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Is it best to purchase cast-for-age ewes or cull maidens?

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Summary

A spreadsheet program was used to calculate the relative worth of cast-for-age (c.f.a.) ewes versus cull maiden ewes from the same source flock. C.f.a. ewes are often considered to be better value for money, as they have been classed into the flock. However, when allowance is made for genetic progress in the source flock, the merit of cull maidens is perhaps higher than appreciated. If cull maidens are acceptable in terms of conformation and 'faults', the decision to purchase them or c.f.a. ewes should be made on the basis of their relative prices. This paper presents some worked examples of these calculations.
Keywords: cast-for-age ewes, cull maidens.

Introduction

When woolgrowers are considering either increasing flock numbers or changing bloodlines in response to the wool market or starting a new stud or commercial flock, they usually purchase either cast-for-age (c.f.a.) or cull maiden ewes (hoggets or two-tooths). A common belief is that c.f.a. ewes are better quality because they have been selected into the flock, whereas cull maidens have not. Where the reason for culling is a conformational fault, e.g. cow hocks (not directly related to wool or livestock returns), this view may be justified. However, if the reason for culling is the level of production, e.g. low clean fleece weight (CFW) or high fibre diameter, the relative genetic merit of c.f.a. versus maiden ewes from the same source will depend on the relative rates of genetic progress being made in the source flock. C.f.a. ewes are selected from maidens some years ago. During this time, if there is a genetic progress, the estimated breeding value (EBV) of maidens will increase and it could be possible for cull maidens to have superior EBVs for production than c.f.a. ewes sold from the same flock.

This paper aimed to study the main factors affecting the relative financial value (FV) of cull maiden ewes and c.f.a. ewes sold from a source flock. It was assumed that the cull ewes were acceptable in regard to subjectively scored faults (Casey 1991).

Method

A spreadsheet program (QUATTRO PRO) was used on a 386 PC, to calculate the difference and ratio of the EBV of c.f.a. ewes: EBV maiden two-tooth ewes for a number of different flock structures and selection intensities.

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The basis of the program was as follows:

Let: Flock average at time zero = X_1,
Response to selection per year $(\Delta G) = [(i_m + i_f)/2] \,.\, h^2 d / 1$

Flock average after N years of selection $X_N = X_1 + N \,.\, \Delta G$

where i_m = standardised selection differential for males
i_f = standardised selection differential for females
h^2 = heritability of trait or index
1 = generation interval
d = standard deviation of trait or index

This assumes the same selection criterion in males and females. If males are selected more efficiently than females then the EBV of cull maidens will be underestimated, as genetic progress will be greater.

Let: EBV of c.f.a. ewes N years into the selection program $(EBV_{cfa}) = X_{N-a} + i_f \,.\, h^2 d$

where a = Number of age groups of breeding ewes
= Time (years) between 2-tooth and c.f.a.

In this study the starting value was assumed to be the flock average when c.f.a. ewes were 2-tooths.

Let: EBV of unselected 2-tooth ewes N years into the selection program $(EBV_u) = X_1 + N \,.\, [(i_m + i_f)/2] \,.\, h^2 d / 1$

EBV_s = EBV selected 2-tooths
EBV_c = EBV culled 2-tooths
p = proportion of 2-tooths kept
1-p = proportion of 2-tooths culled

then: $p \,.\, EBV_s + (1-p) \,.\, EBV_c = EBV_u$
$EBV_s = EBV_u + i_f \,.\, h^2 d$

Therefore: $EBV_c = (EBV_u - p.EBV_s) / (1 - p)$
$= [(1-p) \,.\, (EBV_u) - (p \,.\, i_f \,.\, h^2 d)] / (1-p)$

Lag (L) in years between EBV_c and $EBV_{cfa} = (EBV_{cfa} - EBV_c) / \Delta G$

In this study the source flock was assumed to be a self-replacing flock with 3, 4, 5, 6 or 7 breeding ewe age groups and 2, 3 or 4 ram breeding age groups. Rams were joined to 50 ewes each. Sheep were first joined at 18 months of age. Ewes were c.f.a. 6 months after the last lambing period. Maidens had a 70% weaning percentage, while adults had a 90% weaning percentage. Deaths and culling (wastage) removed 10% of each age group between lambing periods. These assumed values resulted in the values shown in Table 1.

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Table 1 Genetic parameters for different flock structures

Ewe Age Groups (= a)		Ram Age Groups 2	3	4
3	p* (fraction)	0.893	0.893	0.893
	i_f	0.19	0.19	0.19
	i_m	2.23	2.33	2.36
	I (years)	2.75	3.0	3.25
	p_m^x	0.01	0.01	<.01
	ΔG (kg/year)	0.084	0.08	0.075
	L^+ (years)	-1.0	-1.2	-1. 5
4	p	0.691	0.691	0.691
	i_f	0.899	0.899	0.899
	i_m	2.23	2.33	2.36
	I	3.0	3.25	3.5
	p_m	0.06	0.035	0.02
	ΔG	0.086	0.083	0.078
	L	0.5	0.3	0.1
5	p	0.568	0.568	0.568
	i_f	0.677	0.677	0.677
	i_m	2.23	2.33	2.36
	I	3.25	3.5	3.75
	p_m	0.21	0.16	0.10
	ΔG	0.085	0.082	0.077
	L	1.5	1.4	1.1
6	p	0.486	0.486	0.486
	i_f	0.804	0.804	0.804
	i_m	2.23	2.33	2.36
	I	3.5	3.75	4.0
	p_m	0.37	0.295	0.25
	ΔG	0.082	0.079	0.075
	L	2.4	2.3	2.0
7	p	0.428	0.428	0.428
	i_f	0.899	0.899	0.899
	i_m	2.23	2.33	2.36
	I	3.75	4.0	4.25
	p_m	0.49	0.425	0.37
	ΔG	0.079	0.077	0.073
	L	3.2	3.1	2.9

* symbol defined in text

x If proportion of 2-tooth rams kept > p_m then $EBV_{cfa} > EBV_c$
If proportion kept < p_m then $EBV_c > EBV_{cfa}$

+ If L is > 0 then $EBV_c > EBV_{cfa}$
if L is < 0 then $EBV_{cfa} > EBV_c$

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To compare the 'value for money' of cull 2-tooths and c.f.a. ewes it is necessary to convert the EBVs to a financial value (FV) which accounts for the number of progeny bred from the ewes and their discounted value. This value can be compared with their relative costs of purchase. The conversion of EBV to FV was based on the method of James (1980) outlined by Cottle (1986):

$$FV = REV \,.\, EBV \,.\, (r^{Y+1} \,.\, P.J/2) \,.\, (1-r^T W^T)/(1-rW)$$

where REV = relative economic value (lifetime returns discounted to Y, including correlated value of lambs' fleeces (0.14) and allowing for wastage)

= \$11.34, 3 ewe breeding age groups
= \$13.84, 4 groups
= \$15.88, 5 groups
= \$17.55, 6 groups
= \$18.91, 7 groups

EBV = EBV_{cfa} or EBV_c expressed as deviations from the mean (X)

r =1(l+d)
d = discount rate (0.1)
Y = age at which returns are first realised (1)
P = number of progeny / year (0.9)
J = total/direct genetic contribution of ewe (allows for future ewe progeny of ewe progeny etc.)

= 1.60, 3 ewe breeding age groups
= 1.56, 4 groups
= 1.53, 5 groups
= 1.49, 6 groups
= 1.46, 7 groups

T = number of times ewes are bred
W = death/culling rate of mature ewes

Results

The values and ratio of EBV_{cfa}: EBV_c can be calculated if the values of i_f, i_m, p and h^2d are given (see Figure 1). The value of h^2d was assumed to be 0.19, typical for CFW. It can be shown that L is independent of this value.

It can be shown that the EBV of ewes is determined by the age structure and rate of genetic progress in the flock from which sheep are purchased. When expressed as deviations from the mean the EBV is independent of the mean. FV is mainly determined by the number of years of use of the purchased ewes (T) and their EBVs.

FV was calculated for both cull 2-tooths and c.f.a. ewes. The differences between these

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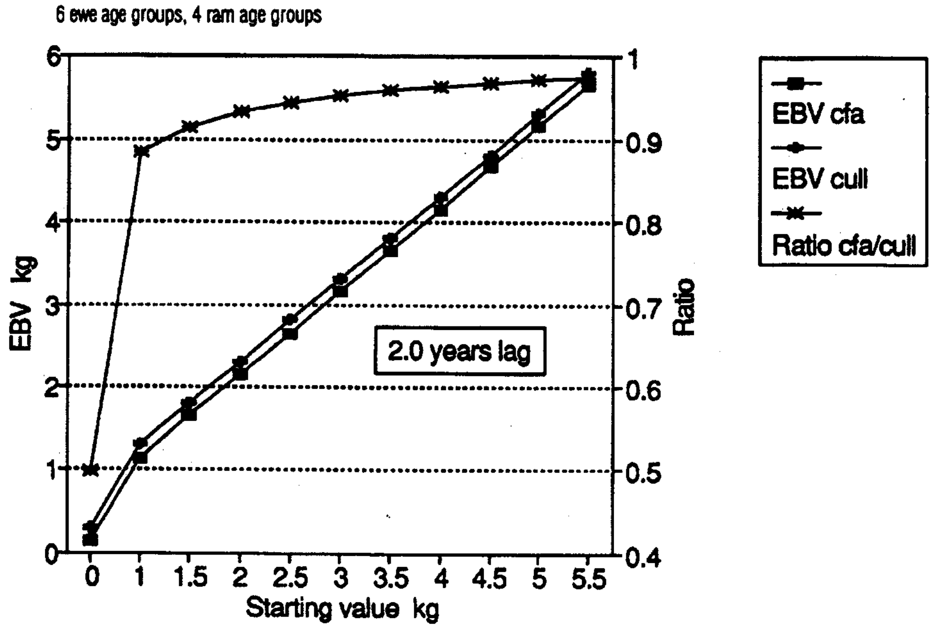
Fig. 1 Ratio EBV_{cfa} / EBV_{cull} 2-tooths



values ($FV_{c\text{-}cfa}$) for different age structures in the flock supplying the ewes and in the flock purchasing the ewes (ie. years of use of the ewes) are shown in Table 2.

The value of $FV_{c\text{-}cfa}$ is independent of the starting value (X_1) but is proportional to the values of REV, h^2d and $(i_m + i_f)/2$. The assumed values for these variables are described above. The value of $FV_{c\text{-}cfa}$ indicates the premium (or discount) which 2-tooths should attract due to their longer productive life and their superior (or inferior) genetic merit which is passed onto offspring.

In addition to the predicted value of progeny, the comparative lifetime performance (LP) of the purchased ewes must also be considered. LP was calculated as EBV . REV1 . $(1 + W.r + W.r^2 + ... W.r^n)$, where n = number of years ewes are kept - 1, REV1 = relative economic value of one fleece plus correlated lambs fleece (1.14 * $4/kg) and W = wastage rate. The differences between these values ($LP_{c\text{-}cfa}$) are shown in Table 3.

The value of $LP_{c\text{-}cfa}$ is also independent of starting value but is proportional to the values of REV, h^2d and $(i_m + i_f)/2$.

The difference in the disposal price of the ewes was assumed to be zero due to their age and discounting of their small residual value.

Discussion

The rate of genetic change in a commercial flock is similar to that in the stud from which rams are bought (if the same grade of ram is continually purchased). The level of production in the commercial flock lags the stud by 2 generations if no selection occurs in the commercial flock and average grade rams are purchased. For a given flock structure $EBV_{c\text{-}cfa}$ is constant and independent of the base level of production in the donor flock. The decision as to whether to buy cull 2-tooth or c.f.a. ewes therefore depends on the age

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Table 2 Financial advantage of cull 2-tooth ewes' progeny ($FV_{c\text{-}cfa}$)

Number of Ewe Age Groups		Number of Sire Age Groups					
		2		3		4	
		Number of Years c.f.a Ewes Used					
Supply Flock	Receiver Flock	1	2	1	2	1	2
3	3	- 1.09	- 1.29	- 1.28	- 1.48	- 1.55	- 1.75
	4	- 1.52	- 1.76	- 1.80	- 2.04	- 2.18	- 2.42
	5	- 1.91	- 2.18	- 2.27	- 2.54	- 2.77	- 3.04
	6	- 2.31	- 2.60	- 2.75	- 3.04	- 3.37	- 3.65
	7	- 2.57	- 2.88	- 3.07	- 3.38	- 3.76	- 4.07
4	3	1.63	1.10	1.38	0.85	1.04	0.51
	4	2.53	1.90	2.16	1.54	1.67	1.04
	5	3.38	2.68	2.92	2.21	2.28	1.57
	6	4.30	3.56	3.72	2.98	2.93	2.19
	7	4.92	4.12	4.27	3.47	3.38	2.58
5	3	3 43	2.70	3.15	2.42	2.76	2.03
	4	5.20	4.34	4.79	3.93	4.22	3.66
	5	6.88	5.92	6.35	5.39	5.61	4.65
	6	8.66	7.64	8.00	6.99	7.10	6.08
	7	9.86	8.76	9.13	8.03	8.10	7.01
6	3	4.85	3.98	4.55	3.68	4.12	3.25
	4	7.29	6.28	6.86	5.84	6.24	5.22
	5	9.61	8.47	9.05	7.91	8.25	7.11
	6	12.06	10.85	11.37	10.17	10.38	9.18
	7	13.71	12.41	12.94	11.64	11.83	10.53
7	3	6.02	5.06	5.72	4.75	5.27	4.30
	4	9.03	7.90	8.59	7.46	7.94	6.80
	5	11.88	10.61	11.31	10.04	10.47	9.9
	6	14.89	13.54	14.19	12.84	13.14	11.79
	7	16.91	15.46	16.12	14.67	14.95	13.49

structure of the flock and selection policies of the ram breeder who supplies rams to the breeder of the surplus ewes.

The values in Tables 1, 2 and 3 can be used to help decide which type of ewes to purchase as follows: Suppose a woolgrower has the option of purchasing either 2-tooths or c.f.a. ewes from a breeder who purchases rams from a stud with 5 age groups of ewes and 3 age groups of rams. Reference to Table 1 indicates that the cull 2-tooths ewes will be superior genetically if the studbreeder keeps less than 16% of his 2-tooth rams for

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Table 3 Financial advantage in lifetime production of cull 2-tooth ewes (LP_{c-cfa})

Number of Ewe Age Groups		Number of Sire Age Groups					
		2		3		4	
		Number of Years c.f.a Ewes Used					
Supply Flock	Receiver Flock	1	2	1	2	1	2
3	3	- 074	- 0.87	- 0.87	- 1.00	- 1.05	- 1.18
	4	- 0.86	- 1.00	- 1.02	- 1.16	- 1.24	- 1.37
	5	- 0.97	- 1.10	- 1.15	- 1.28	- 1.40	- 1.53
	6	-1.05	- 1.19	- 1.25	- 1.39	- 1.53	- 1.66
	7	- 1.12	- 1.25	- 1.33	- 1.47	- 1.63	- 1.77
4	3	1.10	0.75	0.93	0.58	0.70	0.35
	4	1.43	1.08	1.23	0.88	0.95	0.60
	5	1.71	1.36	1.47	1.12	1.15	0.80
	6	1.93	1.58	1.67	1.32	1.32	0.97
	7	2.12	1.77	1.84	1.49	1.45	1.10
5	3	2.31	1.83	2.12	1.64	1.86	1.38
	4	2.95	2.47	2.72	2.24	2.40	1.92
	5	3.47	2.99	3.21	2.73	2.84	2.36
	6	3.90	3.42	3.61	3.13	3.20	2.72
	7	4.25	3.77	3.93	3.45	3.49	3.01
6	3	3.27	2.70	3.07	2.50	2.78	2.21
	4	4.14	3.57	3.90	3.33	3.54	2.97
	5	4.86	4.29	4.57	4.00	4.17	3.60
	6	5.44	4.87	5.13	4.56	4.68	4.11
	7	5.92	5.35	5.58	5.01	5.10	4.53
7	3	4.06	3.43	3.86	3.22	3.55	2.92
	4	5.13	4.49	4.88	4.24	4.51	3.87
	5	6.00	5.37	5.72	5.08	5.29	4.65
	6	6.72	6.08	6.40	5.76	5.93	5.29
	7	7.30	6.66	6.96	6.32	6.45	5.81

breeding. As a self-replacing flock with this age structure only needs to keep 2% of rams to maintain numbers, it is very likely that genetic progress is fast enough for cull 2-tooths

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to be superior genetically. Reference to Tables 2 and 3 indicates the premium that the grower can pay for the 2-tooths. If c.f.a. ewes were only used once by the grower before sale or slaughter, the progeny value (FV) premium for the 2-tooths ranges from \$3.15 to \$9.13, if they are to be bred for 3 to 7 years. If the c.f.a. ewes were used twice this premium ranges from \$2.42 to \$8.03/head. The LP premium for the 2-tooths ranges from \$2.12 to \$3.93 if the c.f.a. ewes are only used once or \$1.64 to \$3.45 if they are used twice.

Thus if the c.f.a. ewes are to be bred for 2 years and the 2-tooths for 5 years, the 2-tooth ewes should be bought if they cost less than \$5.39 + \$2.73 = \$8.12/head more than the older ewes. This is based on the assumption that no rams are being bred from the ewes. If rams are bred the J value (and therefore FV) would increase.

It is interesting to note that young commercial ewes are typically \$5 to \$10/head dearer than c.f.a. ewes, so market values appear to reflect the differences in worth calculated in this paper. Therefore cull 2-tooths may sometimes be better 'value for money'. The validity of this statement obviously depends on the rates of genetic gain in the studs, ie. the values of h^2d, i_m and i_f and the assumed REV of the selected trait(s).

In this study the REV of CFW is assumed to be \$4/kg. If this doubled to \$8/kg the premium for 2-tooths would double to \$16.24 in the above case study. Similarily if the value of h^2d doubles, FV and LP double. The number of years the c.f.a. ewes are used also affects the proportion of 2-tooths culled in the initial stages of flock build-up before equilibrium has been reached. This has not been taken into account here.

The guidelines presented in this paper provide sheep breeders who are faced with the decision of buying young or old ewes with an objective method to compare their relative values. If the young ewes are visually acceptable the results reported here suggest that often they may be the best option if they have superior genetic merit and more productive years ahead of them.

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