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Potential for Fecundin to Influence the Reproductive Performance of Merino Ewes in Western Australia

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Abstract

Four experiments were conducted at different locations in Western Australia to evaluate the effectiveness of immunizing young (maiden, 1½ year old) and adult Merino ewes with Fecundin to improve their reproductive performances. The ovulation rates of immunized maiden ewes was increased (0·06–0·30) above that of untreated ewes in both experiments 1 and 2. However, there were no significant improvements in the marking percentages for the immunized ewes with the differences between the untreated and immunized ewes ranging from −16·4 to 5·8%. In comparison with untreated ewes immunization 6 and 2 weeks before the start of joining depressed ewe fertility by 26·1% whereas immunization 8 and 4 weeks before the start of joining did not significantly affect fertility. The availability of oat grain *ad libitum* prior to parturition and during early lactation did not improve the survival of lambs born to immunized ewes. In experiments 3 and 4 immunization of adult Merino ewes increased their ovulation rates (0·41–0·63) above untreated controls and tended to increase the proportion of pregnant ewes which had multiple pregnancies (from −2·3 to 34·2%). The responses at the end of lambing were variable (from −19·8 to 37·5% lambs marked) with high lamb mortalities occurring in some experiments. There was no adverse effect on the reproductive performances following consecutive annual immunizations over 3 years and the absence of treatment for 1 year did not prevent a response in the following year.

Introduction

Since Scaramuzzi (1976) and Cox *et al.* (1976) reported that ovulation rates (OR) of ewes immunized against steroids were increased, many studies have confirmed the potential for the immunological manipulation of reproduction (see Cox *et al.* 1985 and Smith 1985 for recent reviews). With the demonstration of the effectiveness of an androgen-serum albumin immunogen to both increase OR and the subsequent lambing performances of ewes (Cox *et al.* 1982), a preparation of polyandroalbumin, androstenedione -7α- carboxyethylthioether – human serum albumin in DEAE-dextran adjuvant (Fecundin, Glaxo Australia Pty Ltd, Boronia, Vic.) has become available (Scaramuzzi *et al.* 1983; Geldard *et al.* 1984).

Geldard (1984) reported that maiden ewes responded as well as adult ewes following vaccination with Fecundin, but more lambs were born to vaccinated adult ewes. In addition, McMillan and Smith (1985) demonstrated the effectiveness of annual or biennial active immunizations of Romney ewes against oestrone, while Cox, Wilson, Wong, George and Paull (unpublished data, cited by Cox *et al.* 1985) also showed that annual immunizations of Merino ewes with Fecundin is effective. Fecundin has since been shown to be effective in Western Australia (Croker *et al.* 1987*b*) and that the interval between the boost vaccination and the introduction of entire rams affects the percentage of barren ewes (Croker *et al.* 1987*a*).

The experiments in this paper examined the performances of ewes vaccinated before being joined with rams for the first time (maiden, 1½ year old ewes) and also the performances of commercial ewe flocks vaccinated for a number of years. These experiments were initiated because of the apparent smaller and less reliable responses obtained from Merino ewes in Western Australia following their vaccination with Fecundin (Croker *et al.* 1987*b*) when compared with the results of Geldard (1984).

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Materials and Methods

The four experiments were carried out on properties in the south-west of Western Australia where sheep production is the main enterprise and the climate is typically Mediterranean. Pastures in this area are based on various cultivars of subterranean clover (*Trifolium subterraneum*) and the average rainfall, most of which falls in the winter months, ranges from 550 to 750 mm in the locations of the properties.

Experiment 1 was on the Western Australian Department of Agriculture's Research Station at Mt Barker which is situated approximately 340 km south of Perth; experiment 2 was on a private property at Chowerup which is approximately 250 km south of Perth. Experiments 3 and 4 were carried out over three consecutive joining periods on private properties at Jingalup, approximately 250 km south of Perth, and at Darkan, approximately 160 km south of Perth, respectively.

Experimental Design

At each vaccination ewes received 2 ml Fecundin or, in experiment 2, 2 ml testosterone immunogen (Cox *et al.* 1982) subcutaneously. The intervals between vaccinations varied as did the boost to joining intervals. The ewes were grazed together at all times except for the duration of lambing or, as in year 2 of experiment 1, when additional treatments were imposed.

Maiden Ewes

Experiment 1

In all, 210 maiden (19–20 months of age) Collinsville ewes were stratified on weight into three groups in the first year. The immunized ewes were vaccinated with Fecundin either 8 and 4 or 6 and 2 weeks before the entire rams were joined with them for 6 weeks from 2 December 1982. The ewes received daily a maintenance ration of oat grain (500 g per head) during late pregnancy and lactation.

In the second year 200 similar ewes which weighed 40 kg or more were stratified on weight into four groups. The two immunized groups were vaccinated 7 and 4 weeks before the entire rams were joined with them for 6 weeks from 6 December 1983. Approximately 1 month before the expected start of lambing, the four groups were separated. Two of these subgroups (one untreated and one immunized) then received daily a maintenance ration of oat grain (500 g per head) while the other subgroups were given an *ad libitum* ration of oat grain. Supplementation of the ewes continued until approximately 1 month after lambing finished.

Experiment 2

From the available maiden (19–20 months of age) Peppin ewes 287 weighing 40 kg or more were randomly allocated to two groups of 100 (untreated or vaccinated with Fecundin) and one of 87 which was vaccinated with a testosterone immunogen similar to that used by Cox *et al.* (1982). The immunized ewes were vaccinated 6 and 3 weeks before the entire rams were joined with them for 8 weeks from 11 January 1984.

Mature Ewes

Experiment 3

As reported by *Crocker et al.* (1987*a*), 447 strong-wool Merino ewes (31–32 months of age) which had lambed following their joining as maiden ewes were randomly allocated to four groups — untreated, 147; three groups of 100 ewes which were vaccinated 8 and 4, 6 and 3 or 5 and 2 weeks before joining was started on 12 February 1984.

In the second year, the untreated ewes from year 1 were subdivided into two groups and 28 similar-aged ewes were added to those which again received no treatment while 24 similar-aged ewes were added to the group which was vaccinated with Fecundin 8 and 4 weeks before joining was started on 11 February 1985. The previously immunized ewes were re-allocated to two groups, one which received a boost vaccination 4 weeks before the start of joining, whereas the other was not treated.

In the third year, all the ewes which had been vaccinated in years 1 and 2 received a boost treatment 4 weeks before the entire rams were joined with the flock for 6 weeks from 11 February 1986.

Experiment 4

A total of 400 strong-wool Merino ewes (31–32 months of age) which had lambed following their joining as maiden ewes were randomly allocated to two groups. One group was vaccinated with Fecundin 6 and 3 weeks before the entire rams were joined with them for 6 weeks from 7 March 1984. In the second year both of these groups were re-randomized into two subgroups. Half of the previously untreated ewes were vaccinated 8 and 4 weeks before the entire rams were joined with them for 6 weeks from 6 March

1985 while half of the previously immunized ewes received a boost vaccination 4 weeks before the start of joining. In the third year all previously immunized ewes received a boost vaccination 4 weeks before the rams were joined with them for 6 weeks from 5 March 1986.

Management around the Joining Period

In most experiments the ewes were weighed following their allocation to treatment groups and subsequently at various intervals. Testosterone-treated wethers (Fulkerson *et al.* 1981) were introduced at a ratio of approximately 1 per 100 ewes 14 days before the entire rams were to be joined with the ewes in experiments 1 and 2. Approximately 2.5% of entire rams were joined with the ewe flocks for the lengths of joining mentioned previously. In experiment 1 the rams were fitted with harnesses and crayons.

Laparoscopic Examination

Apart from year 1 in experiment 4, approximately 50 ewes from each treatment group were examined by laparoscopy 15–20 days after the start of joining to determine the mean OR of the ovulating ewes.

Pregnancy Diagnosis

Apart from year 1 of experiment 1 when ewes were examined with a Scanopreg (Ithaca), all ewes were scanned using real-time ultrasound to determine their pregnancy status (Fowler and Wilkins 1980). The interval between the removal of the entire rams and the scanning varied from 43 to 56 days.

Lambing

In the first year of experiment 1, the ewes were not split into treatment groups for lambing. The ewes were split in the other experiments to allow an accurate measure of the proportion of lambs still alive to the ewes present at the end of lambing. At the completion of lambing the udders of the ewes were examined for evidence of lambing and confirmation of whether lambs were still being suckled (Dun 1963). In experiments 3 and 4 barren ewes were culled from the flocks each year following this examination. The percentages of lambs which died were calculated from the numbers present at pregnancy diagnosis, and which were presumed to have been born, and the numbers present at the end of lambing.

Statistical Analysis

Where appropriate, data were examined by analysis of variance, otherwise the data were tested by χ^2 analyses.

Results

Experiment 1

At the start of joining in both years there were only small differences in weights between groups (Table 1). No weights were measured prior to, or after, supplementation ceased in year 2, but the high-nutrition ewes had an average daily consumption of 1·14 kg oat grain per head whereas the low-nutrition ewes ate an average of 500 g grain per head over the same period (Table 1).

In the first year of the experiment there was no effect of immunization on the incidence of mating marks and after 3 weeks of the joining period an average of 89% of the ewes had been raddled. In contrast, in the second year significantly fewer of the immunized ewes had raddle marks after 3 weeks of joining (92·0 *v.* 81·0%; $P < 0.05$). However, there were no significant differences between the treatment groups in the proportions of ewes which were raddled at least twice during the joining period (Table 1).

The OR of the ovulating ewes in the first year was only significantly ($P < 0.001$) higher for those immunized 8 and 4 (8/4) weeks before the start of joining (1·00, 1·06, 1·30 for untreated, 6/2 and 8/4 groups, respectively) while in the second year, following immunization 7 and 4 weeks before joining, the OR also was significantly ($P < 0.001$) increased (1·09 *v.* 1·33, Table 1).

Following the 6/2 weeks treatment in year 1 there was a significant ($P < 0.001$) depression in the proportion of ewes which were pregnant (80·3, 54·2, and 78·6% for untreated, 6/2 and 8/4 groups, respectively). Significantly ($P < 0.05$) more of the pregnant immunized ewes had multiple births in the second year (15·9 *v.* 4·9%).

There were no differences between groups in the level of lamb mortality in year 1, but in the second year the incidence of lamb deaths was significantly ($P < 0{\cdot}01$) higher in the immunized groups which were given an *ad libitum* ration of oat grain prior to and during lambing.

Table 1. Liveweights and reproductive performances of maiden ewes
Experiment 1

Year 1

Treatment of ewes	Untreated	Fecundin-treated	
Immunization (weeks before start of joining)		6/2	8/4
Weights (kg) on 2.xii.1982[A]	44·7	43·8	43·9
Ovulation rate (of ewes ovulating)	1·00	1·06	1·30
Ewes present at end of lambing	61	59	56
Ewes lambed (as % of ewes present)	80·3	54·2	78·6
Multiple pregnancies (as % of pregnant ewes)	0	9·4	9·1
Lambs alive (as % of ewes present)	65·6	49·2	71·4
Lambs dead (as % of lambs born)	18·4	17·1	16·7

Year 2[B]

Treatment of ewes	Untreated			Fecundin-treated		
Nutrition in late pregnancy and early lactation	Low	High	Mean	Low	High	Mean
Weights (kg) on 6.xii.1983[A]	48·2	48·8	48·5	48·0	47·5	47·8
Ovulation rate (of ewes ovulating)	1·05	1·12	1·09	1·32	1·35	1·33
Ewes present at end of lambing	48	48	96 (total)	51	46	97 (total)
Ewes lambed (as % of ewes present)	83·3	85·4	84·4	84·3	84·8	84·5
Multiple pregnancies (as % of pregnant ewes)	5·0	4·9	4·9	14·0	17·9	15·9
Lambs alive (as % of ewes present)	75·0	79·2	77·1	80·4	63·0	72·2
Lambs dead (as % of lambs born)	14·3	11·6	12·9	16·3	40·0	26·3

[A]Date rams joined with ewes.
[B]Fresh ewes were used in Year 2.

Table 2. Liveweights and reproductive performances of maiden ewes
Experiment 2

Treatment of ewes	Untreated	Fecundin-treated	Testosterone-immune
Weights (kg) on 11.i.1984[A]	44·9	43·3	43·4
Ovulation rate (of ewes ovulating)	1·02	1·24	1·31
Ewes present at end of lambing	90	85	68
Ewes lambed (as % of ewes present)	76·7	71·8	77·9
Multiple pregnancies (as % of pregnant ewes)	10·1	6·6	1·9
Lambs alive (as % of ewes present)	61·1	63·5	66·2
Lambs dead (as % of lambs born)	27·6	16·9	16·7

[A]Date rams joined with ewes

Experiment 2

At the start of joining there were only small differences in the mean liveweights of the ewes (Table 2). Both the immunization with Fecundin ($P < 0{\cdot}05$) and the testosterone immunogen ($P < 0{\cdot}01$) increased the OR above that of the untreated ewes (1·02, 1·24, 1·31 for the untreated, Fecundin and testosterone-immune groups, respectively). However, there were no significant differences between treatments in pregnancy rates or in the incidence of multiple pregnancies (Table 2).

Experiment 3

The liveweights of the groups were similar 8 weeks before the start of joining in year 1. Because the ewes were grazed together thereafter, it is assumed that the weights were still similar at the start of joining. In both years 2 and 3 the ewe groups were of similar liveweights (Table 3).

Table 3. Liveweights and reproductive performances of adult ewes
Experiment 3

Year 1 (ewes 2½ years old)[A]

Treatment of ewes	Untreated	Fecundin-treated
Weights (kg) on 20.xii.1983[B]	63.5	62.6
Ovulation rate (of ewes ovulating)	1·45	1·93
Ewes present at end of lambing	135	283
Ewes lambed (as % of ewes present)	92·6	85·5
Multiple pregnancies (as % of pregnant ewes)	36·8	74·4
Lambs alive (as % of ewes present)	107·4	87·6
Lambs dead (as % of lambs born)	15·2	41·2

Year 2 (ewes 3½ years old)[A]

	Untreated	Treatment in		
		Year 2	Year 1	Years 1 and 2
Weights (kg) on 10.ii.1985[B]	54·3	53·4	56·3	56·2
Ovulation rate (of ewes ovulating)	1·42	1·98	1·57	1·98
Ewes present at end of lambing	88	87	131	132
Ewes lambed (as % of ewes present)	96·6	86·2	89·3	92·4
Multiple pregnancies (as % of pregnant ewes)	55·3	56·0	53·0	59·8
Lambs alive (as % of ewes present)	125·0	119·5	117·6	114·4
Lambs dead (as % of lambs born)	16·0	11·1	14·0	22·6

Year 3 (ewes 4½ years old)[A]

	Untreated	Treatment in		
		Years 2 and 3	Years 1 and 3	Years 1, 2 and 3
Weights (kg) on 11.ii.1986[B]	53·7	52·5	53·0	54·4
Ovulation rate (of ewes ovulating)	1·48	2·11	2·03	1·97
Ewes present at end of lambing	80	66	110	109
Ewes lambed (as % of ewes present)	92·3	86·4	86·4	91·7
Multiple pregnancies (as % of pregnant ewes)	39·2	68·4	63·2	62·0
Lambs alive (as % of ewes present)	112·5	115·5	118·2	122·9
Lambs dead (as % of lambs born)	12·6	18·8	18·1	17·1

[A]Ewes shorn in late January.
[B]Date rams joined with ewes.

The OR of the immunized ewes was increased significantly (1·45 *v.* 1·93; $P < 0·001$) in year 1 and the pregnant immunized ewes also had more multiple births (36·8 *v.* 74·4%; $P < 0·001$). However, the higher incidence of barren immunized ewes (14·5 *v.* 7·4% of ewes present, $P < 0·1$) and particularly the higher mortality of the lambs born to the treated ewes (41·2 *v.* 15·2% of lambs born, $P < 0·001$) resulted in a lower percentage of live lambs per ewe present at the end of lambing (87·6 *v.* 107·4%).

In the second year, the ewes immunized for the first time and those which were given a boost immunization both had higher ($P < 0·001$) OR than the untreated ewes and those not boosted (1·98, 1·98 *v.* 1·42, 1·57, respectively). However, there were similar proportions of pregnant ewes and ewes with multiple pregnancies at lambing for all groups (Table 3).

In the third year, the three immunized groups all had significantly ($P < 0·001$) higher OR than did the untreated ewes (2·11, 2·03, 1·97 *v.* 1·48). At lambing there were small depressions in the percentage of pregnant immunized ewes, but these ewes had more ($P < 0\cdot01$) multiple pregnancies than did the untreated ewes (68·4, 63·2, 62·0 *v.* 39·2% of pregnant ewes — Table 3).

Experiment 4

The ewes were weighed 8 weeks before the start of joining in year 2 and it is assumed that similar small differences would have been present when the rams were joined with the ewes. In both other years the ewe groups were of similar weights at the start of joining (Table 4).

Table 4. Liveweights and reproductive performances of adult ewes
Experiment 4

Year 1 (ewes 2½ years old)[A]				
Treatment of ewes	Untreated			Fecundin-treated
Weights (kg) on 7.iii.1984[B]	44·3			44·4
Ewes present at end of lambing	197			199
Ewes lambed (as % of ewes present)	92·9			93·0
Multiple pregnancies (as % of pregnant ewes)	4·4			27·0
Lambs alive (as % of ewes present)	88·8			111·6
Lambs dead (as % of lambs born)	8·4			5·5
Year 2 (ewes 3½ years old)[A]				
	Untreated	Treatment in		
		Year 2	Year 1	Years 1 and 2
Weights (kg) on 9.i.1985[B]	54·0	52·3	51·5	53·4
Ovulation rate (of ewes ovulating)	1·23	1·67	1·31	1·76
Ewes present at end of lambing	97	95	97	96
Ewes lambed (as % of ewes present)	97·9	94·7	94·8	95·8
Multiple pregnancies (as % of pregnant ewes)	25·8	48·4	31·9	60·0
Lambs alive (as % of ewes present)	105·2	121·1	110·3	142·7
Lambs dead (as % of lambs born)	8·1	11·5	5·3	7·4
Year 3 (ewes 4½ years old)[A]				
	Untreated	Treatment in		
		Years 2 and 3	Years 1 and 3	Years 1, 2 and 3
Weights (kg) on 5.iii.1986[B]	49·4	46·4	48·0	48·1
Ovulation rate (of ewes ovulating)	1·59	1·90	1·99	2·05
Ewes present at end of lambing	94	97	94	91
Ewes lambed (as % of ewes present)	97·8	90·7	97·8	97·8
Multiple pregnancies (as % of pregnant ewes)	39·6	53·9	63·4	72·3
Lambs alive (as % of ewes present)	126·6	119·6	137·2	144·0
Lambs dead (as % of lambs born)	7·0	17·1	15·7	18·1

[A]Ewes shorn early February.
[B]Date rams joined with ewes.

The immunized ewes had more multiple ovulations in years 2 and 3 (year 2: 1·23, 1·31, 1·67, 1·76 for untreated, no boost, vaccinated for first time and boosted groups, respectively, $P < 0\cdot01$; year 3: 1·59, 1·99, 1·90, 2·05 for the untreated and immunized groups which all received a boost, $P < 0\cdot001$).

The ovulations were not recorded in the first year, but at lambing the immunized ewes had more multiple pregnancies (27·0 *v.* 4·4%; $P < 0\cdot001$). The immunized ewes also had more multiple pregnancies than did the untreated ewes and those not boosted ($P < 0\cdot001$) in the second year (25·8, 31·9, 48·4, 60·0% for untreated, no boost, vaccinated for first time and boosted groups, respectively). In the third year both the ewes which received their third treatment ($P < 0\cdot001$) and those boosted after missing a year ($P < 0\cdot01$) had significantly more multiple pregnancies than did the untreated ewes, but the increase for those vaccinated in years 2 and 3 was not significant (39·6, 53·9, 63·4, and 72·3% for untreated, vaccinated years 2 and 3, vaccinated years 1 and 3 and vaccinated years 1, 2 and 3 groups, respectively — Table 4).

Discussion

The results from these experiments provide further evidence to that of Cox *et al.* (1982), Scaramuzzi *et al.* (1983), Geldard *et al.* (1984) and Croker *et al.* (1987*b*) of the effectiveness of treating Merino ewes with Fecundin to improve the reproductive performances of ewe flocks. However, the OR data reported here only give the responses obtained during the first oestrous cycle of joining and are not the overall OR at conception. These OR may not be an accurate reflection of the potential lambing because only 50 ewes from each group were examined. Although mating records were not obtained in experiments 2, 3 and 4 to show when the ewes came into oestrus, it is likely that some ewes did not conceive during the first cycle. This would contribute to differences between the observed OR and the observed lambing performances. If the ewes do not conceive at the first oestrus, their performance will be influenced by their subsequent ability to maintain the ovulation response. Although androstenedione antibody titres can be maintained at levels which give good ovulation responses 7 weeks after the boost vaccination (Cox *et al.* 1984), longer intervals may result in a fall in the response. With 3 or 4 week intervals between the boost injection and joining, which in experiments 1 and 2 produced significant ovulation responses in the first oestrous cycle of joining, the time to the end of the second oestrous cycle would be approximately 6–9 weeks. This may be too long to elicit a full response for those ewes either coming into oestrus for the first time after 3 weeks of joining or those not conceiving when first mated.

In the first year of experiment 1, there was only a small non-significant increase in the ovulation of the maiden ewes treated with Fecundin 6 and 2 weeks before the start of joining. It is unusual not to observe higher OR in immunized ewes where the interval between the boost injection and joining is 2 weeks. For example, Croker *et al.* (1987*a*) have recorded increases of 0·22 and 0·47 in the OR of mature Merino ewes injected with Fecundin 6 and 2 and 5 and 2 weeks, respectively, before the start of joining. In the experiment reported here there was an indication that the syringe used for the second injection of the 6/2 group was not dispersing the correct amount of Fecundin and it would appear that these ewes were treated with insufficient Fecundin to elicit the full ovulation response.

Although the responding maiden ewes being joined with rams for the first time had a similar ovulation response following immunization to that observed in the adult ewes (the OR were increased by approximately 27 and 33% for maiden and adult ewes, respectively) very few had multiple pregnancies. The low proportion of multiple pregnancies together with the higher level of barrenness in maiden immunized ewes, particularly with the 6/2 weeks treatment, which Croker *et al.* (1987*a*) have shown markedly depresses fertility, resulted in these ewes having relatively poor lambing performances compared with the older ewes. This difference between the young and adult ewes may have been associated with the relatively low liveweight of the maiden ewes.

It also appears that embryo mortality influenced the performances of some ewes. Boland *et al.* (1986) reported that there can be significant reproductive wastage in Fecundin-treated Merino ewes using short boost-to-joining intervals with loss of ova, a possible decrease in fertilization rates and loss of embryos during the first 3 weeks of pregnancy. They found that these effects may be more pronounced at higher levels of circulating androstenedione antibody. Higher levels of embryo mortality than usually occur could be expected in some of our experiments because the high losses recorded by Boland *et al.* (1986) were observed in ewes with boost-to-joining intervals of 14 and 25 days — similar to the intervals we utilized. Boost-to-joining intervals of less than 28 days are now accepted as being too short (Croker *et al.* 1987*a*).

The final lambing results recorded in some of our experiments were also affected by the relatively high levels of lamb mortality. These deaths though have not been induced by the

Fecundin treatment because in a number of years treatment produced a high incidence of multiple births but lamb mortalities were quite low (e.g. experiment 4, year 2). Treatment groups were separated for the lambing period so that accurate numbers could be obtained. It would appear that on occasions differences between the lambing paddocks contributed to the lamb mortalities recorded. For example, in the second year of experiment 1 the lambs from the different treatment groups were of similar weight at birth (average of 4·1 kg) suggesting that treatments had no effect but there were foxes near to the paddock in which the Fecundin-treated ewes given the *ad libitum* oat ration grazed and they probably contributed to the lamb mortality of 40% in this flock compared with the 14% for the other three groups.

Experiments 3 and 4 show that there is no adverse effect on the performance of adult ewe flocks following treatment in three consecutive years. In addition, the results from these experiments confirm that treatment may be missed one year and only a normal boost immunization treatment is required to restore the repsonse in the subsequent year. The retention of the ability to respond in alternate years provides flexibility for stock managers because they can change their strategy depending upon the host of factors which can affect the management of a sheep enterprise.

It would appear from experiment 2 that the testosterone immunogen provides a similar stimulation of ovulation to that which follows treatment with Fecundin. Confirmation of the effectiveness of this immunogen in Western Australia requires further examination in adult ewes.

The results from these experiments indicate that the typically low liveweight Western Australia maiden Merino ewes probably should not be treated with Fecundin. It has been confirmed that Fecundin can improve the reproductive performance of adult ewes with either consecutive annual or alternate year treatments, but variability in the level of response was obtained. Altering management to improve the level of lamb survival could reduce the variability in response following treatment of ewes with Fecundin.

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