



**TO: NORFOLK ISLAND BRANCH | TERRITORIES DIVISION  
DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT AND CITIES**

**AUSTRALIAN FEDERAL GOVERNMENT**

**PROPOSAL FOR IMPROVING RUMINANT LIVESTOCK PERFORMANCE ON NORFOLK ISLAND:**

**ARTIFICIAL REPRODUCTION FOCUS**

**March 2019**

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## Executive Summary

### *Background:*

This report represents outcomes from a study of means to improve artificial insemination (AI) and embryo transfer (ET) for ruminant livestock on Norfolk Island. Cattle, goats and sheep are a particular focus of the study.

This proposal considers, but is not limited to: biosecurity related requirements; selection of suitable ruminant livestock; availability and adequacy of handling facilities and equipment; cost and storage of semen and drugs; personnel qualification requirements; cost of an AI technician; barriers to AI delivery; identification of program participants; possible training opportunities for participants; work health and safety; animal welfare; and, options for Australian Government assistance to the Island to improve AI on Norfolk Island.

The study was undertaken through liaison with the Department of Infrastructure, Regional Development and Cities (Department), the Department of Agriculture and Water Resources, the Administrator of Norfolk Island, and a community and stakeholder visit to Norfolk Island.

### *Current Position:*

*For all ruminant enterprises on the Island, the **time line to produce new males is now critically short.** There is **genuine urgency** in the requirement to initiate programs to produce new seedstock. A failure to produce programs will result in in-breeding or less than satisfactory outcomes with certain males being over-represented in herds and flocks.*

Sheep numbers on the Island are low and there is a need to provide new genetic material. It is possible, that sheep will be lost from the Island.

Goat numbers are low, but there is a firm vision for development of the small goat industry and excellence in execution of the current enterprise. This enterprise will need ET to achieve its goals.

### *Overcoming Impediments to implementation of artificial breeding on Norfolk Island*

**Recommendation:** Evaluate needs for liquid nitrogen on the Island and purchase a small liquid nitrogen plant that can meet the Island's needs. Information on a potential supplier is provided on page 18 of the report.

**Recommendation:** There needs to be a champion within the Biosecurity group of Commonwealth Department of Agriculture to facilitate the timely, that is rapid, clearance of genetic material to enter the Island and to assist in the early rejection of proposed sites that are deemed for the collection of embryos and semen.

**Recommendation:** Three new vet crushes be installed at existing sites and entry races be concreted. One or two larger handling facilities be established capable of yarding and handling a minimum of 120 adult head with covered crush facilities (perhaps yards suitable to approximately 260 head in total), walk over weigh scales and aligned calf marking and handling facilities. These are essential for both occupation and health considerations and also to ensure good animal health. Details on

suppliers that can provide suitable options, and of potential crushes and yards, can be made available by Dr Lean on request.

**Recommendation:** There needs to be an upskilling program for veterinarian Candice Nobbs and Darren Bates, who is trained and has conducted AI according to Dr Nobbs. Given that they have the pre-requisite skills and experience, this should entail a refresher course and time with an experience AI technician and trainer for a period of 3-5 days in Australia.

**Recommendation:** Individual producers with scale of enterprise and a small committee of the Norfolk Island Cattle Association Inc (NCIA) be tasked with identifying suitable embryos and semen for the cattle population. The methods of implementation and numbers of bulls to be generated should reflect the guidelines established in this document. Artificial insemination and embryo transfer programs be initiated and supported for cattle with a view to producing a strong framework for future use.

**Recommendation:** An embryo transfer program for the development of the goat flock be undertaken in conjunction with Ms Emily Ryves to allow development of the goat enterprise.

**Recommendation:** That sheep AI be undertaken in conjunction with the goat program.

**Recommendation:** *Evaluating success and future planning: That there be a review at 36 months of performance resulting from the report regarding numbers of cattle bred by AI and the numbers of cattle bred by ET. This review should include challenges with implementation of programs, costs of implementation and numbers of cattle, sheep and goats resulting. This review should include all options for breeding management.*

**Evaluations of Success of programs:** Each stage of the plan to establish AI and ET on Norfolk Island needs to be reviewed to ensure that timely execution is occurring. Delays in activity will rapidly compound and extend timelines. Given that the current situation is already suboptimal and further delay will be damaging, attention to timing and detail are necessary.

Success will be defined, in conjunction with producers on the Island; however, a preliminary vision may be;

**For AI:**

- Selection of 40 to 60 head for breeding
- Successful conduct of the AI program with > 55% pregnant to first mating
- Birth of 25 to 40 head of cattle to AI
- Establishment of routine AI programs on the Island within 12 months (i.e. by March 2020)

**For ET:**

- Selection of 40 to 60 head for breeding
- Successful conduct of the ET program with > 60% pregnant to implantation
- Birth of 25 to 40 head of cattle to ET

- Establishment of regular ET programs on the Island – perhaps 2 per annum within 12 months (i.e. March 2020)
- Bulls of high quality available on the Island by March 2020
- Sufficient new genetics available on Norfolk Island to allow generation of bulls to meet the market.

**Recommendation:** That there be consideration given to appointment of a person to provide support for agricultural development on the Island.

## Brief

This report represents outcomes from a study of means to improve artificial insemination (AI) and embryo transfer (ET) for ruminant livestock on Norfolk Island. Cattle, goats and sheep are a particular focus of the study.

This proposal considers, but is not limited to: biosecurity related requirements; selection of suitable ruminant livestock; availability and adequacy of handling facilities and equipment; cost and storage of semen and drugs; personnel qualification requirements; cost of an AI technician; barriers to AI delivery; identification of program participants; possible training opportunities for participants; work health and safety; animal welfare; and, options for Australian Government assistance to the Island to improve AI on Norfolk Island.

The study was undertaken through liaison with the Department of Infrastructure, Regional Development and Cities (Department), the Department of Agriculture and Water Resources, the Administrator of Norfolk Island, and a community and stakeholder visit to Norfolk Island.

## Methods

- Background research: cattle yard manufacturers, Island geography and climate, history of cattle, sheep and goats on Norfolk Island and contact with suitable reproductive service providers.
- Visit 25/2/2019 to 1/3/2019 - Review all of the above in the context of Norfolk Island interests: structures and facilities with view to meeting local goals. Evaluate challenges including practical provision of liquid nitrogen for maintenance of temperature sensitive semen and embryos and explored limitations to implementation of oestrous synchrony programmes.
- Develop during the visit understandings of desired outcomes for Island residents: these are segmented reflecting the needs of different types of livestock enterprise, including numbers of stock owned, by cattle/sheep/goats and key enterprise type – i.e. growing or breeding for sale or family consumption.
- Pivotal to the understandings of the industry was time spent with Emily Ryves, Candice Nobbs, David Evans, James Partridge, and a meeting with approximately 30 cattle producers and one goat producer as members or guests of the Norfolk Island Cattle Association Inc (NICA).
- Consideration has been given to long term breeding goals. What are the best outcomes for individual producers and whole of island performance?
- Discussions with Ron Nobbs in regards to the sheep industry.
- Discussions and contact with practitioners in Australia who are active in the embryo transfer and artificial insemination of cattle and small ruminants.
- Materials received from Mayor Robin Adams on behalf of NICA, that include 'Cattle on Norfolk Island – our Heritage and Traditions' (Appendix 2).
- Reporting and refining this proposal including specific recommendations on methods and requirements for implementation.

## Acknowledgements

Sincere thanks to Ms Fiona Anderson and Mr Eric Hutchinson for their interest, facilitation and support during the visit. Also, thanks to the staff of the Norfolk Island Branch | Territories Division Department of Infrastructure, Regional Development and Cities for assistance and background.



## Cattle

### *Background and Context*

The goals of purchase of male breeding stock are two-fold i) to maintain high rates of pregnancy in ruminant herds; and ii) to increase rates of genetic gain in populations.

### *Perspectives from the Visit*

The focus for the majority of cattle owners on the Island, according to interviews conducted, is to achieve pregnancy of cattle. A lower focus is on the rate of genetic gain.

### *Current Practices*

There is a population estimated to be approximately 1200 head of cows, exclusive of calves. There appears to be only 2 producers who hold more than 100 head. Many of the cattle are held in small herds to essentially provide a family larder. The holdings likely reflect relatively small lot holdings of many land holders of 10 to 50 hectares. Some bulls are bred for sale on the Island.

While the normal mating ratio for cows to bulls is 40:1, sharing of bulls may reduce the number of bulls used, but spreads the age of calves – this may or may not be considered desirable. In normal cattle enterprises a seasonal calving is preferred to make optimal use of pasture growth patterns. However, in the case of the cattle on Norfolk Island, James Partridge noted advantages of calving in batches to minimise drought risk and provide continuity of supply of stock. I consider that strategy to be sound.

The majority of cattle observed are cross-bred; however, there are a number of readily identifiable breeds and apparently pure-bloods including Angus, Hereford, Simmental, Limousin, Devon, South Devon and Norfolk Blue. In general, the cattle are of good quality, being large bodied and relatively likely to finish with adequate fat cover. Many of the cattle are finished at lighter weights (190 to 220 kg carcass) than those on mainland Australia, reflecting difficulties in finishing cattle on variable quality kikuyu pastures and preferences for smaller cuts of meat. Further, it was reported that fat cover is often present while these animals are unweaned, or just weaned. Limited observation of carcasses and the wider observation of cattle supported this.

The genetic base of the Island is diverse and there are few producers that have a comprehensive program of genetic selection. There is a benefit in the diversity of breeds used on the Island and in cross-breeding that can produce 'hybrid vigour' and increased weight gains. That noted; however, the meeting with individuals and NICA highlighted the desire to maintain breed diversity with 'pure-bred' cattle, but also suggested a potential for a direction towards a group goal of a Norfolk Brand.

The communal grazing of cattle provides excellent visual amenity (see photo 1), is of deep historical and cultural significance, and obviously provides a focus for tourists. There are approximately 209 head of adult cattle grazing on the communal lands of 183.5 Ha (Lane, GHD report 18/2/2016) and this stocking rate represents an approximate stocking rate of 17 dry sheep equivalent.

*However, the communal grazing of cattle ensures that the Island is particularly vulnerable to spread of disease, providing support for the decision to prohibit live importation.*



Photo 1: Communal grazing providing visual amenity.

### *Production environment*

I evaluated the production environment while travelling around the Island (almost all roads were driven) and in discussion with those interviewed. The soil types are predominantly red volcanics (krasnozemic soils). Kikuyu grass dominates the pastures – there is some couch and some buffalo. There is a ‘French clover’ present in significant amounts in the kikuyu pastures (Photo 2). The ‘clover’ appears to be a *Desmodium* spp., rather than a true clover. It was observed and reported that small areas of other grasses are present.





Photo 2: Desmodium spp. 'French Clover' in the kikuyu

The kikuyu observed was lush and young with recent growth following rain (Photo 3) and a prolonged dry spell; some areas of kikuyu have deeper thatching. There is ample opportunity for efficient cow-calf operations on the Island; however, there will be times when fattening is more difficult due to aging of kikuyu and, consequent, loss of feed value.





Photo 3: Kikuyu was generally young and lush, however, there was some deeper thatched areas.

The Island has significant potential to increase the scale of production, given the high-quality soils, relative abundance of land and high rainfall (1324 mm per annum); however, the systemic resilience provided by a lower stocking is important to manage weather fluctuations and susceptibility of kikuyu to army worm infestation, given that supplementary feeds are expensive at \$1500 per tonne for very basic pellets and to be delivered from Australia or New Zealand.

There are agronomic efficiencies that might be achieved on the Island with a detailed review of this area.

### *Reproductive Management*

#### *Current Practices*

The current practices are based on the presence of a number of imported bulls. These bulls were, in general, privately imported and are more than 6-7 years old. The last importation was reportedly in November 2014. There has been limited use of artificial insemination, with reportedly limited success (less than 50% pregnancy to AI), to provide new genetic material (programs were reported for Norfolk Blue, some Speckled Park, Simmental and Angus cattle). The dairy cattle were evident as Holstein and Jersey cattle were observed, but the status of bulls for the dairy enterprises was not made clear. Bulls are sometimes used by one enterprise for 2 to 3 years and are then passed on to another enterprise. Apparently, some cross-bred bulls also exist.

Under best practice, bulls are used for 2 seasons on a single farm, at most. This policy is designed to optimize genetic gain and minimize the risks of in-breeding. The current situation of aged bulls being used for more than 4 years is already suboptimal and is likely without immediate action to deteriorate further towards a worst practice scenario, that is, old bulls will be used over their own or closely related progeny.

It takes more than 2 years to produce replacement bulls from embryo transfer or from artificial insemination. The period arises from i) identification of suitable seedstock that will comply with quarantine requirements, ii) negotiation with seedstock producers to obtain embryos, iii) either purchase of 'off the shelf' or program flushes of embryos and obtainment of permissions for these to enter Norfolk Island, and iv) organisation for an embryo transfer expert to visit Norfolk Island to transfer embryos (See Figure 2. that highlights the timelines) v) gestation interval of cattle 9 months vi) age to sexual maturity and use 14-15 months. While artificial insemination has a shorter time line to adoption because of the ability to purchase semen that is more available than embryos, ultimately, this has only a modestly shorter time to generation of new bulls with the two dominant factors being gestation length (9 months) and time to sexual maturity (~14 - 15 months) (See Figure 1. that highlights the timelines). Further, a major limitation to use of AI to generate bulls is that 50% of the genetic gain will likely come from a cow with an uncharacterised genetic base. (It is possible to obtain estimates of genetic merit for Stud Angus cattle; however, there are very few, if any, cows on the Island with full stud records).

Genetic characterisation of the production traits of cattle has made marked gains recently, resulting in the ability, within the Angus breed, to provide accurate assessments of the genetic merit of male and female cattle. Within 10 years, many of the major breeds will have similar capacity to determine merit.

On request, Dr Lean can provide more information on the methods used in AI and ET in cattle.

**Conclusion:** For all enterprises on the Island, the **time line to produce new bulls is now critically short**. There is **genuine urgency** in the requirement to initiate programs to produce new seedstock. A failure to produce programs will result in in-breeding or less than satisfactory outcomes with certain bulls being over-represented in cow herds.

*It is worth noting, in this context, that turn-over of bulls often approaches 40% per annum reflecting problems with health, reproductive disorders and age.*

## Biosecurity Discussions

### *Discussion with Federal Department of Agriculture and Water Resources*

I met with Andrew Moss, Adam Robinson, and Georgina Ressler via phone and Darren Mietzel in person at Norfolk Island. A summary of the outcomes of the discussion is outlined below. The following were canvassed in discussion i) limitations on semen and embryos that can be imported to the Island – these were clarified, ii) rationale for the ban on importation of live animals – these were clarified and are outlined in Table 1 below.

Table 1. Outcomes of Discussions with the Departmental Officers on 26/02/2019.

Method	Cattle	Sheep	Goat
<b>Artificial Insemination</b>	Collected according to OIE in facilities approved by the department. Must apply for permit – can be collected internationally as long as this meets Australian permit conditions.	Collected according to OIE in facilities approved by the department. Must apply for permit – can be collected internationally as long as this meets Australian permit conditions.	Collected according to OIE in facilities approved by the department. Must apply for permit – can be collected internationally as long as this meets Australian permit conditions.
<b>Embryo Transfer</b>	Collected according to OIE in facilities approved by the department. Must apply for permit – can be collected internationally as long as this meets Australian permit conditions.	Collected according to OIE in facilities approved by the department. Must apply for permit – can be collected internationally as long as this meets Australian permit conditions.	Collected according to OIE in facilities approved by the department. Must apply for permit – can be collected internationally as long as this meets Australian permit conditions.
<b>Live Importation</b>	Prohibited because of Johne's disease, Leptospirosis, tick borne diseases including Theileria and Q fever risks	Prohibited because of virulent footrot and Johne's disease	Prohibited because of Johne's disease, Caprine Arthritis Encephalitis, Q fever

*Comments on current situation regarding biosecurity constraints to conduct of artificial reproductive program*

While there appears to be few limiting inhibitions to obtaining semen for use, there may be challenges in obtaining embryos suitable for importation. The process will require testing using practical examples once potential sources and practitioners are confirmed.

**Recommendation:** There needs to be a champion within the Biosecurity group of Commonwealth Department of Agriculture to facilitate the timely, that is rapid, clearance of genetic material to enter the Island and to assist in the early rejection of proposed sites that are deemed for the collection of embryos and semen for all species.

**Table 2 A, B, C. Strengths and weaknesses of the different methods of breeding in the current Norfolk Island context and notes regarding numbers required**

**A: Cattle**

Method	Cattle
<b>Artificial Insemination (AI)</b>	<p><b>Assessment:</b> Relatively easily applied and a wide range of bulls can be selected. Can reduce the need for bulls on the Island. Can, if well applied, increase genetic gain. With ~1200 cows on the island, AI could constitute a small business or augment the veterinary business. However, some local generation of bulls is both likely and pragmatic, particularly for use in smaller herds.</p> <p><b>Requirements:</b> Needs semen to be available on Island and mostly requires synchrony. Needs to have a constant supply of liquid nitrogen. May need further skills development in AI in cattle. There will be the potential, with on Island storage of semen to maintain AI skills and regularly breed cattle.</p> <p><b>Weakness:</b> Time required to generate bulls is substantial and resultant bulls have limitations, having been bred from local cows. There will not be sufficient success with AI to obviate the need for bulls. In the longer term, if female embryos are imported, bulls may be bred by AI on the Island.</p>
<b>Embryo Transfer (ET)</b>	<p><b>Assessment:</b> Needed to provide bulls. However, the number of bulls required for logical use is quite large. There will be more than 40 bulls (perhaps 50) bulls required on the island at any given time (given age structures i.e. growing bull calves through to aged bulls, i.e. 5-6 yo). These numbers are estimated based on having some phenotypic selection pressure and in order to provide some variation in breeds. In order to provide reasonable genetic gain, bulls should turn over every 2 years, so 25 to 30 bulls per annum should be generated. A tiered system of bull generation makes most sense. This may be achieved by purchase of elite embryos that can generate bulls for both breeding elite herds of cows and generating local bulls. This means that there would be a regular requirement to synchronize around 80 cows per annum and transfer around 40 male embryos per annum (to allow some selection pressure based on phenotype).</p> <p><b>Costs:</b> circa \$1000 to \$1500 per embryo (exclusive of synchrony drugs, veterinary and operator costs) (see Appendix 3). However, it may be that custom flushing may be required to obtain genetics desired by Island owners.</p>
<b>Live Importation</b>	Not available due to quarantine risk – however, expensive and problems with bull survival. Risk is high and \$ per live calf high, especially if used to aim for genetic gain.
<b>Note regarding bull numbers</b>	It will be important to implant more bull embryos than bulls required. This strategy is needed, in part, to reflect losses of embryos and calves, but also to ensure that there is some potential to select the best calves to use as bulls with regard to genotypic and phenotypic characteristics.



**B: Sheep**

Method	Sheep
<b>Artificial Insemination (AI)</b>	Relatively easily applied using ‘shot in the dark’ or ‘over the rail’ insemination methods. These methods vary in success rates and the current benchmark for high rates of pregnancy is laparoscopic AI. All of these could be done in conjunction with a specialist in sheep reproduction. The AI could provide sufficient diversity and gain to provide rams from existing ewe flock, if regularly conducted. There are now only 17 head of sheep with Ron Nobbs.
<b>Embryo Transfer (ET)</b>	Ron Nobbs indicated a willingness to work in conjunction with Emily Ryves, should a specialist be contracted to inseminate the sheep to provide diversity in the genetic base.
<b>Live Importation</b>	Not available due to quarantine risk. It may be possible with further developments and very specific approaches to limit disease, but little practical benefit over AI/ET. The last ram cost \$6500 to import. This represents an extraordinary cost and financial risk per sheep produced.
<b>Note regarding ram numbers</b>	The low numbers and modest goals of the sheep enterprise suggests that an AI program, conducted in conjunction with the goat program, may provide sufficient new genetic material to manage the aspirations for the sheep flock.

**C: Goats**

Method	Goat
<b>Artificial Insemination (AI)</b>	Relatively easily applied; however, given the low number of goats, is not sufficient to provide appropriate diversity of genetics, nor to provide number to ensure skills maintenance for practitioners.
<b>Embryo Transfer (ET)</b>	Is essential given the small number of goats on the Island. There will be a need to bring in a skilled ET practitioner. Given previous difficulties with AI, prior establishment of liquid nitrogen production and storage may be an essential component of a strategy; however, this is consistent with AI in cattle. There is an opportunity to synchronise goat breeding activities with sheep breeding using AI to allow sufficient tasks to encourage skilled operators to visit.
<b>Live Importation</b>	Not available due to quarantine risk. Costs of bringing in a buck (were this feasible) are high versus ET generation of bucks.
<b>Note regarding billy numbers</b>	In this case, the risk regarding billy numbers may be mitigated by increased diversity of doe lines by transfer of doe embryos. Sufficient diversity of does might allow use of AI of does in conjunction with selection of male kids from AI and ET. The immediate need will be for ET of male and female embryos.

**Selection of suitable livestock**

The process of selection of suitable livestock needs to be a joint effort of the NCIA and the major cattle owners. The goat selection needs to be done by Emily Ryves and sheep by Ron Nobbs, probably in conjunction with the specialists supplying the ET and AI services. In all cases, the selections will be



subject to the Biosecurity constraints and conditions that apply to the Island and it is critical that these be rapidly clarified on a case by case basis.

## Adequacy of cattle handling facilities and equipment

Current cattle handling facilities on the Island are rudimentary, in many cases, and inadequate in all cases for conduct of modest scale embryo transfer programs in cattle. Only one site was identified that would be suitable for a small- scale transfer. The photos below show some of the facilities. There is a need, if there is to be an interest in developing a cattle industry on Norfolk Island to provide suitable facilities for conduct of embryo transfer and artificial insemination. The facilities, while rudimentary are satisfactory, but far from ideal, for artificial insemination programs of modest scale, perhaps 20 to 30 head inseminated at a single site. These would be much improved by installation of modern veterinary crushes.

### *Occupational health and safety and animal welfare*

The primary concerns in regards to both these matters relate to the cattle handling facilities. The current facilities are not satisfactory from an occupational health and safety perspective. Given, that there are communal aspects of management, it is vital that this be rectified. Further, animals are at most risk of injury when handling facilities are poor both during times of challenge, e.g. calving or when being routinely handled for animal husbandry reasons. New facilities and enhancement of existing yards will reduce the risk of problems.

### *Other infrastructure: Including storage of semen and drugs*

If the Island is to depend on artificial means of reproduction, it must have a readily available and secure supply of liquid nitrogen and sufficient diversity of holding tanks to provide backup if there is tank failure. The following site contains information on apparently suitable systems. Further, there is information on the other uses for liquid nitrogen that would be beneficial to the Island economy.

<https://www.velocityscientific.com.au/products/liquid-nitrogen-generation.html>

There is availability of drugs suitable for synchronisation of oestrus through the local veterinary practice. Prior planning and ordering will be required to ensure that adequate supplies are present when these are required.

### *Personnel qualification requirements*

While there are capable people on the Island (veterinarian and one other trained in AI), regular practice and refinement of skills is essential. There is no one capable in embryo transfer skills on the Island and these skills will need to be imported for each program as these are extremely high-level skills.

## Cost of contracting operators for conduct of AI and ET

There are several approaches that have been used to explore the best options for costs. The emphasis has been on ET, as this is considered the more critical part of the plan. Contact has been made with four practitioners and two have provided estimates of their costs in producing embryos (see Appendix 3).

The estimates range from \$150 per embryo including semen, and from \$135 to \$464 depending on the type of super-ovulatory program used and the responses achieved. The pricing of a contract mating flushing\* of selected cows remains to be determined, but perhaps this would be available on a 50% share basis resulting in embryo costs of approximately \$300 to \$400 each.

There needs to be consideration of whether the ET practitioners may be suitable to perform AI programs and whether the AI and ET are considered to be conducted simultaneously.

**Embryo Pricing:** There is limited availability of embryos for some breeds in Australia. However, Angus embryos are available and are priced at \$800 to \$1000 each. Similarly, there are Holstein embryos available for \$800 to \$1000 each. The pricing on the embryos will clearly depend on the genetics sought, availability of donor cows and pricing of ET services. Ideally, for the first round of implantation, suitable embryos would be available that would allow these to be used; however, there may be sufficient time and opportunity for some contract mated production of embryos.

\*Contract mating and flushing is where the owner of a cow agrees to have their cow flushed for embryos on behalf of another cattle enterprise.

## Recommendations

**Background:** The situation on the Island with regard to genetic gain in cattle is now **parlous**. The youngest bulls representing genetics that were unrelated to other Island cattle are now 6-7 years old and will be 9-10 years old by the time that new bulls can be generated with ET or AI.

**Biosecurity:** There needs to be a champion within the Biosecurity group of Commonwealth Department of Agriculture to facilitate the timely, that is rapid, clearance of genetic material to enter the Island and to assist in the early rejection of proposed sites that are deemed for the collection of embryos and semen for all species.

**Establishment of liquid nitrogen facilities:** While it may be feasible to conduct an AI program without facilities on the Island, there is a structural need for liquid nitrogen production. Liquid nitrogen is a hazardous product and minimising the need to move this is logical for on-going service of semen and embryo tanks. The need should be considered in conjunction with other industries on the Island and a suitable plant be established. *Time Frame:* Immediate (within 8 weeks).

**Actions:** A potential supplier of liquid nitrogen plants has been identified and others should be sought. The Island needs to identify the opportunities to use liquid N on the Island and decide on the scale of plant and a provider using some of the information supplied in this document.

Tanks suitable for storage of embryos and semen should be purchased and established on the Island with sufficient potential to store semen and embryos and with suitable security to ensure the integrity of the tanks. The ideal time to purchase these will be in conjunction with the visit of ET and AI specialists. *Time Frame:* Have these purchased and delivered to the Island, at least 3 weeks prior to the visit of the ET or AI specialist.

**People:** There needs to be an upskilling program for veterinarian Candice Nobbs and Darren Bates, who is trained and has conducted AI according to Dr Nobbs. Given that they have the pre-requisite

skills and experience, this should entail a refresher course and time with an experience AI technician and trainer for a period of 3-5 days in Australia. Ideally, there can be small group, AI conducted on a regular basis, providing a new industry base. Given, the current situation regarding genetics, this training is needed in conjunction with any synchrony program. *Time Frame:* Urgent.

**Actions:** The National Herd Improvement Organisation in Australia has been contacted to identify someone suitable to conduct a refresher course for two people. The criteria for training include a dry laboratory retraining in technique and to be able to breed a number of cows under supervision. Following their response (8/03/19) evaluation of suitable sites will be made

**Facilities:** While some AI can be conducted in current facilities, there are limited suitable facilities for ET on any scale. Given that there will need to be up to approximately 60 embryos inserted immediately and some modest scale AI programs implemented, establishment of better facilities suitable for purpose is required. Given, that the industry is, in part, communal, i.e. more than 200 head of cattle are managed on common ground and most cattle handling facilities on the Island are shared, there is a need to upgrade facilities with group access at several sites.

**Recommendation:** Three new vet crushes be installed at existing yards and entry races be concreted. One or two larger handling facilities be established capable of yarding and handling a minimum of 120 adult head with covered crush facilities, walk over weigh scales and aligned calf marking and handling facilities. These are essential for both occupation and health considerations and also to ensure good animal health.

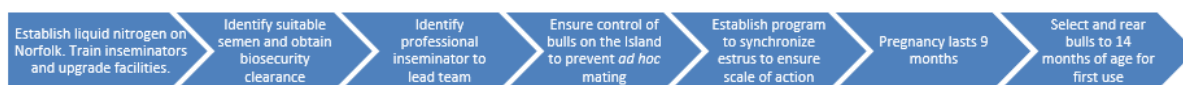
**Actions:** Quotations were sought for suitable yards and crushes from Proway at Wagga Wagga and Thompson Longhorn in Goomburra Queensland. A quotation (Thompson Longhorn 6/03/19) on suitable crushes indicates costs between \$8000 and \$10,500 exclusive of shipping and installation. *Time Frame:* Crushes: 2 immediate – another in 2 years. *Time Frame:* Yard and handling facilities for ET and AI: Immediate. It is estimated that each yard and handling facility would costs approximately \$100-130K exclusive of shipping costs.

*Proposed Reproductive Programs:*

**AI:** For many of the cattle enterprises an immediate program of AI will increase genetic diversity and maintenance of existing / desirable attributes of cattle owned. Given that there is now sexed semen available, consideration could be given to using this to either generate more females or more males.

In order to establish an AI program as rapidly as possible, there are a number of simultaneous activities required that are reflected in the process diagram and Hazards Analysis Critical Control Point (HACCP) outlined below. The following could be considered to be a HACCP approach to establishing a rapidly implemented successful AI program on the Island.

Figure 1: Process diagram for artificial insemination on the Island



## Artificial Insemination: HACCP with potential timing

### April-May 2019

- Artificial inseminator identified for training of Norfolk Island personnel and to travel to Norfolk for conduct of a breeding program.
- Those to be trained in AI travel to Australia for refresher course and training including breeding cattle.
- Meeting of NICA and large herd owners to identify who will utilise AI and embryo programs
- Semen sources identified and cleared for export to Norfolk Island
- Liquid nitrogen plant established

### May 2019

- Forty to sixty cattle identified and suitable for artificial insemination on Norfolk Island
- Non-pregnant, but fertile, cows identified and withheld from bulls
- Semen is imported and first semen tank is in place.

### July to August 2019

- Synchrony programs conducted using drugs that were previously ordered.
- Insemination program conducted by AI technician in conjunction with those trained on the Island for AI. Oestrous detection devices are placed on cattle 3 days after breeding.

### August 2019

- Bulls placed with the cows 10 days after AI or second round of AI conducted by the inseminators based on the Island.

### September to October 2019

- Confirm 25 to 40 head pregnant to AI

### June 2020

- Calves on the ground – 25 to 40 head

### June 2020 to December 2021

- Review of nutritional management of bulls and heifers
- Selection of bulls for use (if any) and castration of non-selected males.

### October – November 2021

- Heifers ready to mate at weight ~ 350 kg. Bulls ready to use at 14-15 months (limited numbers).

## Embryo Transfer

In order to maintain novel genetic material on the Island and to establish genetic gain for targeted traits in several breeds, ET is needed.

In order to establish an ET program as rapidly as possible, there are a number of simultaneous activities required that are reflected in the time line below. The following is a HACCP approach to establishing a rapidly implemented successful ET program on the Island.

Figure 2: Process diagram for embryo transfer on the Island



### Embryo Transfer: HACCP with potential timing

#### March 2019

- Embryo transfer practitioners contacted regarding costs and availability of embryos. Some details included in this report.

#### April-May 2019

- Meeting of NICA and large herd owners to identify who will utilise AI and embryo programs
- Embryo sources identified and cleared for export to Norfolk Island
- Liquid nitrogen plant established.

#### May 2019

- Forty to sixty cattle identified and suitable for ET on Norfolk Island
- Non-pregnant, but fertile, cows identified and withheld from bulls
- Embryos are imported and first semen/ storage tank is in place.

#### July to August 2019

- Synchrony programs conducted using drugs that were previously ordered.
- ET program in conjunction with local veterinarian. Oestrous detection devices are placed on cattle 3 days after breeding.

#### August 2019

- Bulls placed with the cows 10 days after AI.

#### September to October 2019

- Confirm 25 to 40 head pregnant to ET

#### June 2020

- Calves on the ground – 25 to 40 head

#### June 2020 to December 2021

- Review of nutritional management of bulls and heifers
- Selection of bulls for use and castration of non-selected males.

**October – November 2021**

- Bulls ready to use at 14-15 months. Any heifers generated are ready to mate (~350 kg liveweight).

**Review of Success**

There should be a review of performance resulting from the report regarding numbers of cattle bred by AI and the numbers of cattle bred by ET. This review should include challenges with implementation of programs, costs of implementation and numbers of cattle resulting.

**Evaluations of Success of programs:** Each stage of the plan to establish AI and ET on Norfolk Island needs to be reviewed to ensure that timely execution is occurring. Delays in activity will rapidly compound and extend timelines. Given that the current situation is already suboptimal and further delay will be damaging, attention to timing and detail are necessary.

Success will be defined, in conjunction with producers on the Island; however, a preliminary vision may be;

**For AI:**

- Selection of 40 to 60 head for breeding
- Successful conduct of the AI program with > 55% pregnant to first mating
- Birth of 25 to 40 head of cattle to AI
- Establishment of routine AI programs on the Island within 12 months (i.e. by March 2020)

**For ET:**

- Selection of 40 to 60 head for breeding
- Successful conduct of the ET program with > 60% pregnant to implantation
- Birth of 25 to 40 head of cattle to ET
- Establishment of regular ET programs on the Island – perhaps 2 per annum within 12 months (i.e. March 2020)
- Bulls of high quality available on the Island
- It is expected that approximately 5 bulls of high quality would result from an ET program with 25 to 40 head born and that there would be about 8-15 bulls that would be of lesser quality or steers. There should be between 13 and 20 female head unless embryo sexing methods were used.

**Recommendation:** That the success of the program be briefly reviewed in 18 months to evaluate total number of calves and kids born. A full review should be conducted in 36 months to evaluate whether the use of ET and AI is a sustainable solution for reproductive management of ruminant livestock on Norfolk Island.

## Goat program

### *Background and Context*

I visited Hilli Goat Farm and found the facility and enterprise to be functioning at a very high level. While the enterprise is small, there was high quality presentation and produce. There were more than 20 visitors mostly international visitors (Photos 4 and 5). I talked with Emily Ryves about her experiences with AI in goats. While AI is a useful adjunct to the existing Billy, ET will be needed soon to provide sufficient diversity. The goal is to expand to 20 does that will allow supply of produce to local restaurants, supermarkets and provide year-round supply for their own enterprise.





Photo 4: tourists at Hilli farm.



Photo 5: Goats grazing kikuyu on Hilli farm.

### *Recommendations*

The goat program should be conducted in conjunction with the sheep program (see below). Given that Emily Ryves has already made contact and used a reproductive program including use of AI, there are pre-existing skills and contacts for genetics. It is unlikely that a program will be put in place before next autumn, by which time all of the infrastructure for holding semen and embryos should be in place.

## Sheep program

### *Background and Context*

There are a few remaining sheep on the Island, however, there is potential to increase the sheep flock in order to displace imports of sheep meat.

### *Recommendations*

Ron Nobbs indicated that he was willing to work in with the goat program in order to facilitate the conduct of this. Given that both species are autumn breeders, this should be possible. However, there will need to be close communication and facilitation of that process. This may be done through the local veterinary practice as there will be a need to synchronize the oestrous synchrony programs for the two species. It is very possible that the local veterinary service could undertake the 'shot in the dark' or 'over the rails' inseminations following up-skilling in conjunction with an initial visit.



## Options for Assistance

Overarching principles: That there is a public good need to create facilities and conditions that allow private citizens to produce ruminant livestock on Norfolk Island. The private citizens need to have financial responsibility for selection of the livestock.

Detail on these options is provided under Recommendations: In summary

- Co-ordination with the Biosecurity group of Commonwealth Department of Agriculture to facilitate the implementation of programs by providing assistance with rapid responses confirming suitability of semen and embryo sources proposed for import for all 3 species, i.e. cattle, sheep and goats.
- Establishment of a liquid nitrogen plant on the Island, the scale of which will be determined, in part, by the uses for this in other industries on the Island.
- Assistance with the establishment of 3 crushes and 1 or 2 sets of cattle yards estimated costs in the order of \$170K (1 set yards) and \$270K for two sets of yards exclusive of installation and transport.
- Support for training of local personnel in AI and in synchrony methods.
- Support for conduct of embryo transfer programs in cattle. Support may include financial support for a cattle ET expert to visit and implant embryos. This should represent a public – private partnership to produce new genetic material on the Island.
- Support for conduct of embryo transfer programs in goats. Support should include financial support for a goat ET expert to visit and implant embryos. The program should be conducted in conjunction with a program of sheep AI.
- Consider the appointment of an advisor to provide stimulus to the develop agriculture on the Island.

## Appendix 1

*Itinerary & Activity Log*

Professor Ian Lean

<b>MONDAY 25 FEBRUARY 2019</b>		
Time	Location	
		Arrive and check in
3.30 – 4.00pm	Office of Administrator	Entry meeting with Administrator and meet team
4.00 – 6.00 pm	Tour South Eastern End of Island	Check crush near Administrative HQ in KAHVA (Photos 6 and 7) and Stockyard Rd – Cattle grazing on roads. Evaluated soil types – red volcanics (krasnozemic soils). Kikuyu dominates the pastures – there is some couch. Kikuyu is lush and young – some areas have deeper thatching.

<b>TUESDAY 26 FEBRUARY 2019</b>		
Time	Location	
8.00 – 11.00	Various	Visit potential crush and infrastructure sites and storage of liquid nitrogen. Continued to investigate the different roads and facilities on the island. Met
11.00 – 1.30pm	Office of Administrator	Met with Candice Nobbs -veterinarian and discussed practical implementation of artificial insemination in goats, potential for programs in sheep and implementation of cattle artificial insemination and embryo transfer. Background on cattle management and herd structures.
LUNCH BREAK – 60 mins		
2.30 – 3.30pm	Office of Administrator	Begin draft in relation to infrastructure
3.30 – 4.30	Biosecurity	Process/permits etc overview

<b>WEDNESDAY 27 FEBRUARY 2019</b>		
Time	Location	
10.00 – 11.30	Office of Administrator	Tour of KAVHA – visited. Spent time with Mr David Evans (Dids) discussing the history of cattle on the island, methods of slaughter and ownership structures of cattle herds on the island. Few herds are of significant size.
12.00 – 1.30	Various	Continue infrastructure site visits
2.00 – 4.30	Hilli Goat Farm	Tour of facilities and lunch with Mr Eric Hutchinson (Administrator). The farm, produce and associated enterprise (café) are extremely well executed. When I visited, there was approximately 16 visitors including those from New Zealand, Austria, Wales and Australia.
4.30 – 5.00	Hilli Goat Farm	Talk with Ms Emily Ryves about experience (AI – goats). While AI is a useful adjunct to the existing Billy, ET will be needed soon to provide sufficient

## RUMINANT REPRODUCTION: NORFOLK ISLAND

### WEDNESDAY 27 FEBRUARY 2019

		diversity. The goal is to expand to 20 does that will allow supply of produce to local restaurants, supermarkets and provide year-round supply for their own enterprise. Also discussed with Mr Steve Ryves.
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### THURSDAY 28 FEBRUARY 2019

Time	Location	
9.00 – 10.00	Office of Administrator	Prepare for stakeholder meeting (DRAFT overview)
11.00 – 11.30	Office of Administrator	Meet Ms Candice Nobbs – inspect facilities and discussions
11.30 – 2.00 pm	Mr James Partridge Calebs Lane	Inspect cattle, handling yards, slaughter and butchering facility, discussions
2.00 – 2.45 pm - drive and assess areas of the Island not previously visited		
2.45 – 5.00 pm	Governors Lodge	Prepare for stakeholder meeting (DRAFT overview)
5.15 – 7.30 pm	NICS	Stakeholder meeting (Cattle association and others). Approximately 30 members and guests were present and there was vigorous discussion for approximately 1.30 hr. The Association was challenged to produce a vision for cattle enterprises on the Island as a future vision.
7.30 – 10.00 pm		Dinner – Dinos

### FRIDAY 1 MARCH 2019

Time	Location	
8.30 – 10.30	Governor's Lodge	Report and review
10.30 – 11.55	Olives Café	Meet with Mr Ron Nobbs to discuss sheep
		Check in and depart

### SUBSEQUENT TO FRIDAY 1 MARCH 2019

Time	Location	Contacts
	CAMDEN	Proway, Thompson Longhorn, Peter Younis (ET vet), Rob Pashen (ET vet), Matt Izzo (ET vet), Holbrook Breeders Australia (ET services), KO Angus



Photo 6: Existing crush at KAVHA

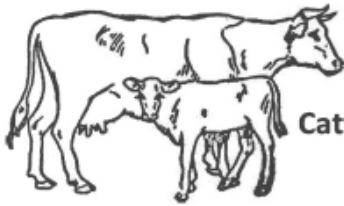




Photo 7: Existing crush and yards at KAVHA

## Appendix 2

### *Materials from Norfolk Island Cattle Association*



#### **Cattle on Norfolk Island – our Heritage and Traditions**

##### **What does heritage mean?**

*"Heritage includes places, values, traditions, events and experiences that capture where we've come from, where we are now and gives context to where we are headed as a community.*

*Our heritage gives us understanding and conveys the stories of our development as a nation, our spirit and ingenuity, and our unique, living landscapes. Heritage is an inheritance that helps define our future"*

**Department of Environment website [www.environment.gov.au/heritage/about](http://www.environment.gov.au/heritage/about)**

The heritage and traditions surrounding cattle on Norfolk Island aligns with the above definitions.

*"The cattle industry is one of the oldest surviving industries on Norfolk Island and is a significant part of primary industry on Norfolk Island. The existing use principle should be applied in acknowledgement that cattle have grazed in KAVHA since as early as 1796 when there "was an enclosure for cattle in the centre of the valley and a granary.....Grazing was the main land use in the Pitcairn Settlement and breached dam was used to grow vegetables"*

***'Freemen & Convicts' published by the KAVHA Management Board/DIRD in 2013 with content by Jean Rice Architect; see page 36***

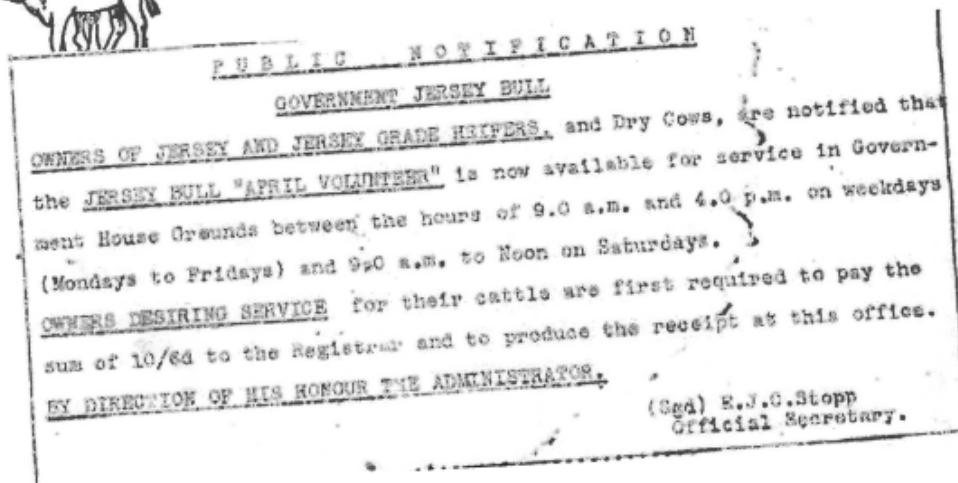
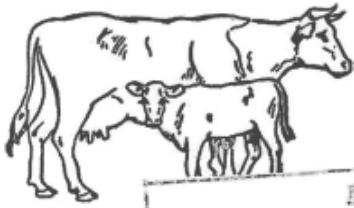
*"They (the Pitcairners on arrival on Norfolk Island in 1856) are rather alarmed at the number of cattle on the island; for, though they had a bull and a few cows at Pitcairn, they made no use of them, as none of the people, not even the babies, would drink milk!"*

***Letters from Captains Fremantle & Denham from Norfolk Island 9 August 1856***

*"They (the Pitcairners) told me that the Bishop of New Zealand had been there; they also said that they were out of flour, and that beef and potatoes formed the substance of their meals. They, considering they had never tasted meat of any kind at Pitcairn, took very kindly to animal food, and had devoured a good number of the sheep and cattle which had been left when the convicts were removed to Van Diemen's Land. Some whalers had called in for fresh provisions and water, and beef had been sold to them at 3d. per pound. The cattle were in beautiful condition; they had killed one which weighed 1,400 pounds, a very fair weight for a grass-fed bullock, but one could not wonder at their condition when one saw the luxuriance of the grass, which covered the ground with a mat some eight or nine inches deep."*

***Captain Denham's journal on his visit to Norfolk September 1857***

It could be argued that the cattle industry on Norfolk Island commenced in 1857 with the sale of beef to visiting whalers!



*Norfolk Island Weekly 10 November 1939*

At a meeting of the Australian and New Zealand Technical Committee on Animal and Plant Quarantine held in Canberra in May 1965 the animal health status of Norfolk Island was considered in relation to the transport of livestock through the Island from Australia to New Zealand and back by aircraft. The members of the Committee agreed that the disease status of the Island should be ascertained and recommended that an animal health survey be carried out by a veterinary officer.

Survey undertaken 14 to 30 October 1965 (Cth)

Recommendations that flowed from the 1965 Commonwealth survey included "all cattle grazing on the common lands at Kingston and elsewhere be mustered at least twice each year and treated with Thibendazole or other approved anthelmintic for the control of internal parasites".

"These reports should be interpreted as suggested guidelines for the establishment of a sound animal husbandry industry on the Island, with a particular reference to Common Lands"

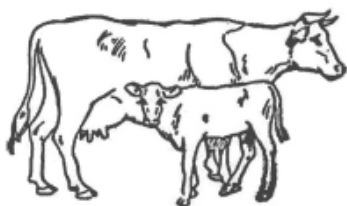
Letter 15 April 1969 to Administrator from the Senior Veterinary Officer with the Commonwealth Department of Health

"...recent amendments to the Pasturage and Enclosure Ordinance, and to the Stock Diseases Ordinance, which now allow the implementation of a Stock Health Programme.....which will improve cattle health thereby improving meat production, fertility, and reduce the incidence of calving losses... and will be put into effect at the beginning of 1980.

"an amount will be charged to stock owners with stock on the common which truly reflects the cost of drench, delousing agent and labour involved....."

*Hansard 1980 J.H. Ryves Member of the Legislative Assembly*





The stock health programme has continued uninterrupted from 1980 up to and including the present day with the cost of drenching and delousing included in the agistment fee which in 2014 is \$125 per head.

*Gazette No. 13 of 27 March 1980 (NI)*

Employment of an agricultural officer and discussions with NSW Department of Primary Industry to provide extension officers with a broad background in horticulture and livestock to visit Norfolk Island to conduct an audit of the current agricultural system.

*Recommendation Acil Tasman Economic Development Report 2012 (Cth)*

“The Director National Parks (DNP) recognises the importance of the contribution cattle grazing makes to the Norfolk Island economy and identity. We agree, in principle, that if it is possible to support the industry without compromising the integrity of the national park, then we should endeavour to do so.”

*Dr Judy West, Assistant Secretary, Parks Island and Biodiversity Science,  
Parks Australia 9 February 2015*

“The removal of cattle from KAHVA will have a direct financial impact on local families who rely upon the meat to feed their family and the income earned from these cattle. Additionally, there will be a flow on financial effect to numerous businesses on the Island such as butchers, hardware stores for fencing supplies, fencing contractors, reduced Government GST revenue, etc.

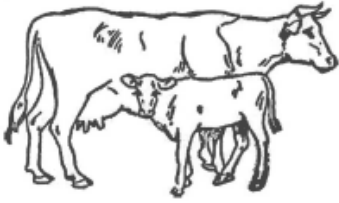
“Removal of cattle from KAHVA would significantly reduce the total herd across the island. At least 100 cattle and 100 calves would be removed from public land if KAVHA was not accessible for grazing. This has a flow on effect to the amount of cattle that can also graze on private land, as the public and private areas operate hand in hand as a part of the cattle owners’ agistment management strategy for feed and control.”

*Submission to Chief Executive Officer of Norfolk Island Administration  
21 October 2014 from Cattle Association*

#### **Moving forward to 2015 -**

- Cattle grazing on common land contribute to the incomes for a significant number of families across the island;
- The cattle industry provides meat to a significant number of island families, who share it not only amongst themselves but also to those less fortunate than themselves;
- Cattle with rights to graze on Common land (the common herd) make up one quarter of the entire cattle population on the island;
- Twice yearly muster not only ensures the health of the common herd, it also provides cattle owners with the opportunity to share genetics; and undertake further management and sales;
- What started as a government stock health program has become a cultural event in which whole families (from toddlers to our elderly) participate; and
- Cattle grazing on common land provide a valuable and cost effective service in reducing and preventing woody weeds.





### Summary

The following succinctly summarises and supports the assertion that the cattle industry is an important part of Norfolk Island's heritage and traditions:

"From the beginning, the Pitcairn customs of sharing were evident in their new settlement on Norfolk. Examples include the establishment of a common store for their food and the designation of common grazing lands at the KAVHA site and elsewhere on the island, indicating the communities' continued sharing of resources as an important cultural tradition. The free-roaming chickens and cattle appear to be an expression of this custom."

*NSW Dept. of Commerce 2007: pp. 249-260  
Kingston and Arthur's Vale Historic Area Heritage Management Plan June 2015: p. 42 (Cth)*

Aaron Graham

A handwritten signature in black ink, appearing to read 'Aaron Graham'.

Vice President  
Norfolk Island Cattle Association  
Class of '85



## Appendix 3

### *Details of embryo collection costs and quotations*

Email potential Supplier

I've found some time to work this out. It was in fact a good exercise to look at the costs anyway. The table below shows the cost to a client of superovulation, flushing and freezing embryos under a few scenarios.

The calculation included all drugs, consumables and professional fees. I reckon this is a realistic figure. Any reduction would involve discounting professional time and I am reluctant to do this given the expertise and time involved to do it properly.

The variables include the number of cows flushed at one time, the dose rate of folltropin which will vary from 20 ml to about 10 ml and the embryo yield which will again vary from 0 to 30. In this instance I have used 1 cow, with 2 or 5 embryos to be frozen or 4 cows with 12 to 20 eggs frozen.

The cost to produce an embryo then is between \$135 and \$464.

It is likely that the more cows done the less is the risk of getting a completely dud day.

	<b>Flush and freeze 1 cow and 5 or 2 embryos</b>		<b>Flush 4 cows and freeze 20 or 12 emb</b>
number embryos	5		20
number embryos	2		12
Total per embryo high yield high dose	\$ 186		\$ 157
Total per embryo low yield high dose	\$ 464		\$ 262
total per embryo high yield low dose	\$ 163		\$ 135
total per embryo high yield low dose	\$ 407		\$ 225
Dose high 20 ml			
Dose low 10 ml			

Email Potential Supplier 2

It costs about \$150.00 to produce an embryo (this includes donor hormones, flushing fees, average \$20.00 semen and travel)

Email re Angus Embryos

Here are a few options we currently have available for frozen embryos for sale:

\$1,000 xx DREAM NZCJ45 X USA18170041 SYDGEN ENHANCE – J45 IS A MATERNAL SISTER TO THE TWO PREVIOUS AUSTRALIAN RECORD PRICED COWS, ONE OF Y301'S BEST BREEDING DAUGHTERS

\$1,000 KENNYS CREEK WILCOOLA J228 X USA18170041 SYDGEN ENHANCE - DAM PURCHASED FOR \$18,000, HAS PRODUCED OUR TOP PRICED BULL AND SOLD IN EXCESS OF \$20,000 IN EMBRYO SALES

\$900 KENNYS CREEK WILCOOLA NDIJ228 X USA18181757 G A R FAIL SAFE - DAM PURCHASED FOR \$18,000, HAS PRODUCED OUR TOP PRICED BULL AND SOLD IN EXCESS OF \$20,000 IN EMBRYO SALES

\$800 xx DREAM NZCL61 X SMPG357 PATHFINDER GENESIS – THESE EMBRYOS ARE VERY SIMILAR BREEDING TO OUR 2018 MELBOURNE ROYAL INTERBREED CHAMPION HEIFER

\$800 xx DREAM NZCL61 X NBHL348 CLUNIE RANGE LEGEND - L61 IS A DUGHTER OF OUR J45 DONOR, SIRED BY ARDROSSAN HONOUR, LEGEND CALVES ARE STANDOUTS

Prices are per embryo and +gst, we offer a 50% guarantee on conception for all embryos sold, implanted by a mutually agreed technician.