Improving the success of sheep artificial insemination programs

A handbook for producers

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Summary

Poor synchrony of oestrus is the most likely cause of poor AI results in the Merino. In this document, background information on the variability of oestrus is provided and strategies to improve the success of AI programs are outlined. The research has identified that, at the time of pessary insertion, ewes are already predestined to perform differently and that this difference results from inadequate follicle growth during pessary treatment. Modifications to the treatment protocol have resulted in improved potential lambing percentages (up to 35%) and these modifications are also expected to reduce the variability associated with AI programs. On-farm evaluation of these new protocols will be examined in the 2021/22 breeding season. In addition, recommendations on how to best manage flocks for AI are presented together with information on the implementation and troubleshooting of the AI program.

Background

Evidence collected over several decades indicates that the success of AI in the Merino has remained highly variable with little or no improvement. This assessment is supported by findings of a SASBMA survey of the 2011 and 2012 seasons. Of the 32 respondents representing 54 flocks, 12 reported pregnancy rates below 50% in at least one of the two years including six who reported rates below 35%. Information indicated that poor synchrony of oestrus was primarily responsible.

The research funded by AWI Ltd aimed to improve synchrony of oestrus and to develop new strategies to improve the success rates of AI programs. Trans-rectal ultrasonography was used to examine what really happens to the ovary during the synchronisation procedure and these observations, together with associated experiments, have resulted in the recommendations outlined in this document. In addition, background information on the challenges of synchronising oestrus is provided as well as steps producers can take to implement and monitor the well-being of the program.

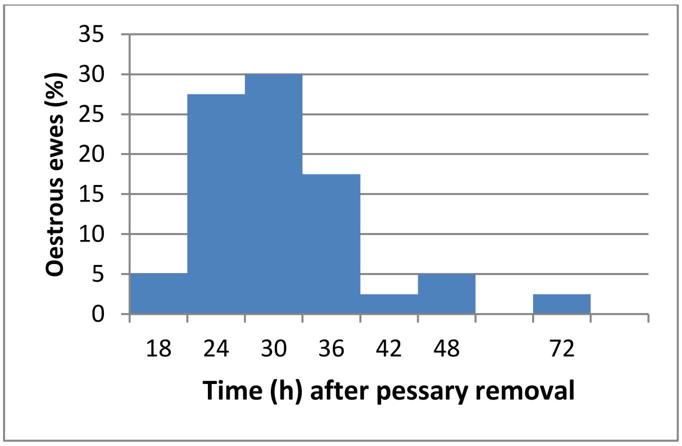
Patterns of oestrus

One of the major problems facing the AI industry is the incorrect belief that pessary treatment always results in an adequate synchrony of oestrus. This is not the case with poor synchrony being responsible for most failed AI programs. Consequently, it is important for producers to become familiar with how variable the patterns of oestrus are (Figure 1).

Figure 1. Examples of variation in oestrous patterns after pessary removal. These charts plot the percentage of new ewes in oestrus (using teasers with harnesses and crayons) at 6-h intervals after pessary removal. Ewes were observed up to 48h with a final observation at 72h.

Flock 1 (total ewes in oestrus = 97.5%)

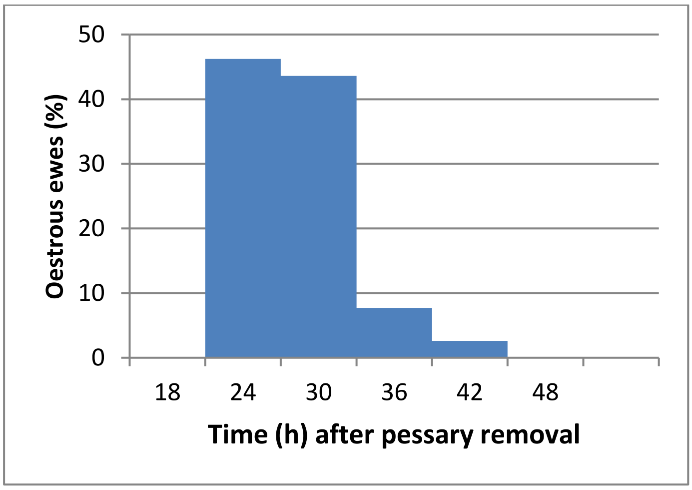
An example of a very good synchrony that is normally associated with high pregnancy rates.



- 30.0% in oestrus at 24h
- 2.5% not detected in oestrus
- 2.5% in oestrus after 48h

Flock 2 (total ewes in oestrus = 97.5%)

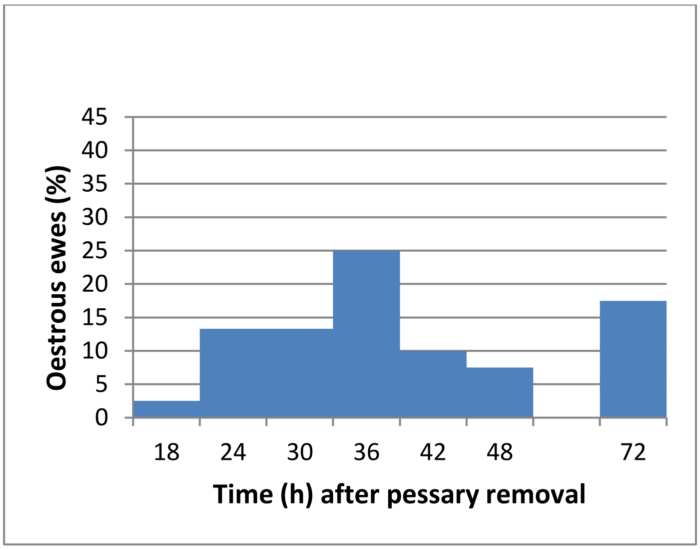
Another example of a very good synchrony.



- 46.0% in oestrus at 24h
- 2.5% not detected in oestrus
- 0.0% in oestrus after 48h

Flock 3 (total ewes in oestrus = 87.5%)

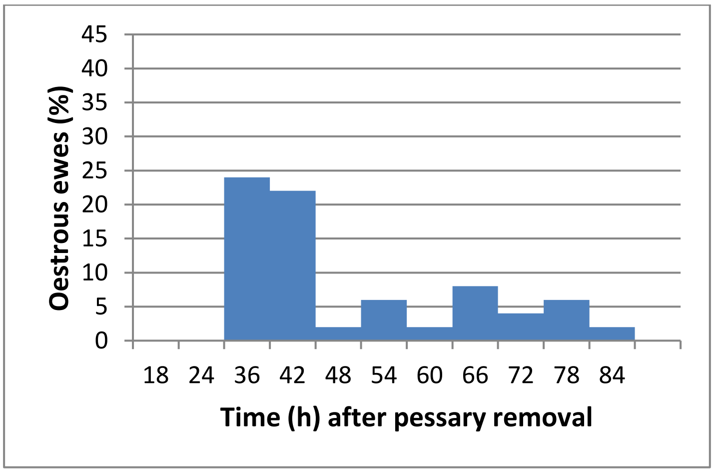
An example of synchrony spoilt by a significant number of ewes coming into oestrus after 48h (17.5%) or not coming into oestrus at all (12.5%) –in this flock, 30% of the flock are at a high risk of not getting pregnant.



- 15.0% in oestrus at 24h
- 12.5% not detected in oestrus
- 17.5% in oestrus after 48h

Flock 4 (total ewes in oestrus = 74.0%)

An example of a very poor synchrony with no ewes in oestrus at 24h, less than half in oestrus at 48h and 26.0% not coming into oestrus. This pattern is associated with very low pregnancy rates (e.g. 20 – 30%).



- 0.0% in oestrus at 24h
- 26.0% not detected in oestrus
- 30.0% in oestrus after 48h

Given its importance, it is desirable that the pattern of oestrus be identified as soon as practicable after pessary removal. Ideally, the timing of insemination is based on this pattern although last minute changes to the timetable may not be possible. The normality of oestrus can be determined using the following criteria:

- Time when ewes are first observed in oestrus. The best opportunity to gauge normality occurs 24h after pessary removal. Generally, a minimum of 10 – 20% of ewes should be in oestrus although this figure can be as high as 40 - 60%. Absence of mounting activity at this time is indicative of a delayed oestrus.
- The percentage of the flock not detected in oestrus at the commencement of insemination. Generally, ewes that come into oestrus after 48h (0 – 30% in the examples in Figure 1) have a much reduced chance of getting pregnant.
- The percentage of the flock that fails to come into oestrus (up to 20%). Some of these ewes will conceive to AI (e.g. 30 – 40%) but a decision needs to be made on the economic worth of insemination.

It is important for producers to get familiar with the oestrous patterns of their flocks. Individual flocks can show significant variability between years and accumulated knowledge is valuable when planning and implementing future programs.

What really happens during pessary treatment?

It has been thought for 50 – 60 years that progesterone from the pessary prevents follicle development and that after the pessary is removed, an ovulatory follicle develops in association with a synchronised oestrus. In fact, pessary progesterone appears to play little or no role in controlling development of the ovulatory follicle.

Using trans-rectal ultrasonography, it has been shown that the ovulatory follicle can emerge at any time during pessary treatment. As a result, when pessaries are removed, there is a wide range of follicle ages (1 – 14 days or more) and this adversely impacts the success of AI programs. Ewes with young follicles (those that form late in the pessary period) come into oestrus later and with greater variability than ewes with older follicles. These ewes are also the least fertile. Ewes with ovulatory follicles that emerge mid-way through pessary treatment are the most fertile and show minimal variability in time of onset of oestrus. Additionally, one side effect of pessary treatment is a disproportionate number of ewes with young follicles and this further contributes to poor flock performance. The key to improving synchrony of oestrus and the success of AI programs in general, lies in the development of treatment protocols that are better able to control the age of the ovulatory follicle and/or improve the quality of these follicles.

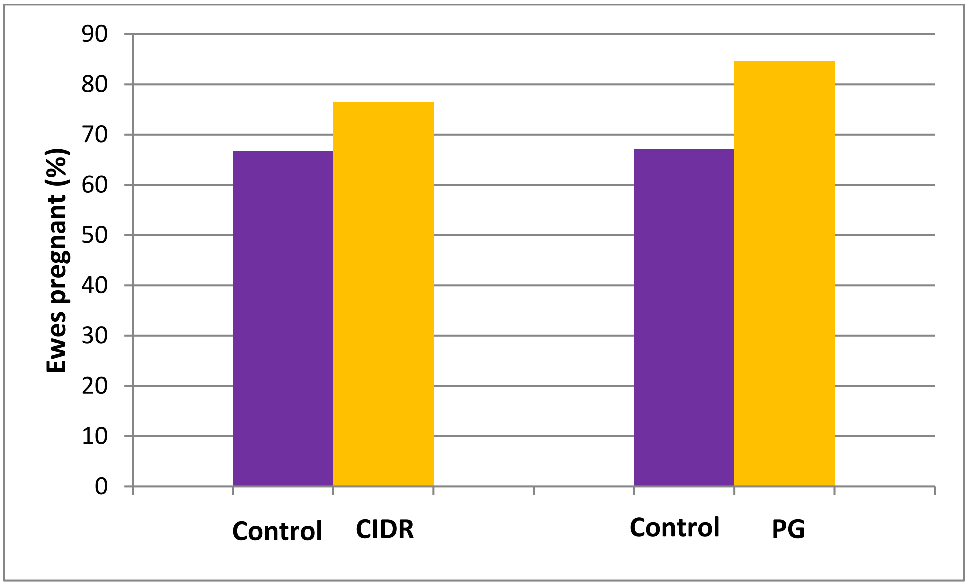
Strategies to improve success rates – changes to the treatment protocol

Several modifications to the treatment protocol have been developed.

1. **Pre-treatment before pessary insertion**

   Pre-treatment leads to better control of follicle development during pessary treatment. Using either a CIDR or prostaglandin (PG) pre-treatment, pregnancy rates were improved in the experiments conducted (Figure 2).

Figure 2. The effect of pre-treatment with either a CIDR or prostaglandin (PG) on pregnancy rates following AI with frozen-thawed semen.

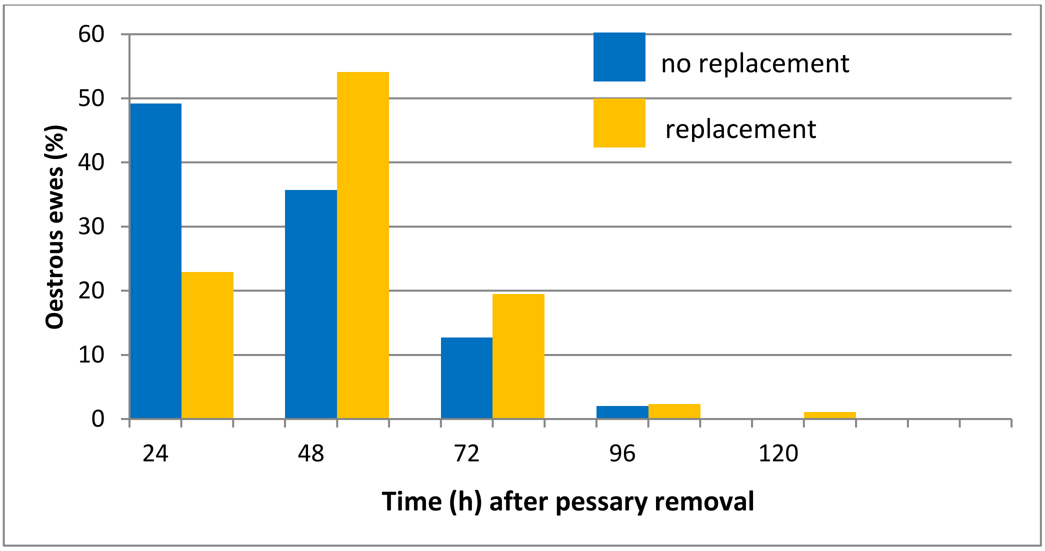


The potential lambing rate (fetuses/100 ewes inseminated) was not improved with the CIDR pre-treatment due to a reduction in litter size (a reduction most likely due to chance). However, the potential lambing rate was substantially improved with the PG pre-treatment (140.0% versus 106.3%) due to increases in both fertility and twinning rate.

2. **Replacement of pessaries on day 9**

   Although pessary replacement is an additional expense, it does change the pattern of oestrus (Figure 3). The overall pattern is delayed and this necessitates a later time of insemination. Although further research is required, pessary replacement might be a worthwhile strategy in flocks with a history of poor AI performance.

Figure 3. Effect of pessary replacement (day 9) on timing of oestrus.



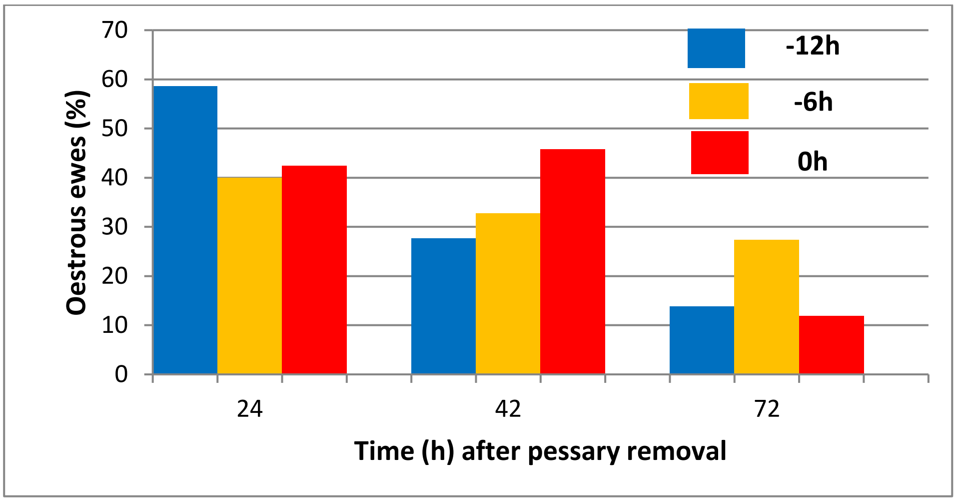
3. Early treatment with PMSG

The inability of young ovulatory follicles to produce sufficient oestrogen is a likely cause of poor synchrony following pessary removal. PMSG, which stimulates follicle growth, is usually given at pessary removal but treatment 12h beforehand results in an improved synchrony (Figure 4a) in association with an increase in both pregnancy rate and litter size. In the experiment conducted, the potential lambing percentage (fetuses/100 ewes inseminated) was increased by approximately 17% (Figure 4b). Because this treatment induces an earlier onset of oestrus, it is important that insemination commences no later than 42 – 43h after pessary removal.

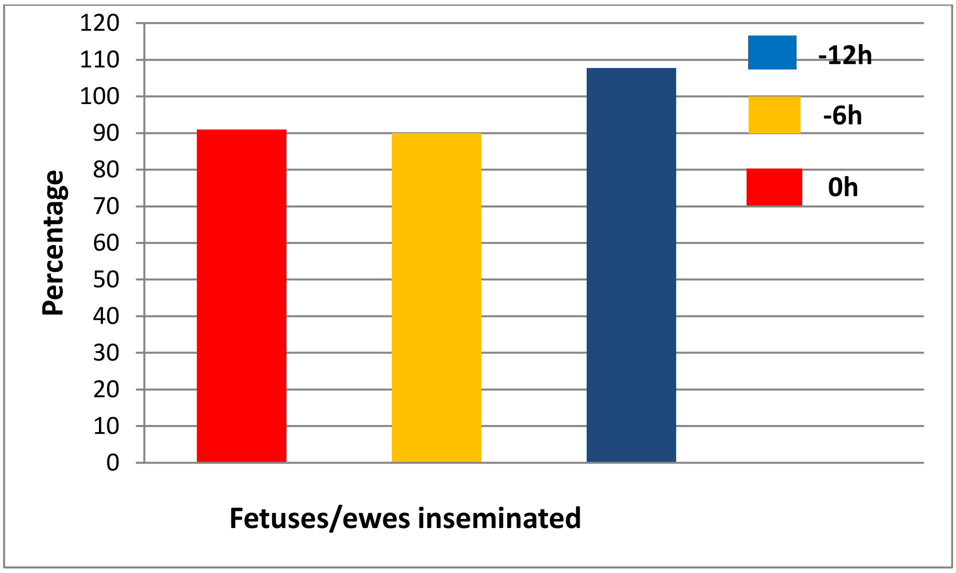
An interesting observation was that some ewes treated early with PMSG displayed overt sexual behaviour at 24h (mounting teasers and other ewes) indicating an increase in oestrogen production. Again, this approach has the potential to be particularly useful in flocks that have a history of performing poorly, especially when a delayed oestrus is implicated.

Figure 4. Effect of early PMSG treatment (-12h, -6h and 0h relative to pessary removal) on AI outcomes.

(a) Timing of oestrus.



(b) Fetuses/ewes inseminated



4. Treatment with 500 i.u. PMSG rather than 400 i.u.

An increasing number of AI programs now use the higher dose and, whilst it does increase the cost, there is an increase in litter size and a small improvement in synchrony. This is another strategy to use in "problem" flocks.

Protocol details for (1) a standard program, (2) a CIDR pre-treatment program and (3) a PG pre-treatment program are provided in Appendix Tables 1, 2 and 3 respectively.

Strategies to improve success rates – changes to flock management practises

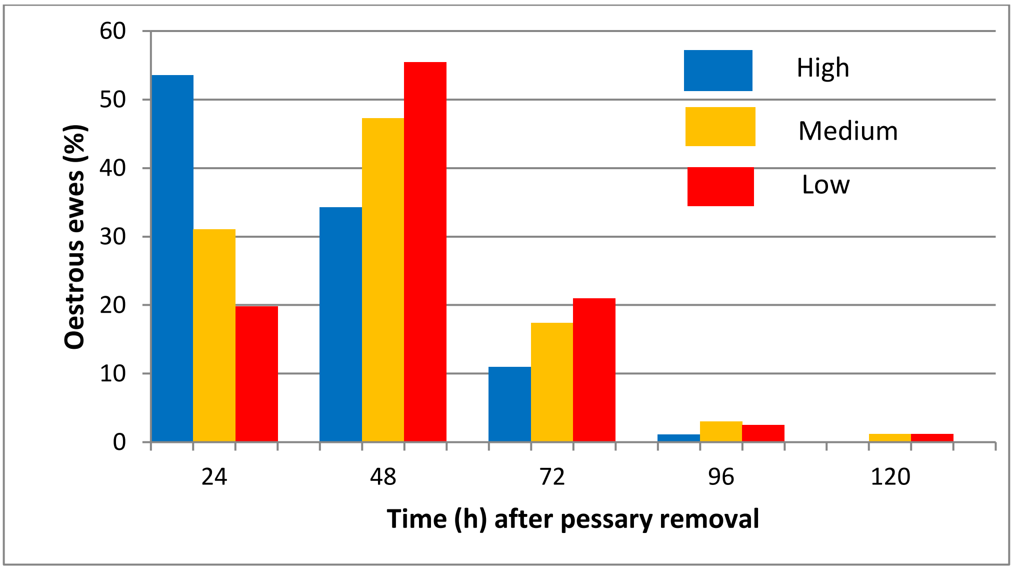
1. **Long and short term nutrition**

   It takes approximately six months for follicles to fully mature and this period corresponds approximately with the interval between the previous lambing/lactation and the cycle of AI. Nutrition during this period – **long term nutrition** – influences the success of AI programs. The benefits of high nutrition (BCS 4.0$^+$) when compared with either medium (BCS 3.3$^+$) or low (BCS 2.7$^+$) nutrition are:

   - Oestrus occurs earlier (Figure 5) – hence insemination should commence no later than 42h after pessary removal in such flocks.
   - More ewes come into oestrus (e.g. 91.9% versus 85.2% and 85.7%).
   - Pregnancy rates are higher (e.g. 81.1% versus 71.1% and 73.7% using chilled semen).
   - Litter size is higher (e.g. 1.50 versus 1.35 and 1.28).

On the other hand, high nutrition (1.75M) during the pessary period – **short term nutrition** - increases pregnancy rate (e.g. 79.0% versus 72.3% for the 1.0M group) but there is no effect on either time of oestrus or litter size. The reasons for the higher pregnancy rate are not known but may be associated with improvements in oocyte/embryo quality.

Figure 5. Timing of oestrus following pessary removal in ewes fed either a high (BCS 4.0$^+$), medium (BCS 3.3$^+$) or low (BCS 2.7$^+$) diet between the previous lambing/lactation and the cycle of AI.

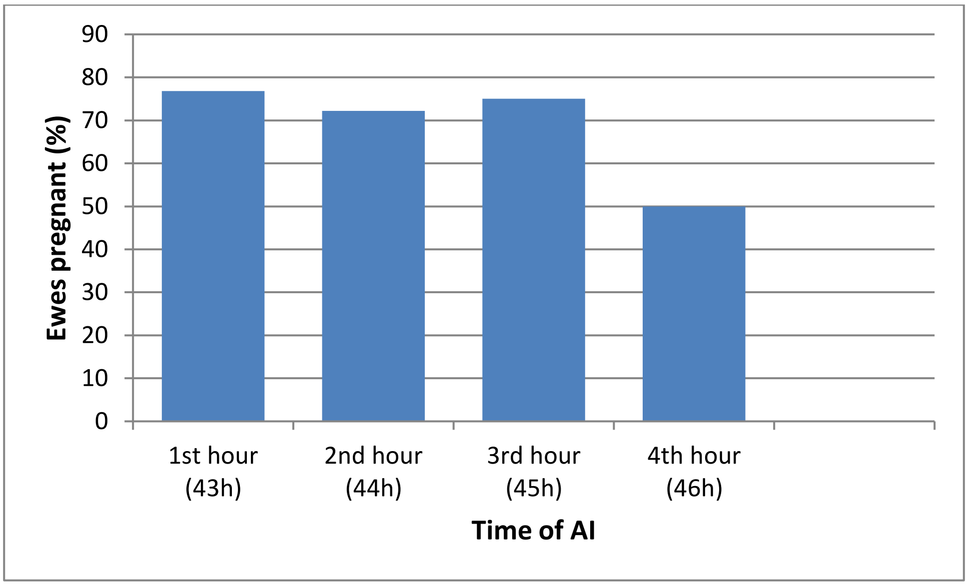


Whilst maintaining high levels of nutrition can be challenging, particularly if Spring pastures are poor, these results indicate the importance of nutrition leading up to and during the conduct of the AI program. However, because of their ammonia producing ability, diets high in nitrogen (e.g. lucerne, clover, lupin grain) should be avoided from two weeks before to two weeks after AI.

2. **Managing ewes on the day of AI**

Both anecdotal and research evidence indicate that pregnancy rates can be highest in ewes that are inseminated earlier in the program. This is exemplified in Figure 6 where pregnancy rates declined in ewes that were inseminated after the first three hours.

Figure 6. Effect of time of insemination on pregnancy rate (insemination with frozen-thawed semen commenced at the start of the first hour, approximately 42h after pessary removal).



The reasons for this decline are not clear - it is highly unlikely that semen quality is involved but it may be related to an increase in the number of ewes ovulating later in this period. Alternatively, time–critical exposure to pheromones produced by a large number of cycling sheep may be responsible. Until these data are validated and better understood, it is recommended that pessary removal in large programs be staggered in groups on a three-hourly basis.

3. **Using teaser marks**

   Again, preparing teasers is an additional cost but the information they provide is invaluable.

   - They indicate the normality of the synchrony, especially at 24h and this can lead to late adjustments in insemination time. This may not be logistically possible but information on the pattern of oestrus is always useful.
   - Insemination of ewes in groups based on occurrence of oestrus (e.g. at 24h and 36h) is good practice. This avoids situations where ewes that ovulate early aren't inseminated until much later. This routine requires drafting and this is a negative.
   - Unmarked ewes are generally less fertile than marked ewes and a decision on whether they are worth inseminating needs to be made. Alternatively, these ewes can be inseminated with fresh semen should it be available.

   In addition, teasers can play an important role in stimulating follicle development in ewes that are in anoestrus. This is particularly the case in Spring when ewes need to be isolated for several months before exposed to teasers.

4. **Maximising exposure to the ram effect**

   In addition to the conventional use of teasers, ewes can be shedded with but physically separate from entire rams for up to 6h after pessary removal to maximise exposure to male pheromones. This exposure potentially improves follicle maturation which can be beneficial.

5. **Culling dry ewes**

   Selection of ewes known to have lambed previously in AI programs should improve pregnancy rates.

Implementing an AI programs

In addition to the issues outlined above, other aspects that are important in implementing an AI program include:

- **Length of pessary treatment** – a 14-day period is standard and, given what is now know about follicle growth patterns, there is little reason for change.
- **Timing of insemination** – insemination needs to be timed to just precede the occurrence of oestrus. A very rough rule-of-thumb is that ovulation occurs approximately 24h after the onset of oestrus. With CIDRs, insemination should commence 42 – 44h after removal as ovulation normally commences from about this time (this is earlier than the 48 – 50h timing used with sponges). Ideally, there needs to be some flexibility as indicated by the following:
    - there is natural variability in the timing of oestrus with some flocks being "early" (centred around the 24 – 30h period) and others being "late" (centred around the 30 – 36h period).
    - well-nourished flocks come into oestrus earlier than less-nourished flocks (insemination from 42h after pessary removal).
    - maiden ewes come in to oestrus earlier than mature ewes (insemination from 42h after pessary removal).
    - if pessaries are replaced (day 9), onset of oestrus is delayed (insemination from 48h after pessary removal).
    - if PMSG is given at -12h, onset of oestrus occurs earlier compared with conventional treatment (insemination from 42h after pessary removal).

Mounting activity at 24h after pessary removal is a guide to when insemination should occur – activity at this time indicates that insemination should occur at 42 – 44h whereas a lack of activity indicates the need for a later insemination (e.g. 48h). Late changes in timing are not always possible (depending on the practitioner's work schedule etc) and, with large programs, there is very little flexibility.

- **Volume of semen** – there is a tendency for some producers to reduce the volume of semen per ewe so that more ewes can be inseminated. This strategy is only worthwhile with a good synchrony. It is also desirable that each uterine horn be inseminated when frozen-thawed semen is used.
- **Preparing teasers** – teasers (10% of ewe numbers) should be introduced to the ewes at pessary removal. It takes two weeks of testosterone treatment to induce male-like behaviour. A better response is generally obtained with a 4 – week treatment. Teasers should be fitted with harnesses and crayons or have briskets painted with branding fluid. To avoid inaccurate marks being recorded, run teasers with ewes for several hours before harnessing/painting of briskets.
- **Stress** – it is important that ewes are exposed to minimum stress, particularly between the times of pessary removal and AI. Dogs should not be used and minimum drafting is desirable.
- **Weather** – whilst chronic hot weather can adversely affect AI outcomes, very few programs are aborted because of it. Consistently hot weather from about three days before AI until three days afterwards can affect patterns of oestrus and pregnancy rates. However, heat stress needs to be unrelenting with minimal or no relief at night and this is uncommon in most sheep grazing areas of Australia. Adequate shade/water is essential. Similarly, extreme cold/wet weather in the days leading up to AI and shortly thereafter can adversely affect success rates particularly in recently shorn sheep. Shedding of shorn sheep, especially at night, is desirable.

Trouble shooting

Much of the troubleshooting focuses on the pattern of oestrus which plays a critical role in AI programs. Factors to consider include:

- **No ewes in oestrus by 24h** – this is indicative of a delayed oestrus. This delay can be up to 6 – 12h and, ideally, time of insemination should be adjusted. The factor most likely to influence the pattern of oestrus is nutrition with poorer nutrition slowing the onset of oestrus (and requiring a later insemination).

- **Many ewes in oestrus at 24h** – this is generally not a problem provided insemination commences 42h after pessary removal. Ewes can be in oestrus as early as 18h and up to 60% can be in oestrus by 24h.
- **Less than 50% of ewes in oestrus by 48h** – this indicates a very poor synchrony where pregnancy rates of 20 – 30% can be expected. One option is to not inseminate unmarked ewes or to use fresh semen if available. Poor nutrition can cause a delay in the onset of oestrus and it is suspected that the grazing of oestrogenic pastures can have a similar effect.
- **Teasers not showing interest at 24h** – provided teasers have been properly treated with testosterone, this is indicative of a delayed onset of oestrus.
- **Teaser lethargy** – this is possible if teasers are treated for only two weeks. Longer treatment (e.g. four weeks) overcomes this problem.
- **Ewes in oestrus several days after AI** – these ewes are either very late coming into oestrus or have re-ovulated after the initial ovulation. Pregnancy to AI is very unlikely but ewes may conceive to backup rams.
- **Ewes behaving as if in oestrus but not attracting the attention of teasers** – a small percentage of ewes (e.g. 5%) can behave in this way. This is normal in a flock treated with pessaries – at least some of these ewes are marked eventually.
- **Ewes producing mucus but not marked by teasers** – mucus is seldom seen during the conduct of a normal AI program but should it be seen (e.g. should the ewe be held in a recumbent position), its nature is indicative of the oestrous status of the ewe. Ewes with globular opaque mucus can be 12h or more from oestrus whilst ewes with clear viscous mucus are generally in oestrus or approaching oestrus.
- **Flocks with a high incidence of uterine fluid** – this condition can only be observed by the practitioner whilst inseminating. The incidence is seasonal, being more common in Spring and its presence can be (but not always) associated with the consumption of oestrogenic pastures. These ewes will not get pregnant to AI but may conceive to backup rams as the condition can be transient.

What is the best treatment protocol?

There are a number of variations to the conventional protocol that can be considered. One of the current constraints is that several are based on observations of naturally cycling flocks (the "Autumn" protocols) and the extent to which they are useful in Spring remains to be determined. It is hoped that further research can be conducted in the Spring, 2021. In addition, on-farm evaluations, planned for 2021/22, need to be completed before recommendations can be finalised. Summaries of the current options are outlined below.

- **Conventional protocol** (single pessary and PMSG)
  - Can produce good results but is unreliable due to large variation in the pattern of oestrus (particularly with ewes coming into oestrus late).
  - It is recommended that 500 i.u. PMSG be used.
  - The preferred timing of insemination should be indicated by the pattern of oestrus (largely based on observations at 24h) – an "on time" oestrus requires insemination from 42h whereas a delayed oestrus necessitates insemination from 48h.

- **Replacement of pessary on day 9**
  - This option uses the conventional protocol (500 i.u. PMSG) but with the pessary being replaced on day 9.
  - Treatment results in a delayed onset of oestrus with insemination needing to commence at 48h.
  - This delay may be useful in some flocks provided the timing of insemination is adjusted.
  - Whilst further research is required, this protocol might best suit flocks with a history of poor performance or are poorly nourished.

- **Treatment with PMSG 12h before pessary removal**
  - This option uses the conventional protocol but with PMSG being given 12h before pessary removal.
  - Treatment results in an earlier onset of oestrus with insemination needing to commence 42h after pessary removal.
  - Increases in both pregnancy rate and litter size result in worthwhile increases in potential lambing rate (e.g. 107.7% versus 90.9%).
  - Likely to improve the outcome in flocks with a history of poor performance, particularly those that experienced poor/delayed synchrony of oestrus.

- **Pre-treatment with CIDRs or PG**
  - This option is based on the conventional protocol but uses either CIDR or PG pre-treatment to better control follicle growth during the AI cycle.
  - Both pre-treatments improve pregnancy rate with the PG pre-treatment producing a marked increase in the potential lambing rate (e.g. 140.0% versus 106.4%).
  - Insemination at 42h after pessary removal is recommended.
  - Both options are likely to beneficial in "problem" flocks with poor/delayed synchrony of oestrus.

- **Combination of one or more treatments**
  - The most likely preferred combination is the use of early PMSG treatment and PG pre-treatment.
  - Insemination will need to commence 42h after pessary removal.
  - This combined option has not yet been examined.

- **PG treatment immediately preceding a 7-day pessary period**
    - This protocol has not been examined in this project but is increasingly being used overseas.
    - Treatment improves the control of follicle growth compared with the conventional protocol.
    - The likely preferred time of insemination is 48h after pessary removal.

Implementation of any of these protocols needs to be integrated with the strategies outlined above (Page 9) on how to best manage flocks in AI programs.

Endnote

Some additional studies remain to be conducted including the evaluation in Spring of one or more of the preferred protocols and the on-property validation of results. This document will be updated as these results become available.

Appendix Table 1. Treatment protocol for a conventional AI program using CIDRs/PMSG.

Day	Activity	Comments
1	Inject wethers (n=10% of ewes) – 2ml Ropel	Ropel* requires a weekly injection (subcutaneous); other products are available
8	Inject wethers – 2ml Ropel Insert CIDRs	
15	Inject wethers – 2ml Ropel	
22	Inject wethers – 2ml Ropel	
23		
24		
25		
26		
27		
28		
29 **2 p.m**.	Inject wethers (2ml Ropel) and harness. Remove CIDRs, inject 500 i.u. PMSG. Run ewes and wethers together from CIDR removal.	Instead of harnesses, paint brisket with branding fluid. To avoid marks from initial activity, consider delaying harnessing/painting for several hours after exposure. Stagger CIDR removal by 3h in large programs.
30 2 p.m.	Observe mounting activity (24h after CIDR removal).	Teaser activity and number of ewe groups (harems) seeking attention indicate normality of synchrony. Consider delaying insemination (if possible) should oestrus be delayed.
31 **8 a.m.**	Commence AI (42h after pessary removal). Record oestrous marks at 2 p.m. (optional)	Option of drafting off marked ewes and inseminating first. Option of not inseminating unmarked ewes or using fresh semen if available.

*Ropel can be given over a two-week period; in this example, it is given over four weeks because the longer treatment induces better male-like activity.

Appendix Table 2. Treatment protocol for an AI program in which ewes are pre-treated with CIDRs.

Day	Activity	Comments
1	Insert first CIDRs	
8	Inject wethers (n=10% of ewes) – 2ml Ropel	Ropel* requires a weekly injection; other products are available
14	Remove first CIDRs Inject wethers – 2ml Ropel	
21	Insert second CIDRs Inject teasers – 2ml Ropel	
22		
23		
24		
25		
26		
27		
28	Inject wethers – 2ml Ropel	
29		
30		
31		
32		
33		
34 **2 p.m.**	Inject wethers (2ml Ropel) and harness. Remove CIDRs, inject 500 i.u. PMSG. Run ewes with wethers from CIDR removal	Instead of harnesses, paint brisket with branding fluid. To avoid marks from initial activity, consider delaying harnessing/painting for several hours after exposure. Stagger CIDR removal by 3h in large programs.
35	Observe mounting activity (24h after CIDR removal).	Teaser activity and number of ewe groups (harems) seeking attention indicate normality of synchrony. Consider delaying insemination (if possible) should oestrus be delayed.
36 **8 a.m.**	Commence AI (usually 42h after pessary removal). Record oestrous marks at 2 p.m. (optional)	Option of drafting off marked ewes and inseminating first. Option of not inseminating unmarked ewes or using fresh semen if available.

*Ropel can be given over a two-week period; in this example, it is given over four weeks because the longer treatment induces better male-like activity.

Appendix Table 3. Daily tasks of an AI program in which ewes are pre-treated with PG.

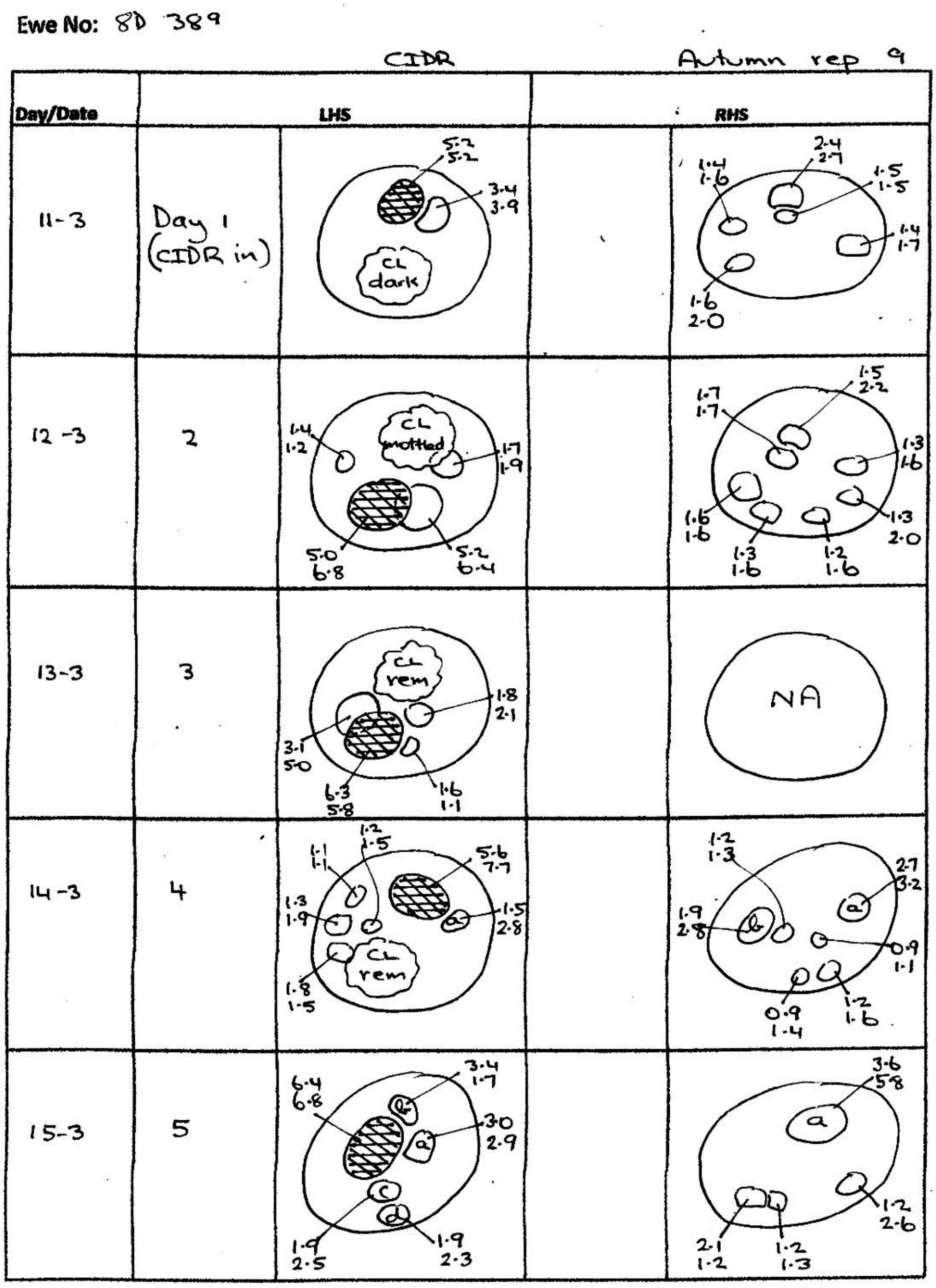
Day	Activity	Comments
1	Inject PG (125 µg/ewe i.m.)	
2		
13	Inject wethers (n=10% of ewes) – 2ml Ropel	
20	Inject wethers (2ml Ropel)	Ropel* requires a weekly injection; other products are available
21		
22		
25		
26		
27	Insert CIDRs Inject wethers (2ml Ropel)	
28		
29		
32		
33		
34	Inject wethers (2ml Ropel)	
35		
36		
37		
38		
39		
40 **2p.m.**	Inject wethers (2ml Ropel) and harness. Remove CIDRs, inject 500 i.u. PMSG. Run ewes with wethers from CIDR removal	Instead of harnesses, paint brisket with branding fluid. To avoid marks from initial activity, consider delaying harnessing/painting for several hours after exposure. Stagger CIDR removal by 3h in large programs.
41	Observe mounting activity (24h after CIDR removal).	Teaser activity and number of ewe groups (harems) seeking attention indicate normality of synchrony. Consider delaying insemination (if possible) should oestrus be delayed
42 **8a.m.**	Commence AI (usually 42h after pessary removal). Record oestrous marks at 2 p.m. (optional)	Option of drafting off marked ewes and inseminating first. Option of not inseminating unmarked ewes or using fresh semen if available.

*Ropel can be given over a two-week period; in this example, it is given over four weeks because the longer treatment induces better male-like activity.

If PMSG is given early (-12h) in any of these protocols, timings need to change. One option is to give PMSG at 6 a.m. and remove pessaries at 6 p.m.on that day. Insemination would then commence at noon (42h after pessary removal). Alternatively, if insemination needs to start earlier, pessaries can be removed at mid-day with PMSG being given the previous mid-night. This would enable insemination to start early on day 24 (6 a.m. = 42h after pessary removal).

Attachment – Follicle map

Follicle maps are constructed from daily ultrasound observations of the ovary and provide a means of monitoring follicle numbers and size as well as luteal development and regression. In this example, the ovulatory follicle (hatched) was present on day 1 and remained until ovulation occurred on day 16.



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CIDR

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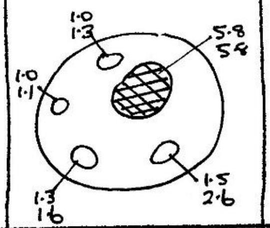
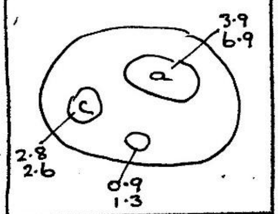
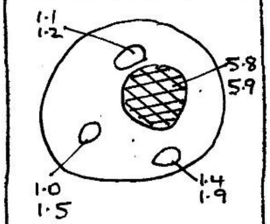
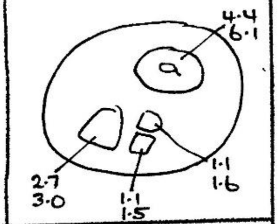
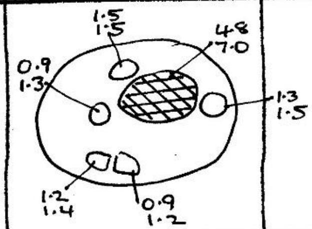
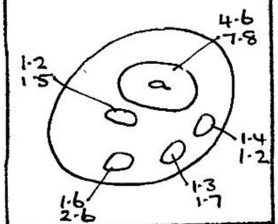
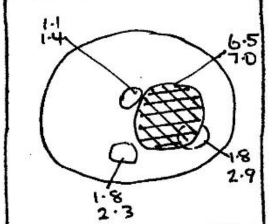
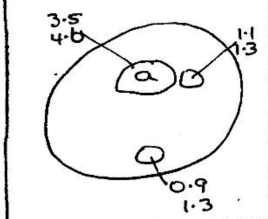
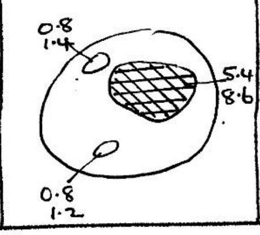
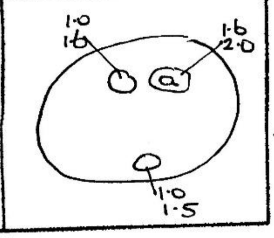
Day/Date	LHS		RHS	
16-3	6			
17-3	7			
18-3	8			
19-3	9			
20-3	10			

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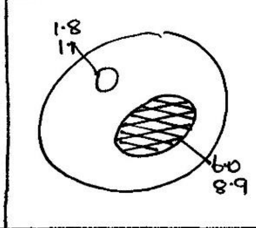
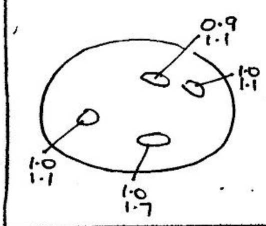
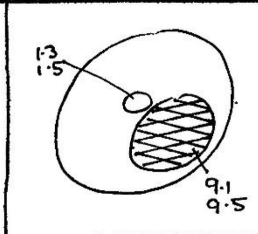
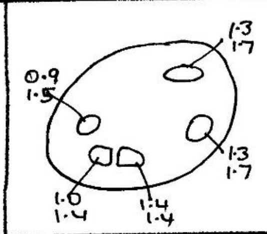
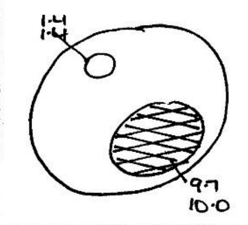
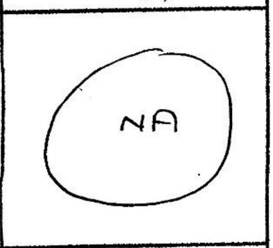
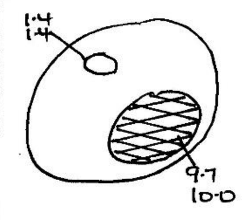
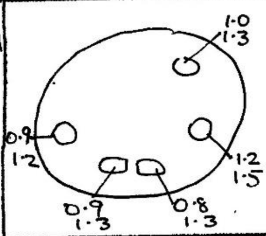
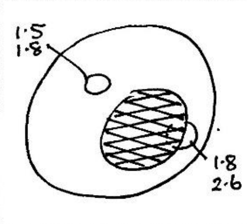
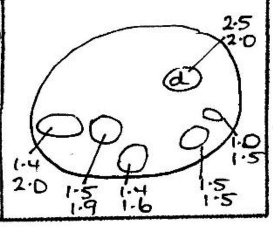
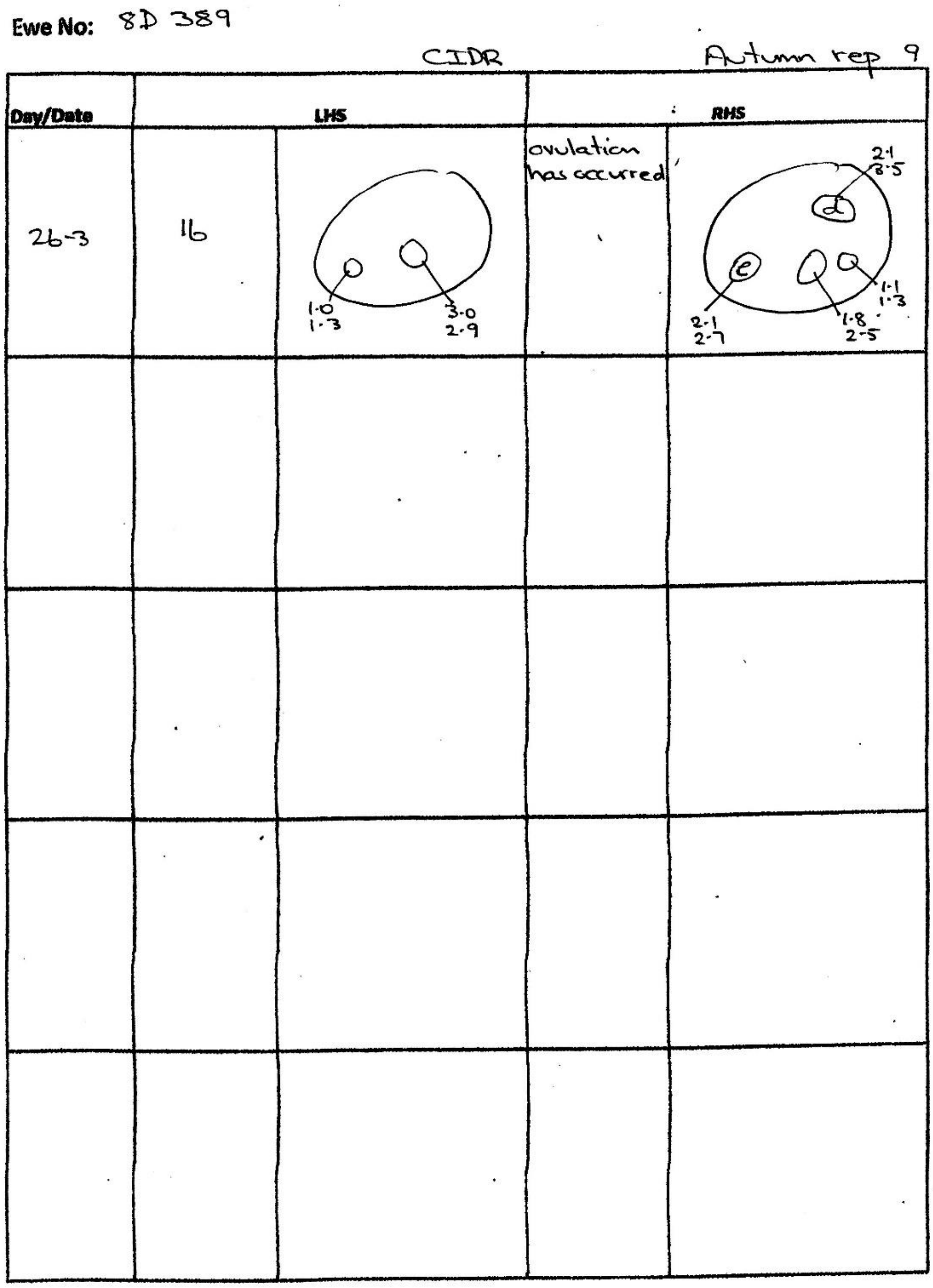
Day/Date	LHS		RHS	
21-3	11			
22-3	12			
23-3	13			
24-3	14		day of CIDR removal	
25-3	15		in oestrus 9a.m. (21h)	



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Day/Date		LHS		RHS
26-3	16	1·0 1·3; 3·0 2·9	ovulation has occurred	2·1 3·5 (CL); 2·1 2·7; 1·8 2·5; 1·1 1·3

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