National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Exemplar for Internal Achievement Standard

Agricultural and Horticultural Science Level 1

This exemplar supports assessment against:

Achievement Standard 91293

Demonstrate understanding of livestock reproductive techniques in commercial production in New Zealand

An annotated exemplar is a sample of student evidence, with a commentary, to explain key aspects of the standard. It assists teachers to make assessment judgements at the grade.

New Zealand Qualifications Authority

To support internal assessment

Grade: Achieved
For Achieved, the student needs to demonstrate understanding of livestock reproductive techniques in commercial production in New Zealand. This involves describing the steps taken when performing each reproductive technique while referring to the structure of livestock reproductive systems. The steps should be written with sufficient detail that another person could carry them out. All steps are not required but most of them, including the main steps, should be included. The reproductive techniques chosen are artificial insemination (AI) of dairy cattle and flushing and embryo transfer with sheep. The student has described steps of artificial insemination for cattle with actions and reasons to demonstrate their understanding. The description includes the collection of semen and the insemination process itself. The steps of flushing ewes prior to mating have been described and explained to show how they influence success of the technique. The explanation for flushing refers to high quality nutrition, including types of feed, the use of Body Condition Scoring and what happens to sheep with scores above and below 3, and the role of the hormone follicle-stimulating hormone (FSH). This explanation is sufficient to contribute towards Merit. However, the explanation and role of hormones for at least one other technique is required in order for Merit to be awarded. The steps of embryo transfer with sheep have been described. The role of hormones progesterone, luteinising hormone and FSH have been included in the description. For Merit, each step of the process must be explained in detail, focusing on how each step contributes to the success of the technique, and the hormones involved. For AI in cattle, the role of hormones in the AI technique must be included, and the explanation could include why and where the semen should be precisely placed for a successful outcome. For embryo transfer with sheep, the explanation of many of the steps for success of the technique were missing and need to be given for this complicated procedure. Flushing with sheep was explained.

Artificial Insemination (AI) is the process of collecting sperm from a bull for an AI technician to insert into a heifer's cervix whilst on heat using special equipment. AI is only successful if the insemination occurs during the cow's oestrus cycle, which is 12-24 hours during the standing heat stage. Artificial insemination is done instead of natural mating to control genetics and what time of year the cows calve. AI has also been shown to improve milk production in the dairy industry.

The first step is thawing out the semen and preparing the heifer for insemination. Semen, once thawed out, is only active for 15 minutes, so the technician has to be aware of how much they can insert within the 15 minutes. Once the semen is thawed out, it'll be dried off and then loaded into a pistolet, one semen straw per insertion. Once loaded, the pisolet needs to be handled with care so it can't be contaminated. It needs to be kept out of the sun, away from any chemicals and handled with clean gloves. The heifer needs to be put into a yard or chute where it will be restrained for the safety of the technician. Then the cow's vulva is wiped clean to prevent any infections in the reproductive tract and to make sure there's a clear entrance for the AI technician.

Next, the pistolet is guided into the cow's cervix by a gloved hand in the rectum. The hand in the rectum needs to palpating the cervix to ensure the pistolet has a smooth passage. To ensure good semen delivery, the hand in the rectum must guide the pistolet to the correct place, which is near the entrance to the uterus but not blocking it or misdireting it into the uterine horn. The pistolet must also not be inserted too deep, or it'll cause severe injury to the heifer and could cause infertility. The semen must be inserted slowly to increase the amount of sperm; also, slow insertion ensures that the pistolet is empty and that all the semen has been inseminated into the cow. Then the pistolet is slowly removed from the reproductive tract and the hand it removed from the rectum. The cow is then released and monitored by farmers to ensure that the cow is pregnant.

The final step is to monitor the cows that have been inseminated to ensure that the insertion has been successful. One way to do this is to notice the change in their behaviour, whether their appetite has changed, or whether they are gaining weight. Another way to tell if it has been unsuccessful is if the heifer comes on heat again within the next 2-3 weeks. This means that she is not pregnant and that she will need to be inseminated again.

Flushing is a technique used to increase the success rate of ewes pregnancies. Flushing is the process of feeding high-quality pasture three weeks before mating and three weeks during. It improves the chance of ovulation by the ewes gaining weight and triggering higher levels of hormones such as follicle-stimulating hormone (FSH). The higher the ovulation rate, the more successful the lambing will be. The success of flushing depends on the quality and quantity of the feed. Silage and leafy pasture are the best feeds for this method.

To ensure you are feeding the right pasture to the right ewe, you must examine their body condition score (BCS). To do this, the farmer needs to get the ewes into a yard where they can be examined by a BCS expert, who would then tell you what their score is. If they are lower than a 3, then they would be drafted off into a herd that would be fed higher quality feed to try to increase the BCS before mating. If the ewes score was higher than a 3, then they would be drafted off separately and fed pasture for maintenance.

After separation, the ewes will be fed high-quality foods like silage, lucerne and leafy pasture. Feeding them more of this high-quality feed increases the chances of lambing by producing a higher level of FSH. This is done 3 weeks before mating to try to increase the hormones and then 3 weeks during to ensure that the ewes are healthy. If feed is low during autumn or due to drought, the farmer needs to feed the ones with a lower BCS to help them be the same live body weight as the ones with a higher BCS. During a drought, the ovulation rates drop, which may delay mating and ovulation rates until the drought breaks, the ewes won't go back to their normal state.

Embryo Transfer (ET) is the process of giving a ewe a series of hormone injections such as follicle-stimulating hormone (FSH) to stimulate more ovulations. These eggs will then be fertilised with the sperm from artificial insemination (AI), which allows them to form embryos. Embryos are the unborn offspring of a mammal. This procedure is mostly carried out in dairy cows but can be done in other animals such as merino sheep. This procedure is very risky and doesn't always work, it also costs a lot of money. If successful, it will increase the number of offspring by 50%, and it also increases the genetic base of a herd and will decrease the chances of diseases.

The steps of embryo transfer are very precise, and if they are done incorrectly, it could affect the ewe seriously. First, you have to choose a ewe that is healthy, has a high BCS and has the best genetics. Embryos can also be bought in from overseas. Ewes that are the embryo donor will undergo the process of being in superovulation,

which is when the ewe is injected with hormones such as FSH to stimulate the ovulation. This process takes around 26 days. On day one, the first injection will take place, then on day 7, the CIDR will be inserted. A CIDR is a silicone-type, T-bone-shaped device that is inserted into a ewe to increase progesterone levels. Progesterone is absorbed from the CIDR by the vagina which will then cause the body to realise levels of lutenising hormone (LH) and FSH. On day 15, the CIDR is changed out for another one, and on days 16, 17 and 18, the ewe is injected twice daily with FSH to increase her hormone levels again. Once again, on day 19, she will be injected twice again, and the CIDR will be removed. This drops the levels of progesterone and increases the FSH levels, then the ewe will start its oestrous cycle. On day 20, the farmer will do two heat detections to make sure that this process has worked. Lastly, on day 26, the surgery to extract all the embryos will take place.

The embryos are extracted using a laparoscope and are directly injected into the uterus of the uwe that is at the same stage of oestrous. To get the recipient ewe at the same stage as the donor, the use of CIDR is in place to synchronise their oestrus cycles. The success of this process depends on the detection of heat of both ewes and the recovery of the fertile eggs. Because there will be lower progesterone levels because of the removal of the CIDR, the timing of the insertion is crucial.

The advantages of this process include a more widespread use of genes from genetically superior ewe, which could also include ones from overseas. This procedure will also increase the number of offspring. It can increase the ewes genes and can increase her number of offspring throughout her lifetime. Also, another advantage is that the flock will be increased genetically, so there will be less chance of diseases transferring over, and the health rate of the ewes will change dramatically.

Justification of the use of Artifical Insemination by beef farmers.

Quality: AI can improve the quality of a herd because you can choose exact genes. With AI, you can choose what bull you want to get your herd pregnant. The more money you spend, the higher chance there is that your bull is very high quality. Being able to choose high-quality semen will also increase the milk production rate because it improves the heifer’s genetics. There is also less chance that diseases will be tranferred over. AI is also an easier way for farmers to monitor the pregnancies. This technique doesn’t just increase the quality of the herd, but it can also improve the quality of farmer’s safety and the farmer’s yards. Having bulls can be dangerous, and they could cause damage to the yards if provoked. Bulls also can cause issues when the herd is getting milked, so not having one on the farm can increase the chances of having fewer issues around the farm.

Quantity: AI creates more pregnancies; a bull will impregnate 50-60 heifers naturally mating. Using AI, one bull's semen can inseminate thousands of cows. AI has a higher success rate than natural mating, which means that farmers will have bigger replacement herds. Also, the replacement herd will have better genetics from this bull's semen and have a lower chance of getting a disease. AI increase the milk production in herds as well because you can choose the genetics of your semen. If you pay more for sexed semen, you could only have females being born, which means better for replacement herds and better for milk production. AI could also increase fertility and how many calves the heifer has by 10%, which benefits the farmer.

Timing: AI can help farmers know what to feed the cows and when. When on heat, you need to increase their feed to increase the rate of conception. AI helps with this because farmers need to keep a close eye on which cows are on heat so they know when to inseminate. Using AI also means that you can calve throughout the year and can control when the heifers calve. Natural mating means that you have calves whenever the bull feels like it, but with AI, the farmers know when the cows are going to calve. This condenses calf rearing into a shorter period and is less costly because the farmers don't have to pay someone constantly to feed the calves. Artificial insemination also means that the heifers will all be on heat at the same time because of the increase in hormones, which is more beneficial for the farmer because then they can control when the cows have their calves.

Economics: AI may seem more expensive than natural mating because you have to pay for semen and technicians, but over time, it ends up being a more affordable and more successful way to go. AI has more benefits than natural mating because farmers can control the genetics and calving times. Natural mating means having to maintain the bull and pay for its feed and repairs when it gets provoked. Artificial insemination also increases the safety on the farm by not having the risk of an angry bull breaking fences or ruining cattle yards when the herd gets milked. AI also reduces the cost of calf rearers by being able to choose when the heifers calve.

Disadvantages: Some of the disadvantages of the technique are if the cow is not on heat and is inseminated, it could affect the cow's fertility and is a waste of semen and money. Also, the money spent on the semen and technician can be a negative, and the labour put into the inseminating the cow could also be a downside because natural mating is much simpler and less labour. Farmers also have to monitor which heifers are in heat, which is also more time-consuming. The maintenance of the yards could also be a negative as the yards where the heifers are being inseminated have to be reasonably clean to decrease the chances that the cow being inseminated gets an infection or disease from the pistolette being dirty.

Grade: Merit
For Merit, the student needs to demonstrate in-depth understanding of livestock reproductive techniques in commercial production in New Zealand. This involves justifying the use of a selected reproductive technique in terms of timing, quantity and genetic potential, and the economics of production. The reproductive techniques chosen are artificial insemination (AI) and artificial hormone application with cattle. The student has described each step of AI and artificial hormone application in detail and explained how each step influences its success. Diagrams for both techniques have been used to support the descriptions. The role of oestrogen and luteinising hormone (LH) have been referred to for AI. For artificial hormone application the hormones progesterone, FSH and LH have been referred to. For Excellence, the student should justify the use of one of the techniques in terms of timing of the use of the technique, quantity, genetic potential and economics of production. This should be explicitly justified and could be made in a final section of the report.

What is artificial insemination?:

Artificial insemination (AI) is when farmers get diluted semen from a bull to then inseminate their cows. The semen will be directly placed into the cows **uterus** so that the embryo can become fertilised and the cow can raise a calf. AI is used to genetically improve the herd, access genetics from around the world, to reduce the number of bulls required, and to have access to breeds that aren't locally available.

Method of artificial insemination:

1 When the cows are ready for AI

For AI there needs to be the right timing for the process to be effective. For the AI to become effective the cow needs to be on standing heat. Standing heat is when the cow has been on its oestrous cycle for around 8-12 hours already. The oestrous is caused by **oestrogen** since the concentration of **progesterone** has decreased which is the hormone that helps to prepare the cows **uterus** for a pregnancy. **Oestrogen** also has a huge influence on standing heat as it helps to start the release of luteinizing hormone from the cows anterior pituitary gland located in the brain. This causes the cows to start standing to be mounted, swelling and reddening of the vulva, and mucus discharge. This then helps the farmers to know when the cows start their oestrous cycle. So if the cow starts its oestrous around 7am then the farmer can collect the cow. So that AI can happen around 3pm-7pm. The reason why it is important to get the timing right for AI is because if the AI is done too late the **sperm cells** won't be able to fertilise the **embryo** in the uterus during the **ovulation period**. This will mean that the cow will not become pregnant and rear a calf. Farmers will usually use fixed-time artificial insemination synchronisation programmes which is where the cows will get specific treatments so that they are all standing at the same time and the artificial insemination can be booked for a certain day. This will allow all the cows to be done at the same time and for the highest percentage of success rate.

2 Positioning the cow

The cow needs to be on a level surface and not on a slope and be slightly restrained to avoid getting kicked but also to still allow the cow to have some movement. The cow should also be in an area where they can have food and water still so they do not become stressed/uncomfortable. These things need to be done so that the cow is relaxed. The reason why the cow needs to be relaxed is because it will increase the success rate of the AI process because their muscles will be relaxed and will make manipulating the catheter easier.

3 Equipment and things to remember:

Preparation is very important because you will need to make sure that you have enough semen and equipment otherwise if you run out you will not be able to finish all the herd. The equipment that you will need is stainless-steel AI gun, non-spermicidal lubricant, gloves (some 35 inch (shoulder length) and smaller gloves). You will need to make sure that all the AI equipment that you are going to be using is clean and sanitary. This is to reduce the risk of bacteria going into the cows **reproductive tract** and an infection occurring in the reproductive tract and vagina. The person who is doing the process of AI will also have to make sure that all bracelets, rings and

watches are taken off. If they do not do this it will mean that these items will be rough and harsh to the cows **rectal lining**. The rings and bracelets could tear the rectal lining and cause harm to the cow . If not treated an infection could occur meaning the cow could die from an infection. The technicians will put the shoulder glove onto their non-dominant hand so that they can use their dominant hand control with the AI gun. If the technician used their non-dominant hand to hold the AI catheter they may not have as much control over the movement of the AI catheter in the **uterus**. This could cause the cow to become uncomfortable for the cow from the catheter touching the **rectal lining**, meaning that the cow will begin to move making it more difficult for the technician. Before the technician inserts their gloved hand that is the palpating hand, the technician will put lubricant onto their hand. This is so that the hand will be able to move in the cows **reproductive tract** without too much friction. This will then help the process to occur faster and for the technician to complete the AI on all cows faster. Before anything else the semen straw needs to be loaded into the catheter. Once the semen has been loaded into the catheter it can be put back into the warmer or in your shirt so that the catheter can stay at a consistent warmth. It should be kept around 35℃ This is so that it does not cool and kill the sperm cells. The semen needs to be used after 10 minutes of thawing the semen otherwise the possibility of an unsuccessful result will become higher.

4 Inserting gloved hand into rectum:

Before the technician inserts their lubricated palpating hand into the cow's **rectum** they will clean the cow's **vulva** with a paper towel. The reason why they clean the **vulva** is to reduce the possibility of taking in bacteria to the cow's **vulva** that can cause an infection. Once the **vulva** has been cleaned the technician will put their figures and thumb together to form a cone. They will gently insert their hand into the **rectum** and take out any excess cow dung (if any) and wipe it away with a paper towel again. However, if the **rectum** is swollen with gas or the cow continues to strain and move about the technician will need to remove their hand to avoid injuring the cow's **rectum wall**. This is because the cow is obviously tense and is holding gas. If they were to continue it could end up hurting the cow and will mean that the AI could become unsuccessful. If this does not happen it is fine for the technician to continue the process. They will apply some downward pressure with their palpating hand which will allow the **vulva** to open more for a clean entrance for the AI catheter.

5 Inserting AI gun:

From the palpating hand opening up the **vulva** the technician is able to easily insert the AI catheter in. To prevent entering the **urethra** and **bladde**r they will insert the AI catheter at a 30 degree upwards angle. The reason why they do not want to enter the **bladder** is because the semen will not be able to fertilise any embryo there. If they do accidently insert the catheter into the urethra the technician will pull the catheter out a bit leaving the tip in the cow's **vagina**. The reason why it is crucial that the tip of the catheter isn't completely pulled out of the **vagina** is because, if the catheter is pulled out completely it allows the possibility of bacteria to enter into the cows **reproductive tract**. It will then mean that the cow could get an infection and become sick needing antibiotics. As the technician pushes the catheter into the cows reproductive

system they will start to level out its angle because the angle of the **reproductive tract** changes the more the catheter is pushed in.

6 Moving the AI catheter:

The technician will continue to push the catheter through the cows **reproductive tract** without too much force with the arm holding the catheter. If too much force is applied it could cause an injury to the cows reproductive system or irritation. If the catheter has residence when trying to push the catheter through it could possibly be blocked by vaginal folds. To manoeuvre around this problem the technician will use their palpating hand to direct the catheter through the **reproductive tract.** Once the AI has been pushed through to the **reproductive tract** the catheter will come to the cervix. The technician will use their palpating hand to find where the cow's cervix is. This is because all cervixes are different sizes. Some are small, some are large. However, all cervix's feel dense so it makes it easy to find the cervix with the palpating hand. The technician will push the catheter to the opening of the cervix and push it in. If it is not going into the cervix they may need to use their palpating hand to straighten out the **reproductive tract** so that the catheter can easily be pushed to the opening of the cervix.

7 Pushing the catheter through the cervix to uterus:

Once the technician gets the catheter to the cows cervix they will push the tip through the opening. They will have to make sure that the tip does not accidently go into the fornix of the vagina. If this does happen the technician will pull the catheter back a little bit and use the palpating hand to hold and close the fornix areas so that the catheter can enter into the cervix easily. If the technician did not do this it would mean that the semen would not be deposited in the vagina instead of the cervix which would not get the cows embryo fertilised.

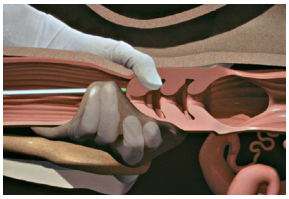
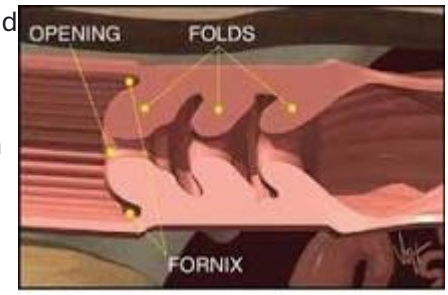


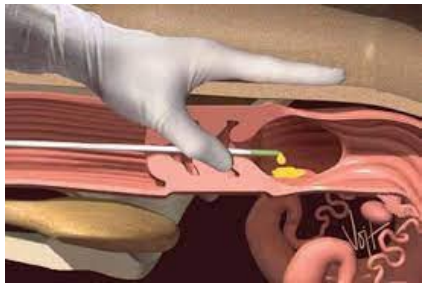
Image of AI catheter getting stuck on fornix

8 Getting catheter through cervix:



They will then continue to push the catheter through the cervix and annular rings. Most cows have around 3 folds. Sometimes the technician will press the cervix against the pelvis to create more support and make it easier for the catheter to be inserted through the cervix. Using their palpating hand they will move the cervix back onto the catheter rather than pushing the catheter through the folds. To get through all the folds in the cervix they will use a small amount of pressure while turning the cervix to get the catheter through the next ring. The reason why only a small amount of pressure should be applied is because they are close to entering the uterine body. This means that if too much force is applied then the uterine tissue could be punctured as it is very thin. This could then later cause prolapse.

9 Depositing the semen:



It is very important for the success rate that the semen is deposited into the uterus. This is because if it is deposited in the cervix most of the sperm will not go into the uterus but will go back out into the vagina. This will mean that the cow would not become pregnant and the AI would be unsuccessful. The way they check to see if the catheter is in the uterus is they will use their palpating hand to see if they can feel the tip of the catheter. If they cannot feel the tip it is still in the cervix. The reason why this is, is because the cervix is very dense whereas the uterus is very thin. So if they can feel the tip of the catheter they are in the uterus. They will deposit the semen in and make sure to do it slowly and to not pull the catheter out before it has finished depositing the semen. Once the semen has been deposited they will pull the catheter out and do the next cow.

What is Artificial Hormone Application?

Is when farmers will be given artificial hormones to get their herd on heat at the same time so that they can all be artificially inseminated on the same day. Generally the hormones will be injected into the cow. Some types of artificial hormones that are used in New Zealand are Cyclase (PG) injection, DIB-H progesterone insert, DIB-V progesterone insert and Gonasyn (GnRH) injection. Many of these artificial hormones applications work together to help ensure that the herd is on standing heat at the same time.

Method of synching herds cycle:

A common synchrony done by Agrihealth is the DIB-CoSynch. The process uses the hormone applications of DIB, Gonasyn and Cyclase. This Program is able to allow/get all the herd to be on standing heat at the same time. This will allow the farmer to have a set time where the AI technician can come in and inseminate all the cows. If the farmer does not use artificial hormones to sync up their herd it will mean that the technician will have to come when the cows get on to their standing heat at different times. This will then mean that the farmer could have a high cost from having to book the AI on many different days.

Day 0

On day 0 the cows will have a DIB inserted into the cows **vagina** using the applicator. The DIB's is a V shaped silicon elastomer and will generally contain 1.0g or 0.5g of **progesterone**. The DIB is very suitable for non-cycling cows or for **oestrus** synchrony programs like the DIB-CoSynch. The DIB insert will make the cow's amount of progesterone increase. The progesterone will help to prepare the cow's body for a pregnancy. On day 0 it is also important that Gonasyn (GnRH) is given to the cow through an injection. The reason Gonasyn is given to the cow is because Gonasyn is a hormone that helps to release more follicle stimulating (FSH) and luteinising (LH) hormones. These hormones help with ovulation in the ovaries. If these things weren't done then it could mean that from the lack of progesterone, FSH and LH hormones.

(DIB and DIB applicator)

Gonasyn injection

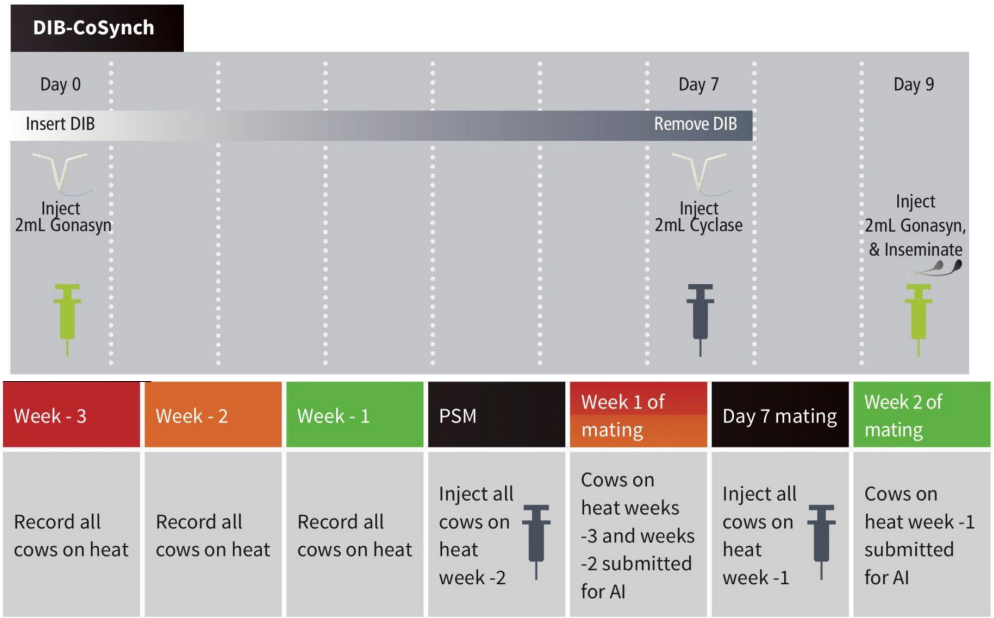
Day 7

On Day 7 the DIB will be removed from the cow's vagina. To do this you will pull on the DIB tail by pulling it firmly out of the vagina. However, you need to make sure you are not pulling it too hard otherwise it could be uncomfortable for the cow or damage the reproductive tract. If the tail is not out of the cow's rectum a vaginal examination may be needed and then remove the DIB insert. When the DIB device is removed the concentration of progesterone in the cow will decrease. This will then lead to their levels of oestrogen increasing to the herd going onto the estrous and ovulation at the same time shortly after. On the same day, inject the cows with 2mL of Cyclase. This will help to get the cows' estrous synched ready for artificial insemination to occur on the same day.

Day 9

On Day 9 before artificial insemination, inject the cows with 2mL of Gonasyn. The Gonasyn will help to release more follicle stimulating (FSH) and luteinising (LH) hormones. These hormones help with ovulation in the ovaries. It will also improve the cow’s fertility. This will then help the cow’s to have a successful pregnancy from artificial insemination. If this is not done then it could mean that the percentage of successful pregnancies in the herd could be lower meaning less cows will rear a calf.

Common synchrony programs



Grade: Excellence
For Excellence, the student needs to demonstrate comprehensive understanding of livestock reproductive techniques in commercial production in New Zealand. This involves justifying the use of a selected reproductive technique in terms of timing, quantity and genetic potential, and the economics of production. The reproductive techniques chosen are artificial insemination and embryo transfer with cattle. Only one technique is required to be justified for Excellence. The student has justified the use of artificial insemination and embryo transfer, with artificial insemination being the stronger. For artificial insemination, the justification includes: • timing – controlling the timing of calving results in calving occurring over a shorter time frame when feed is plentiful in spring • quantity – a higher percentage of cows become pregnant during the calving window • genetic potential – access to the world's best dairy genes is possible • economics of production – the reduced need for bulls on farm reduces costs, and higher milk yields are produced during the lifetime of the cow. For embryo transfer, the four areas of timing, quantity and genetic potential, and the economics of production have been covered, but the understanding of the steps could have been improved by: • including a diagram showing the organs positions relative to each other • expanding the explanations to include how the steps lead to success of the technique.

Introduction

New Zealand's [NZ's] dairy farming industry is well known for its efficient calving and practices that increase milk production and farm income economically. To keep the advantage, dairy farmers use reproductive techniques to manage the fertility, genetic progress and calving timing. The two techniques I will be covering are Artificial insemination [AI] and embryo transfer [ET]. They enable genetic improvement, better management, and better economic returns. This report will explain how each method works, the equipment and biology involved, and justifies their use on NZ dairy farms.

Artificial insemination

AI is a process where semen from a genetically superior bull is collected, processed, and stored most often in frozen straws, before being deposited directly into the uterus of a cow using an insemination gun.

Equipment and Reproductive structures involved

AI involves depositing semen from selected high genetic bulls directly into the cow's reproductive tract during her fertile period. The equipment required includes:
A semen straw, stored in liquid nitrogen tanks An insemination gun for delivering semen Protective gloves, lubricant and other hygienic products Digital heat detection systems such as scratch cards

Heat detection

accurate heat detection is essential for both AI and ET success, where seasonal calving is standard. Signs of heat in cows include: standing to be mounted by other cows [most reliable], increased activity, restlessness and bellowing , Clear vaginal mucus [bull string] swollen and moist vulva, sniffing and licking other cows , following behaviour and chin resting.

Heat detection tools and techniques

Visual observation: checking herds at least twice daily, especially in early morning and evening.
Tail paint and chalk: applied to the tail , worn or rubbed paint indicates mounting and likely on heat.
Heat detection patches: Devices that change colour or pop when pressure is applied.

The reproductive structures involved are:

Vulva: entry point for the insemination gun. Vagina: Passage to the cervix
Cervix: structure that must be navigated carefully
In NZ most AI is preformed by trained technicians who visit farms during the breeding season [spring] to inseminate cows.

Steps of AI

1. Select a cow: choose a superior healthy fertile cow that is on heat [using previously explained methods] because AI is only successful when the cow is ovulating, the alternative is to use hormone protocols to synchronize cycling.
2. Obtain the cow: get the cow into a cattle crush where her head is held still in between bars for stability through the procedure. This is simply a safety measure.
3. Prepare equipment: as liste the equipment must be prepared, all of these tools must be clean and reliable to prevent infection and make sure the semen is alive and ready to fertilize the eggs in the cow.
4. Prepare semen: take the semen straw out of the nitrogen tank, thaw it in hot water for about 30-60 seconds [34-38c]. This needs to be done properly to reactivate the sperm without putting them at risk.
5. Prepare the vulva: Carefully clean the cows vulva with some sort of paper towel to remove dirt ot waste and reduce the risk of infection. This must be done because hygiene is crucial in AI steps to protect the cow.
6. Insert the gun using your arm into the rectum of the cow: wearing a long plastic glove of sum sort carefully insert your arm into the rectum to locate and prepare the cervix through the rectal wall, this is cause the cervix is deep in and hard to see.
7. Insert the gun: using your hand insert the gun into the vagina and gently guide it through the cervix using your hand in the rectum. Ensure not to force it in and aim to deposit the semen in the uterine body [past the cervix]. This must be done because if the semen is incorrectly placed the pregnancy will not likely happen.
8. Deposit the semen: Once the gun is in the correct place slowly press the plunger on the gun in to release the semen. By releasing it slowly it will reduce stress on the sperm and help it to spread out evenly.
9. Remove the gun and clean: carefully withdraw the gun and your arm then discard the used sheath and clean all of the equipment. Removing the gun will prevent damage to the cow.
10. Record the information: record the dare, the semen batch and the id of the cow for tracking and future insemination/pregnancy.

The timing of this process is important, the best time to inseminate a cow is approximately 12 hours after the cow is seen in heat, as this is when fertility is at its highest. This means that close observation of the herd is needed in order to spot oestrus symptoms like heightened activity and mounting behavouir[heat]. The process itself needs a high level of hygiene and precision, as the technician must guide the insemination gun through the cow's vagina and cervix to make sure the semen is placed at the uterine body. This is essential to maximise the chances of successful fertilization and minimize the risk of infection or injury to the animal.

Hormones of AI

1. Estrogen [oestrogen] is the hormone responsible for the visible signs of heat [estrus] within the cows. It rises just before ovulation and causes behaviours like restlessness, mounting, a swollen vulva and clear mucus discharge. These signs help farmers know the best timing for the procedure [AI] to take place. High levels of estrogen indicate that the cow is ready to mate and that the egg will soon be released. Timing AI during this estrogen peak increases the chances of successful

fertilisation.
2. Luteinizing Hormone [LH] is released just before the ovulation period. It plays a key role in triggering the release of the egg from the ovary. This surge in LH usually happens around the middle of the cow's estrous cycle. For AI to be successful, sperm must be present in the reproductive tract before or just as the LH surge happens so it will meet the egg shortly after it gets released. AI timing is often based on predicting this hormones rise.
3. Progesterone is a hormone that keeps pregnancy in the cow. It is high after the ovulation section of the cycle when the corpus luteum forms and prepares the uterus to support a fertilised egg. When the progesterone levels are high, the cow won't show signs of being on heat, and ovulation won't occur. For AI to work, progesterone levels must be low, this means the cow isn't pregnant and is entering a brand new cycle. Sometimes farmers use progesterone releasing devices or better known as a CIDR to control and synchronise the cycle for scheduled AI.
4. Gonadotropin releasing hormone [GNRH] is the hormone that stimulates the cow's brain to then release other hormones, like follicle stimulating hormone [FSH] and LH. It begins a reaction that leads to the development of a follicle and the eventually the release of an egg. In Ai procedures GNRH can be an injection to help control when the ovulation occurs. This will allow for easier and better timing of the insemination.
5. Prostaglandin [PGF2A] is the hormone used to reset the cows reproductive cycle. It creates the breakdown of the corpus luteum, which in result drops the progesterone levels.

Success depends on accurate heat synchronisation or detection, correct semen handling and placement during the procedure. The cows nutrition, health, and body condition. food quality varies depending on the seasons.

Disadvantages:
This Requires technicians, poor technique or mistiming of the procedure reduce the success rates. AI is labour intensive when it relies on visual heat detection on the farm. This doesn't maximise the reproductive output from cows [cows can only have one calf each per year], upfront equipment and training fees.

Justification for Use of AI in New Zealand
Number of cows in calving each year:
AI results in a high percentage of cows to become pregnant during the desired spring calving window, this is critical for matching the milk production. In managed herds, three week submission rates of 80%, six week in calf rates of 75-78% are reachable.
Genetic potential:
Nz farmers have access to semen from the some of the worlds best dairy genes. Farmers select parents based on breeding worth [BW], this combines traits like milk yield, fertility and the longevity.This increases rapid genetic gains.
Timing of calving:

Synchronisation protocols allow for tighter and better calving brackets, this is vital for managing food supply and labour over the NZ spring [season]. Early calving means cows have more time to recover from the birth and cycle back before the following mating. This supports high re productivity.
Economics of milk production:
Ai is cost effective for larger herds of cows. It reduces the need for bulls on farms, which saves costs and reduces the safety risks. The use of top genetics boosts, life time, milk yield and herd profitability.

AI is key to NZ's dairy industry. It makes precise reproduction, improved genes and is cost efficient. The timing of AI is carefully controlled, Hormonal synchronisation protocols inserts make it possible for farmers to get groups od cows ready for insemination so that they can go at the same time. This is a huge advantage throughout NZ's seasonal system, its vital that majority of the herds calves down in spring so they can make the most of the fresh produce. By synchronising the herd, it will increase the number of cows that can get inseminated quickly, this means more cows get pregnant earlier into the season. This is how you can get a tight calving pattern, where most calves are born together, when there's lots of produce to feed them. This means the calves will all arrive around about the same time this makes not only milking and feeding easier to manage but also maintains milk production and makes the most of the springs pasture growth. This ultimately, this planning is what keeps NZ's dairy farms productive, efficient and easier to control/run.

The quality of AI relies on careful semen selection from the worlds best parents[sires], this is evaluated by genetic indexes like BW and production worth [PW]. Strict handling protocols and skilled technicians also have an effect. Healthy well managed cows further improve conception rates or success, with industry targets, such as a 78% six week in calf rate, this is achievable in a well run herd. AI excels in increasing quantity of calving. A single elite bulls semen can impregnate thousands of cows throughout the season. The genetic gains made through AI are rapid, benefiting individual farms and the herd. This scale is unique in only AI, leading 80% of NZ's dairy cows to be bred using this procedure yearly.

The genetic potential for NZ dairy herds furthers through AI technology because farmers can access an international pool of elite sires instead of relying purely on local farm selections. The maintenance of genetic diversity is through the prevention of inbreeding makes sure continued advancement is happening while avoiding negative effects. The system remains in advancement since bulls undergo constant testing through calf performance metrics while farmers select desired traits in cows such as fertility, health and milk production. AI promotes a very good financial opportunity because it remains cost effective for farmer housing herds of about 50-500 cows while cutting the need to stay costly and the bulls that can be potentially dangerous are taken

out of the equation. This also reduces disease transmission among the livestock on their farm. Using extended periods of genetic improvement dairy cows produce greater lifetime yields which will ultimately lead to an increase in farm profitability. The combination of timing, premium semen, mass cow insemination, consistent genetic progress and the cost efficiency makes AI the best breeding technique across all commercial dairy farms nationwide.

Embryo transfer [ET]

Equipment and reproductive structures involved: Et is more advanced technology then AI, used to multiply the genetics of elite cows. The equipment required for ET is more specialized than that for AI. It includes superovulation hormones such as FSH and prostaglandins, AI equipment for inseminating the donor, and catheters and flushing media for collecting embryos form the uterus. A microscope is essential for evaluating embryo quality, and a specialized embryo transfer pipette or gun is then used to deposit the embryos into selected cows. This process is more complex and requires a higher level of experience, expertise and training to ensure that the embryo viability and successful transfer, also the same vital carefulness of management regarding the donor and recipient animals.

Reproductive structures

In ET, the donors cows uterine horns are flushed to collet their embryos, normally 6-8 days after insemination when the embryos are at blastocyst stage. The transfer, the recipient cows cervix is carefully passed and the embryo is deposited into the uterine body close to the active corpus luteum. The placement is critical because the corpus luteum produces the progesterone which is needed for maintaining the early pregnancy. The handling of reproductive structures is crucial for the success of embryo collection and transfer.

<u>Embryo transfer</u>

1. Select the donor and recipient cows
   The donor cow should be elite. The recipient needs to be healthy and have a good enough fertility to carry the embryos.
2. synchronisation of the estrous cycles
   Using progesterone devices and prostaglandin injections to control the timing of heat in the donor and recipient cows. Both cows must be on the same reproductive cycles so the embryos match the uterus stage.
3. Superovulating the donor cow
   This starts by Injecting FSH over a 4 day period to make the donor develop multiple eggs instead of one[induce multiple follicle development]. This leads to the cow producing many embryos from a cow instead of simply one in a cycle.
4. Insemination of the donor cow
   AI happens 12-24 hours after the donor cow shows signs of heat, this is done specifically to then fertilise the eggs released during the superovulation.

5. Flush the embryos from the donor cows
   7 days after the insemination, embryos are flushed out of the uterus using a catheter. This is to collect the fertilised embryos before the implant.
6. Sort and evaluate/manage the embryos
   Inspect embryos under a microscope for quality and the development stage of them. Only high quality embryos are frozen or used.
7. Transfer the embryos into the recipients cows
   Put one embryo into each recipients cows uterus using a pipette, normally on the 7th day of her cycle. This will leave the embryo with the best chance of implantation and pregnancy.
8. Pregnancy check
   Using an ultrasound or palpation after 30 days. This is to confirm if the embryo transfer was successful or not.

Summary

1. Donor selection and superovulation, select a high genetic donor cow. Administer FSH [twice daily for 4-5] to induce multiple follicle development in the cows. Give prostaglandin[hormone] to synchronize estrus and regression of the corpus luteum.
2. Heat detection and insemination of the donor cow, detect heat in the donor cow [or synchronize using hormones]. Inseminate at the right time, normally more then once.
3. Embryo collecting/flushing, 6-7 days after the insemination restrain the donor cow. Insert a catheter into the uterus via the cervix. Recover embryos for inspection and grading under the microscope.
4. Recipient selection and synchronisation. Select healthy and recycling recipients. Using prostaglandin and or CIDRs synchronise the recipients estrous cycle to the donors cycle.
5. Embryo transfer process, Identify your chosen recipient in the correct reproductive stage [witch is the same or synchronised with the donors], Pass the transfer gun through the cervix and deposit embryo into the uterine body.
6. Monitoring and following up, observe the recipients for pregnancy and possible return to being on heat. Record all details for management and future breeding procedures.

Hormones relevant to this technique

1. Gonadotropin, releasing hormone [GnRH]
   Used in donor and recipient cows, the purpose of this is to control the ovulation timing or it helps initiate a new cycle. How it works, it can be used at the start of a synchronisation program or right before insemination to start ovulation.
2. Follicle stimulating hormone [FSH]
   used for the donor cow, the purpose is to stimulate the ovaries to produce multiple follicles or eggs instead of just one. How it works, its given as multiple small injections over a 4 day period during the cow's cycle. This encourages development of many oocytes for fertilisation.
3. Prostaglandin [PGF 2a]

Used in donor and recipient cows, the purpose is to cause regression of the corpus luteum [CL], leading to the start of a new cycle or synchronisation of heat. How it works, it ensures both donor and recipient cows are at the right stage of their estrous cycle. It is usually given around around day 9-12 of the cycle to trigger heat in 2-4 days.

4. Progesterone [often via CIDR- controlled internal drug release device]
   Used in recipient cows, it keeps the cow from coming onto heat to early in the process, it synchronises the uterine environment with the embryos development. It is inserted into the vagina for a total of 7 days, then it is removed to trigger the reaction of heat. This helps line up the recipients cycle with the donors embryo stage.

Hormonal control is critical, FSH stimulates the growth of multiple follicles, it increases the number of eggs released. Prostaglandin and GnRH synchronize the donor and recipients. Progesterone implants or CIDRs may be used to help maintain pregnancy in the recipients.

Success depends on

Success rely s on the donors response to super ovulation, some cows might not yield enough embryos. The quality of the semen and insemination timing also have major effects that determine the success of ET. The management and skill required to do this procedure regarding collection and transfer alter the rate of succession in a big way. The final point being that the health and management of the recipient cows must be up to standard.

Disadvantages

Et is costly, the hormones, veterinary services and sire management are expensive. Also ET is much more complex, it requires skilled personnel and extremely careful management.

Some donors do not respond well this means that the embryo yield is variable. There is increased stress on donor cows and repeated superovulation may affect the health of the cow. The recipient cows are needed this results in additional animals that must be catered for and managed.

Justification for use in New Zealand

ET multiples the reproductive output of elite cows, a single donor can produce 10-20 calves per year through multiple transfers, compared to one calf per year via AI. This is especially valuable for multiplying the genes of top elite cows.

Genetic potential:

Et allows for the most valuable cows to have a greater impact on the herds genetics. By combining the genes of elite sires, farmers can accelerate genetic progress.

Timing of the calving:

Synchronising the donors and recipients allows for planned calving. This supports efficient herd management and helps make sure that calves from elite genes are born at the best times possible.
Economics of milk production:
ET is expensive, but the long term economic benefits far outweigh the costs because elite genetics are involved in the procedure. Calves from ET might have higher lifetime milk yields, better fertility and other desired traits. This justifies the investment for a higher value herd. But ET is generally not cost effective enough for the casual commercial dairy farm in NZ.

Embryo transfer represents the peak of reproductive technology procedures in the NZ dairying industry. It provides great control over elite genetics but comes with a more complex method and a bigger cost. The timing of ET must be managed with crucial care. Elite cows are superovulated using FSH to produce multiple eggs. Recipients are synchronised using progesterone and prostaglandin so embryos can be transferred at the right stage of the reproductive cycle in the cow. This hormonal control makes sure both donor and recipients are ready. This maximises the pregnancy rates and keeps the seasonal calving pattern which is crucial for pasture management.

Quality is critical throughout the ET process. Donors are chosen excellent genes and performance. Embryos are carefully graded under a microscope to make sure only viable ones are used. Recipients are selected for their health and ability to carry out pregnancy. The focus on quality at every step helps produce some of the best calves possible. Although the quantity of calves produced through ET is lower than AI it has a transformative effect at an elite level. A single top cow can produce 10-20 or more offspring per year through repeated flushes or the IVF method. This accelerates the multiplication of rare or highly desirable genetics much further than AI or natural mating could meet.

ET allows for rapid multiplication and combination of elite cow and bull genes. This will drive the production of future herd sires and the valuable breeding females. ET may not have the same wide impact as AI, it is a must for enhancing the genetics of nucleus herds and breeding sires that benefit the entire industry. Economically speaking ET is much more costly and more technically demanding then AI as we know. It requires major investments in hormones, vet expertise, management of the recipients and specialized equipment. But for the best cows. ET can provide major long term returns to farmers. This will include faster genetic gain, the creation of premium breeding stock and the potential to obtain higher prices for elite genes both locally and abroad. For majority of commercial farms the economics surrounding ET aren't favourable. But for high value breeding businesses and developing future sires, ET serves as a good tool for multiplying elite genes and maintaining NZ's lead in dairy breeding innovation.

Hormone Involvement

Changes in hormone use:

Estrous synchronisation, both AI and ET normally use prostaglandin GnRh and CIDRs to bring cows into heat at the same time. AI hormone use, is primarily for synchronising ovulation, reducing the need for visual detection and enabling a fixed timeline for insemination. ET hormone use, Donor cows are superovulated using FSH to produce multiple eggs, as well as prostaglandins or CIDRs for cycle synchronisation. Recipients receive synchronisation protocols to make sure the uterine is ready for the embryo implantation.

Advantages of hormonal involvement

It boosts the conception and submission rates, during the best time windows a far larger percentage of the herd can be inseminated or used for embryo transfer. It reduces labour, instead of consistently visually monitoring cows, farmers can plan and schedule their breeding. Consistent calving patterns, leads to more synchronised calving this improves the efficiency of labour allocation/management, nutrition and overall herd management.

Vital to ET, in order to maximise the number of offspring from elite cows superovulation is a must; without hormone control, donor and recipient cycles would not cycle appropriately. Cost of hormone use and drawbacks/risks, hormonal treatments FSH, GnRH, CIDRs, ect. All increase breeding expenses, especially for ET. Animal welfare must be considered like possible stress, side effects or multiple injections in specific protocols.

Disadvantages and risks surrounding hormonal use

Cost, hormonal treatments add to breeding costs, more so in ET. Animal welfare, some protocols involve multiple injections alongside potential stress or other side effects. Environmentally, excretion of synthetic hormones may have potential impacts if not managed carefully and correctly. Possible reduced fertility, excessive or poorly timed hormone use can reduce fertility and cause reproductive troubles.

Conclusion

While AI is suitable for all possible herds, ET is more strategic and can be used to multiply elite genetics, both have a vital role in maintaning the productivity, sustainability and profitability of the farm, these all help carry the NZ farming industry.