available as a mixture of rack/striploins was produced	est 15.5	14-15
Total yield	74	Range min 68-74 max

Table 6a **Lean, fat, bone yields - Whole carcass vs Genotype and Age for NZ wapiti hybrids**

	NZ Wapiti x Red
Age	*2&3yrs*
n=	6
HCW (kg)	74
Lean	73%
Fat	8%
Bone	19%

Hybrids assessed at 32% Wapiti by *Genomnz*

Table 6b **Rib/Loin Saddle yields (%) by Genotype (Stags) and Age**

	NZ Wapiti x Red
Age	*2 & 3yrs*
Lean	69
Fat	13 (very variable)
Bone	18

Table 6c **Hindleg yields (%) by Genotype (Stags) & Age**

	NZ Wapiti x Red
Age	*2&3yrs*
Lean	77
Fat	7
Bone	16

Programmes are now in progress to provide more substantial data on carcass yield with age as related to strain or crossbreed to better allow the flexibility of such genetic potential to be used more efficiently on farm. With such knowledge and a commitment to feeding appropriately, farmers will be able to stratify their herds selecting 60-70% of breeding hinds to a specific or tiered breeding programme using the advantage of growth rates from terminal eastern or elk type stags, and still retaining a group of elite red hinds to provide replacement females and highly selected red stags. All of these systems demand the continual replacement and within-herd improvement of the end point strains irrespective of end use. With a more structured breeding programme combined with accurate market knowledge farmers can enter contractual arrangements with processors and further fine tune farm management and pasture production systems that favour the climate, environment and management.

The Future

The New Zealand industry is rapidly entering a maturity where objective definition of the genetic value of strain types needs to be known and investment in any production system must utilise the superior breeding stock available.

Recent work utilising the Père David x red backcross hybrid has modelled a number of quantitative genetic traits that have major production advantages. The challenge now is to convert these, and a myriad of others into readily identifiable markers that define superior stock in all the available strain types and continue with some real guidance to blend these traits of economic and management importance into a breed type that itself will be identified as a healthy and highly productive New Zealand deer farmed strain perhaps containing genes from all sources of the great diversity of cervid strain types.

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