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European Innovation Partnership (EIP) Wales

Introducing fat-tailed sheep to Wales to satisfy UK market demand

Final Report

February 2023

Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig: Ewrop yn Buddsoddi mewn Ardaloedd Gwledig
European Agricultural Fund for Rural Development: Europe Investing in Rural Areas

Llywodraeth Cymru
Welsh Government

LAFAN
Grŵp Ymgynghori Lafan
Lafan Consulting Group

FARMGENE
artificial breeding services

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Introduction

In the early 1990s, Anglesey farmer Peter Williams left home to work on a 30,000 head sheep farm near Riyadh in Saudi Arabia. Here he worked with Romney ewes which were crossed with the native fat tailed rams.

Thirty years later, looking for diversification on his Anglesey farm, Peter established that there were no fat tailed breeds of sheep in the UK. This gave him the idea to try and import some to see how they would fare in Wales. In 2018 he chatted with another farmer Bedwyr Jones who farmed in Snowdonia about his idea.

They discussed how, following Brexit, diversification would be even more important and what novel enterprises could bring in additional streams of income to safeguard their businesses. Peter told Bedwyr about the research that he had done with regard to fat tailed sheep with numerous retailers, restaurateurs and abattoirs. He was convinced that there was a gap in the market and that this speciality meat, already popular in many countries, could also appeal to a niche market among ethnic communities in the UK. Peter and Bedwyr decided to take the idea forward together and to initially assess the viability of fat tailed sheep in the UK.

They sought advice from Farming Connect and were advised to apply for support through the European Innovation Partnership (EIP) Wales, which provides funding and expert guidance for developing new ideas and innovative projects on farms. Retired Vet, Tricia Sutton then joined them as a technical advisor for animal health and welfare issues.

Geraint Hughes, their appointed EIP Innovation Broker, helped them to submit an EIP group application for financial support and the additional specialist knowledge needed to turn their ideas into reality.

Because of Animal Health import regulations, it was established that Australia could be a source of fat tailed sheep embryos and semen as they have a similar health status to the UK. The most accessible fat tailed breed in Australia is the Damara.

The Damara Breed

The Damara is a breed of sheep that originated from Egypt then moved down to Namibia and Angola. For over 1000 years Damara were herded by the local inhabitants the Himba and Kam Karrin Hottentot tribes in an isolated region in north western Damara area of Namibia and southern Angola.

The commercialisation of the breed started at the Omatjienne Research Station near Otjiwarongo in Namibia in the late 1950's and early 1960's. Information from Omatjienne generated interest in the breed in South Africa and led to the importation of and the eventual establishment of the South African Damara Breeders' Society in 1992. Damara embryos were first imported into Australia in 1996.

Damara reach sexual maturity at 7 months of age and are non-seasonal breeders, i.e they cycle naturally all months of the year. The tail comprises 5-6% of the carcass weight in a Condition Score 3 Damara.

It has been reported in the scientific literature that Damara have a higher capacity to obtain more nutrients from low-quality pastures. This efficient digestion of high fibrous diets is known to lead to the occurrence of high levels of branch chain fatty acids (BCFA) in Damara tail fat and tissues might be important due to the potential health effects in humans. BCFA have shown antitumoral activity in human cancer cells and also reduce the incidence of necrotizing enterocolitis, a devastating intestinal disease affecting premature infants.

Brae Park Damaras

Several sources of fat tailed sheep were identified by Geraint Hughes as suitable candidates for the purchase of pedigree embryos and semen. When deciding on a breed of fat tailed sheep to import there were several considerations. We had to choose a breed which had a good chance of adapting to British weather conditions and environment. There were cost implications as we had a budget to work to. The embryos and semen had to come from a country which had a similar health status to the UK and they had to come from a

flock which had carried out appropriate health monitoring over several years. Following research on various websites, we found that the Damara breed had several useful characteristics. These may or may not be transferable to the UK farming situation.

As far as breed was concerned, Damara fat tailed sheep had the physical characteristics required.

A Damara ram with its fat tail.

Damara are reported to exhibit a high level of immunity to African internal parasites. If this also applies to internal parasites found in Britain, it could be a big plus considering current internal parasite resistance to many wormers. Damara have long life expectancy partly due to very tough teeth. As the majority of British ewes are culled due to 'broken mouths' this again is a good point in their favour if transferable to UK farm management.

There is a variety of stated fecundity varying from twins in 5 to 10% of births, through 3 lambs in 2 years to an average of 2 lambs. This will probably vary with conditions and would hopefully be on the higher side in the UK.

Brae Park Damaras fulfilled the necessary health requirements and were very helpful and forthcoming when contacted. When all these things were taken into account it was decided to proceed with Brae Park Damaras as a source for our fat tailed sheep.

Brae Park Damaras are a purpose-built Damara Stud, in the high country of the Great Dividing Range, 18 kms from Oberon NSW, Australia. They are a Member of the Damara Sheep Breeders Society of Australia. They maintain a flock of purebred Damara sheep, with a diverse gene pool. They breed purebred rams and ewes for commercial farmers and hobby farmers.

Brae Park Damaras have exported semen and embryos to the United States of America and semen to New Zealand.

Brae Park Damara run a closed flock and have only introduced rams from two other Damara Studs in the last 6 years. The first of these ram introductions involved purchasing the last frozen embryo rams imported from South Africa at Sherana Stud Queensland in 2013 and 2 rams from Jarrara Stud Victoria in 2018.

Embryo and semen collection in Australia

Apiam Genetic Services, Dubbo, NSW, Australia operate an EU approved Ovine Semen Collection Centre in Dubbo New South Wales, Australia. Dubbo is the closest EU approved semen collection centre to Brae Park Damara. Apiam Genetic Services froze semen from two Damara rams and collected embryos from four Damara ewes. The embryo collection required two super ovulation programmes. The number of rams (2) and donor ewes (4) was limited due to the EU requirement that both rams and ewes be scrapie genotype ARR / ARR. The incidence of the scrapie genotype ARR/ARR in the Damara breed is low.

Due to a problem with embryo production at the first flushing in Australia, a second embryo collection programme had to take place resulting in the embryos and semen arriving in the UK a month later than expected.

Farmgene's role in the project

Farmgene is a small ruminant AI / ET company based at Shrewsbury, Shropshire. Ian McDougall is the main veterinary surgeon and has 34 years' experience in artificial breeding in small ruminants. Farmgene facilitated the importation of the semen and embryos collected by Apiam Genetic Services.

Timeline of project breeding activities	
Prior to May 2019	Australia: The selection of Damara ewes and rams based primarily on scrapie genotype.
6th May 2019	Australia: Damara rams and ewes commenced quarantine at Apiam Genetic Services, Dubbo New South Wales, Australia.
6th September 2019	Australia: First embryo collection programme. (See Appendix 1 for Super ovulation programme).
14th October 2019	Australia: Second embryo collection programme.
During September & October 2019	Australia: 150 straws of semen frozen from 2 rams.
3rd December 2019	Australia: 29 Damara embryos & 150 straws of Damara semen were shipped to Farmgene, Shrewsbury UK and arrived on 6th December 2019.
10th December 2019	Great Britain: 15 embryos were thawed and transferred into 15 recipients. (See Appendices 2,3 &4)
10th December 2019	Great Britain: 25 Welsh half- bred were inseminated with Damara semen. (See Appendices 8 & 9)
14th December 2019	Great Britain: 25 Welsh half bred ewes were inseminated with Damara semen.
23rd November 2020	Great Britain: 55 commercial ewes of mixed breeds were inseminated with Damara semen
23rd November 2020	Great Britain: 12 recipients were implanted with frozen Damara embryos
23rd February 2021 to 23rd March 2021	Great Britain: Semen frozen from three British born Damara rams
1st December 2021 to 13th December 2021	Great Britain: Semen frozen from one British born Damara ram
9th December 2021	Great Britain: Embryo transfer programme conducted on three British born Damara ewes. All embryos frozen.

Imported frozen embryo thaw and implantation programmes

The embryos were collected by Apiam Genetic Services on day 6 after insemination and frozen in 10% glycerol.

Two frozen embryo implant programmes were conducted. Prior to implanting, the recipients were programmed as per the Farmgene recipient preparation protocol (See Appendix 2). Only recipients which had demonstrated standing oestrous marked by a vasectomised ram, 7 days before the implantation date were implanted.

Day 6 embryos are usually of the late morula to late blastocyst stages. The embryos thawed were early morula to late morula stages, indicating that they were day 5-5.5 embryos. Early morula embryo in particular do not survive freezing and thawing as well as late morula to late blastocyst embryos. Some of the embryos suffered freeze and thaw damage and were down-graded. (See Table 1). This was reflected in the conception rate achieved. The embryos were thawed using the standard 3 step thaw process (see Appendix 3).

Table 1. Relationship between embryo stage and pregnancy rate 2019 and 2020

Embryo stage	*No. implanted*	*No. Pregnancies*	*% Pregnancy Rate*
Early Morula	7	0	0%
Morula Grade 1	9	9	100%
Morula Grade 2	1	1	100%
Morula Grade 3	1	0	0%
Late Morula	9	5	50%

Some embryos showed signs of freezing and thawing damage (Photos Appendices 5 & 6).

Table 2. Pregnancy rate by donor

Donor identity	*No. Embryo implanted*	*Pregnancy rate*
160228	7	43%
150168	3	66%
160256	13	61%
160240	4	50%

Table 3. Pregnancy rate by sire

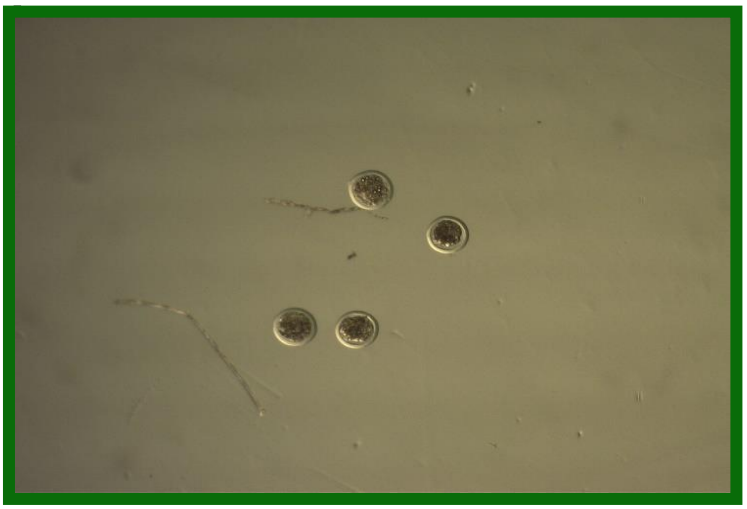
Sire Identity	*No. Embryos implanted*	*Pregnancy Rate*
140151 - Imp	12	33%
170306 - Paul	15	75%

Overall pregnancy rate was 15 pregnancies from 27 embryos implanted - 55%

The data reveal that the donor 160228 produced 4 x early morula stage embryos which resulted in no pregnancies. This is likely to be due to either the donor cycling late or the embryo development suffering due to compromised cell DNA. The early morula stage embryo does not readily survive freezing and thawing and when collected on day 5.5 – 6 is more likely to be suffering retarded growth making it poorly viable even when transferred direct to recipients (rather than being frozen). Under normal circumstances early morula embryos are not frozen, but are implanted fresh.

The ideal embryo stage to freeze on when collected on day 5.5 – 6 are grade 1 Morula, Late Morula, Early Blastocyst and Blastocyst stages.

Ewes inseminated with semen from 140151 had a lower prolificacy than the ewes inseminated with semen from 170306 (see Table 4 below). There may be a connection, 140151 may have semen with DNA fragmentation issues leading to a higher % of degenerate embryos that do not develop to full term.



Two poor quality and two reasonable quality frozen thawed embryos

Missing embryos

Only 1 embryo was recovered from a straw labelled to contain 3 embryos. These embryos were sired by 140151.

Pure imported Damara Progeny performance from Embryos implanted in Great Britain

- 6 live lambs born 1st and 3rd May 2020 with 1 assisted birth and 9 live lambs (5 male and 4 female) were born between the 15th and 18th of April 2021 with no assisted births. (See Table 4. below)
- Lambing occurred indoors under close supervision
- 100% survival to weaning for both programmes
- Colours varied with brown and white, black and white markings typical of the breed (see attached photographs)
- Birth weights ranged from 3.3kg to 6.5kg. Average 4.7kg.

Table 4.

DAMARA EMBRYO LAMBING DATA								
Recipient tag Tag	**DAM**	**SIRE**	**Date of Lambing**	**No. of Lambs**	**Sex**	**Birth Weight**	**Lamb Tag**	**Week 4 Weight**
2517	160256 MELBA	170306 - Paul	03/05/2020	1	F	4.7kg	4466	12kg
2861	160256 MELBA	170306 - Paul	02/05/2020	1	M	6.2kg	4465	17kg
3371	160240	140151 - Imp	01/05/2020	1	M	5.1kg	4463	16kg
3424	150168 GINNY	170306 - Paul	02/05/2020	1	M	4.7kg	4464	15kg
3372	160256 MELBA	170306 - Paul	01/05/2020	1	F	3.3kg	4461	12kg
4405	160240	170306 - Paul	01/05/2020	1	F	4.0kg	4462	14kg
								53 day Wt
2593	150168 GINNY	170306 - Paul	17/04/2021	1	F	5.6	4974	19kg
4870	160256 MELBA	170306 - Paul	16/04/2021	1	F	5kg	4968	16kg
2583	160256 MELBA	170306 - Paul	17/04/2021	1	M	5.7kg	4972	23kg
4190	160256 MELBA	170306 - Paul	15/04/2021	1	M	6.5kg	4967	22kg
6214	160256 MELBA	170306 - Paul	16/04/2021	1	M	5.7kg	4973	17kg
2424	160256 MELBA	170306 - Paul	15/04/2021	1	M	6.3kg	4969	22kg
4868	160228 ESSO	140151 - Imp	18/04/2021	1	F	4.3kg	4971	18kg
6152	160228 ESSO	140151 - Imp	17/04/2021	1	F	5.0kg	4975	22kg
6194	160228 ESSO	140151 - Imp	16/04/2021	1	M	5.6kg	4970	21kg

Comments

Only 4 lambs were born sired by 140151 – Imp compared to 11 progeny sired by 170306 – Paul. Three male progeny are the result of a unique sire/dam combination, 4464 (170306 x 150168), 4970 (140151 x 160228) and 4463 (140151 x 160240), are the only males of each combination. If the Fat tailed trait is to be continued into the future new lines of Damara or breeds exhibiting the fat tail trait will need to be sourced for use by 2023.

Meanwhile semen has been frozen from rams 4464, 4970 and 4463 as a form of insurance against their death or infertility.

Artificial Insemination and Damara cross progeny performance data 2019 – 2021

Semen Collection in Australia

Semen was collected from two pure Damara rams in Australia at the Apiam AI Centre in Dubbo, Australia during July 2019 over a 4-day period. Semen was frozen in 0.25ml straws using the semen freezing diluent Triladyl (Minitube, Germany) and exported to Great Britain in November 2019 along with the Damara embryos. The same rams that sired the embryos were used for semen collection. Semen quality was deemed adequate.

Pregnancy and Birth data for Artificial insemination programmes conducted in 2019 and 2020.

Fifty-four Welsh half-bred ewes were programmed for insemination at Farmgene AI Centre on 10th and 14th of December 2019, and a further 55 were inseminated on farm on the 23rd November 2020 to produce Damara F1 lambs for evaluation. The Farmgene AI protocol using Chronogest 20mg intravaginal sponges was followed (see Appendix 5) on all occasions. Of the 54 ewes commencing the programme in 2019, 50 cycled and were presented for insemination. All ewes programmed for insemination in 2020 cycled and were inseminated. A total of 105 ewes were inseminated, 53 to 140151 – Imp and 52 to 170306 – Paul. The ewes that repeated were served by a Texel ram and the Texel Cross lambs born were used as controls as they were farmed with the Damara F1 lambs.

There were differences between the conception rate and prolificacy achieved between the three insemination programmes with the overall conception rate being 70%. The variations in conception rate and prolificacy that occurred between the AI programmes were due in part to how the ewes responded to their management and the synchronisation programme. While the quality of the semen observed post thaw did vary from 30% to 40% progressive motile and 140151 appeared to have better quality semen once thawed, there appeared to be no significant difference between the conception rate achieved between the two imported rams over the three AI programmes and the average results were commercially acceptable.

There appeared to be a significant difference between rams with prolificacy with ewes inseminated with semen from ram 170306 having 7.6% more lambs.

If the average ovulation rate between the groups of crossbred ewes inseminated was similar then ova fertilised by semen from 170306 appear to have had a lower degeneration rate which might indicate that 140151 semen suffered from a degree of DNA fragmentation.

Ram 170306 also produced better quality frozen embryos which resulted in a better pregnancy rate and more lambs born which would support the above theory.

Table 5. Conception rate to AI by ram 2019 and 2020

Ram	No. ewes inseminated	10th December Conception rate / Prolificacy	14th December Conception rate/ Prolificacy	23rd November Conception rate/ Prolificacy
140151 - Imp	53	55% / 1.83	86% / 1.58	75% / 1.47%
170306 - Paul	52	38% / 2.4	100% / 2.00	70% / 1.62%

Table 6. Summary of Conception rate and prolificacy by ram 2019 to 2020

140151 - Imp	**53**	**71.6%**	**1.57**
170306 - Paul	**52**	**69%**	**1.69**
Summary	**105**	**70.4%**	**1.63**

7- Week-old pure Damara Ram Lamb

10-Week-Old Damara F1 Lambs

Damara F1 lambs born 2020 and 2021 to Damara insemination

- 149 lambs born from both programmes with 10 assisted births in 2020 and no assisted births in 2021.
- Lambing occurred outdoors.
- Numbers born: 2 sets of quads, 4 sets of triplets, 44 sets of twins, 36 singles
- 4 lambs died within 24 hours of lambing, 1 died from pneumonia and one was taken by a fox.
- Colours varied with black, white and brown markings. Fleece/coat varied with some lambs having more hair rather than wool, others with thick curly wool
- Birth weights ranged from 2.5kg to 8kg. Average 4.55 kg
- No creep was fed

Texel cross lambs born 2020 and 2021 from ewes not conceiving to Damara insemination

- 30 lambs born with 1 assisted birth.
- All lambing outdoors and farmed with Damara cross lambs
- 10 sets of twins, 7 singles
- All white lambs, most with woolly, curly coats
- Birth weights for all 30 Texel cross lambs ranged from 1.9kg to 8kg. Average 5.66kg

Growth rate performance of Damara F1 lambs revealed they grew significantly slower than the Texel cross lambs under the same management, grazing the same pasture (see data in table 7 & 8). Observations by Peter Williams, flock manager was that the Damara F1 lambs required less worm treatments, had less dags, did not suffer fly strike and had no greater incidence of lameness than the Texel cross lambs farmed in the same field.

By 127 days of age, Damara F1 lambs were 10% lighter than the Texel cross control lambs were at 115 days of age. (see Tables 7 & 8.) This is not surprising as the Damara has not been selected for growth rate performance. The difference in 49-day weight was in part due to the higher birth weight of Texel cross control lambs (1.1 kg heavier). The Texel cross lambs grew significantly faster between days 49 to day 127 (11.5 kgs for Damara cross lambs and 16.8 kgs (adjusted) for the Texel cross control lambs). During this period the lamb completed the transition from a monogastric to a ruminant, the Texel cross controls either had a greater appetite for pasture (possibly a greater rumen volume) or utilised the pasture consumed more efficiently.

The performance of the pure Damara lambs was superior to that of the Damara F1 lamb because all pure Damara lambs were reared as singles.

Table 7. Summary of pure Damara and Damara F1 lamb growth performance

Lamb Cross	Birth weight (kg)	49 day weight (kg)	127 day weight (kg) DWG Birth to 130 days (kgs/day)
Damara x males	**4.9**	**18.9**	**31.7** **0.211**
Damara x female	**4.2**	**16.1**	**26.2** **0.173**
Damara x average	**4.55**	**17.5**	**29.0** **0.192**
Pure Damara	**5.2**	**20.0 (53 day Wt)**	**30.8 (131 day Wt) 0.195**

Table 8. Summary of Texel cross lamb growth performance.

Lamb Breed	Birth weight (kg)	38 day weight (kg)	115 day weight (kg) DWG Birth to 1145 days (kgs/day)
Texel Control lambs	**5.66**	**18.2**	**32.0** **0.229**

Vet medicines summary for Damara EIP project 2019/20 and 2020/21

- All lambs given oral antibiotic prophylactic at birth
- The first Damara lamb born (4461) was slow to suckle and given extra colostrum by tube
- Coccidiosis drench given to Damara lambs at 3 weeks
- 4466 had intermittent black scour and received coccidiosis drench twice
- All growing well to 29/6/20
- Wormer given in case of Nematodirus spike after dry weather in May
- Damara x lamb –4482 had mild entropion which cleared with topical eye ointment
- At 3 weeks old, 2 ewes had mastitis and responded to antibiotic and anti-inflammatory.
- Damara cross lambs 4490 and 4493 were taken off the ewe with quads
- One lamb 4481 was taken off ewe with triplets and reared on bottle.

New Born Damara Lamb

Semen collection and freezing.

During 2021 semen has been collected and frozen from 4 British born Damara rams.

Table 9. Semen Storage Summary below.

Breed	Date in	Ram name	Ram id	Type	Rating	Actual doses	Destination
DAMARA	07/12/2019	BRAE PARK 140151	140151	S1	xxx	24	Domestic, Australia
						24	
DAMARA	07/12/2019	BRAE PARK 170306	170306	S1	xxx	23	Domestic, Australia
						23	
DAMARA	23/02/2021		4463	S1	xxxNFS	6	DO NOT SELL!
DAMARA	02/03/2021		4463	P1	xxxBronze	26	Domestic
DAMARA	09/03/2021		4463	S1	xxxNFS	8	DO NOT SELL!
DAMARA	16/03/2021		4463	S1m	xxxSilver	9	Domestic
DAMARA	23/03/2021		4463	S1m	xxxSilver	23	Domestic
						72	
DAMARA	16/03/2021		4464	S1m	xxxNFS	23	DO NOT SELL!
DAMARA	23/03/2021		4464	S1m	xxxBronze	11	Domestic
						34	
DAMARA	23/03/2021		4465	S1m	xxxNFS	31	DO NOT SELL!
						31	
DAMARA	01/12/2021		4994	S1	xxxBronze	14	Domestic
DAMARA	03/12/2021		4994	S1	xxxSilver	17	Domestic
DAMARA	13/12/2021		4994	S1	xxxSilver	28	Domestic
						59	
					TOTAL	**243**	

Due to the nervous nature of the rams they had to be collected by electro ejaculation. Semen was diluted in the proprietary semen diluent TRILADYL (Minitube Germany) and frozen in either pellets on dry ice or in 0.25 or 0.5ml straws in liquid nitrogen vapour. Following freezing, a sample of semen from each ejaculate was thawed and assessed for progressive motility, spermatozoa morphology and number of normal progressive motile spermatozoa per dose (ie per pellet or straw). The industry standard if 20 million normal progressive motile spermatozoa per dose post thaw. Farmgene use Computer Aided Semen Assessment (CASA) to determine post thaw quality, which is more accurate than the human "eyeball" semen assessment.

A total of 128 good quality straws of semen have been collected with an additional 68 straws of marginal quality semen held in reserve. (See Appendix 7 for a description of semen quality assessment criteria.)

The project still has imported semen in store; sire 170306, 23 straws and sire 140151, 24 straws in store.

Embryo Collection and Freeze

In December 2021 an embryo flush and freeze programme was conducted whereby embryos were collected from three British born Damara donor ewes that were super ovulated then inseminated with fresh semen from a British born Damara ram, 4994. The ewes, 19 months old, were synchronised with a plastic progesterone impregnated device (CIDR) inserted into the ewe's vagina for 13 days and super-ovulated with a single injection of PMSG and FSH (pituitary hormone) 2 days before the CIDRs were removed.

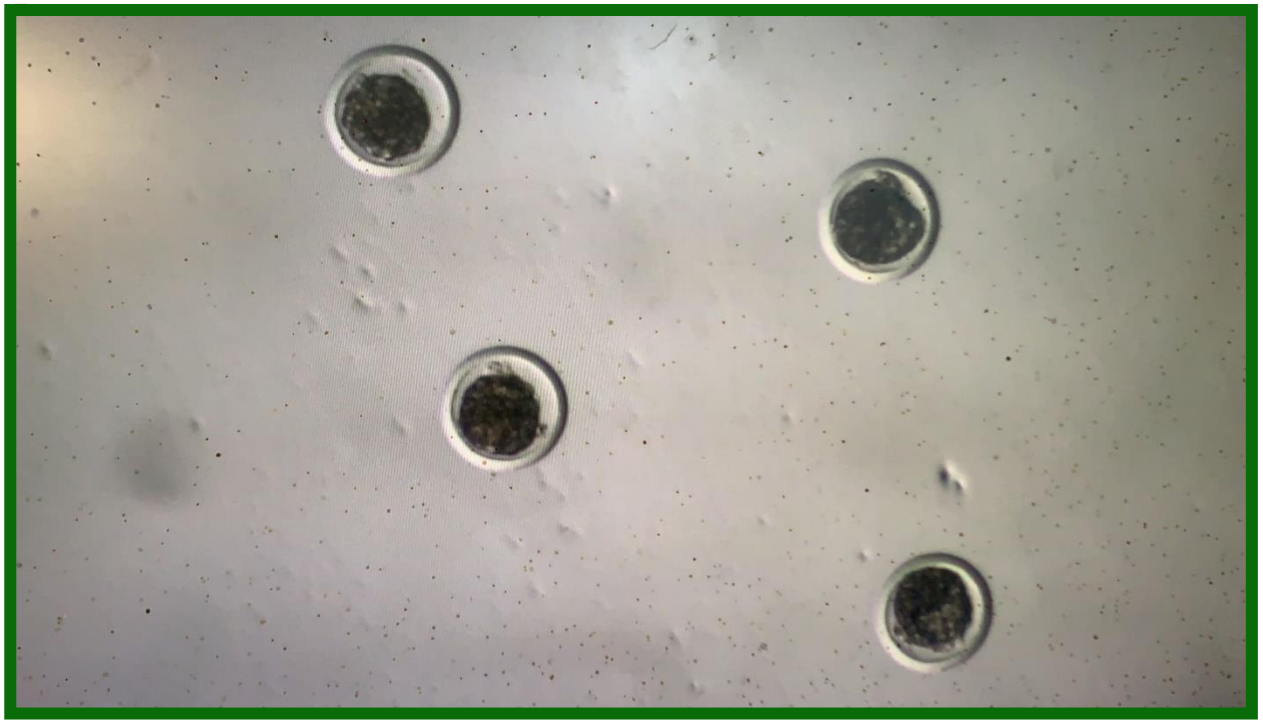
(See Appendix 10 for ET programme details). Two days after CIDR removal the ewes were inseminated via laparoscopy with fresh semen collected from ram 4994.

Donor Data Embryo Flush & Freeze Programme

Table 10.

Breed	ET DAY Donor	Sire	Ufo	Degen	Frozen	Total	% Fertilised	% Useable	AI DAY Semen state
DAMARA	UK070392104461	UK070392104994	0	0	5	5	100	100	Fresh
DAMARA	UK070392104462	UK070392104994	0	1	4	5	100	80	Fresh
DAMARA	UK070392104466	UK070392104994	0	0	3	3	100	100	Fresh

A total of 12 grade 1 embryos were collected and frozen - average 4 per donor. (See Appendix 8 for ET programme summary). While super ovulation was low, the fertilization was very good resulting in 92% of ova ovulated being suitable for freezing. Embryos were frozen in 0.25ml straws using the cryoprotectant glycerol and stored under liquid nitrogen for future use.



Grade 1 fresh Damara embryos collected for freezing from donor ewe 4462 on 09/12/21.

The success of this ET programme demonstrates that embryo transfer can be utilised to rapidly increase the number of pure Damara in the future if required.

Damara flock management 2021/22

In mid-October 2021, 27 Damara F1 hogget ewes were naturally mated to 3 Damara rams 4463, 4464 & 4465 along with 80 Texel cross mixed age ewes. The Damara F1 hoggets scanned 134% compared to 160% scanning for the Texel cross ewes. Lambing is due to commence from March 10th 2022.

The three purebred Damara ewes which were flushed in December 2021 were naturally mated to 4464 after the ET programme and all appear to have held within 7 days of flushing. These ewes are due to lamb mid-May 2022.

Damara the breed, Damara Môn – the product.

When slaughtered, the Damara has a unique carcass, with fat distributed predominantly in the tail, (see photo of Damara F1 carcass on page 14). The carcass and meat from Damara lamb, hogget and mutton has been branded as Damara Môn (see below). While the tail is much smaller than that of the Awassi (see page 14 photo on right), there is more lean meat in the Damara Môn F1. Note the low level of subcutaneous fat in the cutlets pictured on page 15.

A whole Damara F1 carcass – note the large tail. Awassi lamb in a Kuwaiti butcher

A nearby slaughterhouse was used, Snowdonia Meats, that is prepared to slaughter and butcher small numbers of sheep and vacuum pack the cuts of meat in customized printed packaging. https://cigeryri.cymru/abattoir-services/ . If the Islamic market is to be serviced then the carcasses need to be Halal Certified, a form of slaughter as defined in the Koran. Snowdonia Meats do not carry out Halal slaughter.

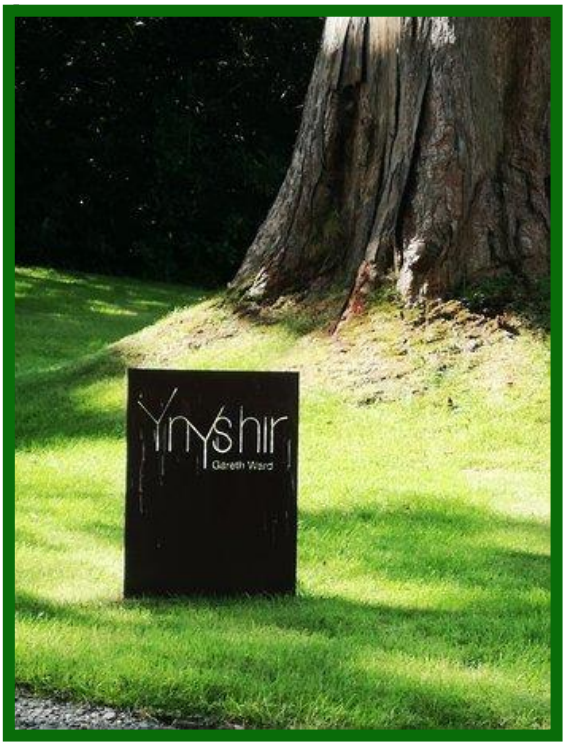
Gower Salt Marsh Lamb also provided information on packaging frozen meat using the WoolCool system, see photos on page 15. https://www.woolcool.com/food/ . Frozen lamb packed in WoolCool with a freezer brick will remain frozen for 24 hours, enabling direct sales to be made to the public. This “sheep based” and environmentally sensitive packaging solution is currently being trialled by Peter Williams.

Damara Môn lamb in WoolCool packaging

Marketing Damara Môn.

The Damara Môn brand with logo (see below left) was launched and good levels of publicity obtained in the print and TV media “Damara Môn”. A Facebook page https://www.facebook.com/DamaraMonUK/ and WhatsApp group were also established. The Damara Môn brand is applied to all meat carrying a proportion of Damara genetics.

DAMARA MÔN



During 2020 and 2021 Peter Williams canvassed numerous meat wholesalers, restauranteurs, specialist supermarkets, Middle Eastern embassies and celebrity chefs with the view to getting Damara Môn onto shelves and menus. However, with the hospitality industry badly affected by the coronavirus pandemic, progress has been slow.

Advanced discussions have been held with Restaurateur and Chef Gareth Ward who owns and operates the double Michelin star restaurant Ynyshir, near Machynlleth, Wales. Samples of Damara Môn have been trialled by Gareth. If Gareth was to incorporate Damara Môn into his menu and this was able to be widely publicised, further sales into the gourmet restaurant trade and beyond might eventuate as Gareth is well known within the gourmet restaurant trade.

"Gareth Ward runs the double Michelin star restaurant Ynyshir Restaurant in Powys, named Best Restaurant in Wales at the National Restaurant Awards 2018 – so it's fair to say, he knows his way around cooking Welsh lamb." excerpt from Wise Living Magazine.

Peter Williams also visited Gower Salt Marsh Lamb https://www.gowersaltmarshlamb.co.uk/about-us.html and observed how this successful family run business operates. Gower Salt Marsh lamb, market approximately 1,000 Gower Salt Marsh lamb carcases annually, using a combination of outlets; via bricks - the farm shop, via clicks - the online portal and through four local restaurants

Conclusion:

The collection, importation of and pregnancy rate results achieved from the frozen embryo implants and frozen semen inseminations conducted in 2019 and 2020 were a success. Despite 4 poor quality embryos being imported and 2 embryos going "missing" the over-all pregnancy rate from implanting the frozen Damara embryos was 51.7% which is within commercial expectations. Artificial insemination using frozen Damara semen resulted in commercially acceptable pregnancy rates (70%). This should give the participants the confidence to import more embryos and semen if required. The success of the embryo flush programme proves that this technology can be utilised in the future to multiply numbers of pure Damara.

The growth rate performance of purebred and crossbred Damara lambs has been assessed. The pure Damara, and F1 Damara lambs grew more slowly to 130 days of age than Texel cross lambs similarly managed, grazing the same pasture.

The prolificacy of the F1 Damara shearlings (136%) was 20-25% lower than what would be expected from standard crossbred ewes of the same age, grazing the same pasture.

The slower growth rate of Damara x lambs and the lower prolificacy of the Damara x ewes will result in a lower kgs carcass weight produced per hectare per year. This will need to be taken into consideration when settling on any sale price of meat per kg.

Favourable comments have been received from individuals eating Damara Môn but no detailed taste comparison testing has been conducted. The coronavirus pandemic made marketing Damara Môn to the hospitality industry very difficult and as yet no firm commitments exist with any restaurants, meat wholesalers or Islamic butchers.

Comments from the group

Comments from Peter Williams

In many countries around the World, Damara lamb meat is prized and is considered to be the best. I first came across the breed when working in Saudi Arabia as a shepherd in the late 80s.

Through the project, we imported semen and embryos, introducing Damara as a new sheep breed to Wales and the UK.

The lambs were very lively at birth, keen to suckle and on their feet very quickly.

The lambs were monitored carefully, and results show that they thrived and coped well with the Welsh climate. They appear to be unfazed by the rain and seem happy here out in the fields.

Through our breeding programme, we now have purebred fat tail ewes on the ground in Wales.

We are now developing a route to market for the 'Damara Môn' brand, to promote the distinct eating experience we can offer.

Comments from Geraint Hughes, Lafan Consulting Group – the project Innovation Broker

Introducing a new breed of sheep to the UK is an accomplishment for all involved with this project, in particular the farmers for having the vision in the first place.

Innovating can be a lonely occupation, and I'm convinced that it was 'EIP Wales' that made the difference to allow Peter Williams, Bedwyr Jones and Tricia Sutton, the Operational Group members, to realise their goal of bringing the Damara breed over to Anglesey. Through the project they have been able to examine the resulting progeny for their adaptability, suitability and viability.

Seeing the Damara lambs prancing in Peter's fields for the first time is a moment I'll forever treasure, and one that 'EIP Wales' can stake a claim for making possible. The programme is far more than just a sum of money. It provided the specialists to guide the group, and exposed raw ideas to the rigor of science. It provided the framework to give the group the confidence to dare think what they might have thought was "impossible" could be pulled off. It wasn't easy, especially importing the genetic material, but they succeeded.

This report shares the findings from this project. At a time when the sheep industry faces multiple "once in a generation" change and disruption, innovating has never been so valuable in my opinion. There are well over 1,000 sheep breeds on the planet, and with far less than 10% in the UK, there must be further opportunities to broaden the genetic base in Wales to develop new markets.

The farmers have gone from strength to strength and have been able to capitalise from further support from Farming Connect to progress with their impressive 'Damara Môn' brand that sold its first meat box in September 2022 online. Targeting the growing interest in north Africa and Middle East cuisine, the group has developed a strong proposition for foodies hungry for a unique eating experience, or indeed seeking a "taste of home" in the UK. I look forward to having my 'Damara Môn' dish in a quality restaurant soon. "Pob lwc" and "llongyfarchiadau" to the members.

Recommendations

The following questions require answers:

A. Is the Damara Môn project to remain wholly Damara fat tail based or to include genetics of other fat tailed breeds?

B. Is Damara Môn lamb/mutton to be marketed to the Islamic population of Britain some of whom are familiar with eating fat tailed lamb/mutton when visiting the country of their ancestors (North Africa, Pakistan, Bangladesh, Middle East)?

C. Can Damara Môn lamb/mutton be marketed as a specialist premium meat, sold to gourmet restaurants and direct to consumers who would be prepared to pay more for a unique eating experience?

D. How will the supply chain of Damara Môn work, what is the cost of production, what are the risks and who is the risk taker regards the possible production of "unsaleable" product? (Identify, quantify).

A. To remain wholly Damara or to include other fat tailed breeds.

The project has a brand and logo based on the Damara breed and a location, Môn. The pure Damara is difficult to farm as the sheep are more feral than domesticated. Other fat tailed breeds such as Awassi, Van Rooy and Karakul are more domesticated and easier to farm. The location restriction hopefully won't be a problem even if the concept becomes extremely popular.

It is now possible to import from Australia, semen and embryos of other fat tailed breeds as well as Damara without scrapie genotype restrictions, making importing new genetics relatively simple. The Damara flock will require new bloodlines by October 2023. It is not possible to import live sheep from Australia.

B. The Islamic market.

Fat tailed sheep are commonly found in the Middle East, North Africa, Pakistan and Bangladesh where the population is predominantly Muslim. The British population contains over three million Muslims. Muslims account for more than 20% of UK sheep meat consumption (24% of lamb and 16% of mutton) despite comprising just 5% of the population.

While 94% of first-generation Muslims eat only halal meat, (a form of slaughter as defined in the Koran) and may find consuming fat tailed lamb desirable, this figure declines to 90% and 81% for second and third- generations. More than 60% of halal consumers eat lamb at least weekly, compared with just 6% of the general UK population.

With a disproportionately young Muslim population in the UK, 33% are under 15 years old compared with a national average of 19%, the reliability of halal demand (and demand for fat tailed lamb) could wane when the next generation become household shoppers.

The consumption of lamb within the Muslim population increases around Ramadan and two specific festivals, Eid-al-Fitr - Festival of Breaking the Fast and Eid al-Adha - the Festival of Sacrifice (See Table 11). On these sacred days, it is traditional for Muslims who are financially able, to sacrifice an animal (one sheep or goat for one person and his/her family). In Britain this translates to an increase in the demand for chilled lamb/mutton from Islamic butchers. The Muslim calendar is based on the lunar month making the lunar year 11 days shorter than the solar year (365 days). Consequently, the Islamic holidays are moving forward by an earlier date of 11 days each year.

The Islamic market requires lamb that is older than 6 months of age and mutton (older than 12 months). If the Islamic market is deemed to be significant, then production of suitable Damara Môn lamb/mutton will need to be timed accordingly.

Table 11. Ramadan and festival dates

Year	Ramadam	Eid-al-Fitr (festival of breaking the fast)	Eid al-Adha
2022	2nd April to 2nd May	2nd May	9th July
2023	23rd March to 21st April	21st April	28th June
2024	12th March to 10th April	10th April	17th June
2025	1st March to 31st March	31st April	6th June

AHDB publication "Consumer Insights" June 2020 made the following points about the Halal meat market.

"Specialist meat shops or butchers are the key channel for more than half of halal consumers. These local independents, often operated by Muslims, are felt to be more trusted as to the requirements of halal meat; while a third of halal consumers appreciate the convenience and personal service of their local ethnic shop.

Supermarkets are less widely used. Only 27% of halal consumers regularly shop at a supermarket for halal meat, compared with 81% of the general population, who use a supermarket weekly for buying meat. Over three-quarters of halal meat is bought fresh from the counter. Clear halal certification is vital for retailers. When deciding where to buy halal meat, the top priority for halal consumers is that products display halal certification.

Having halal certification is five times more important to halal consumers than the retailer having a good range of options, and ten times more important than acceptable prices. Halal certification is deemed by many halal consumers to be a mark of assurance that the product has been produced under strict guidance and supervision. There is a preference for retailers to label halal meat in both Arabic and English".

Damara Môn may appeal to the wealthy Islamic consumer as it will more closely resemble the type of lamb/mutton they may have consumed while in their home land visiting friends and relatives. The visual appearance of the Damara Môn carcass with its fat tail on display in specialist Islamic butchers' shops may be what is required to drive sales around these festival dates.

Market research needs to be conducted to ascertain if there is a viable Islamic market for Damara Môn lamb and mutton, and if so, what cross and age is best received, the 50%, 75% or pure-bred Damara Môn. This would have a major bearing on future production targets. The research would also have to gather data on the acceptable age range of Damara Môn, chilled or frozen, any bias of sex and ideal carcass weight. Taking into account the AHDB findings that specialist butchers are the key channel for more than half of halal customers and that these outlets would be best suited to market a premium product, the preferred presentation of the product also needs to be identified – whole carcasses, primal cuts, offal etc. Marketing whole carcasses will simplify the management of the supply chain.

Peter currently has 27 x 22-month-old and or 37 x 10-month-old 50% Damara F1 rams that could be used to test the Islamic market between April 2nd and May 2nd. (Check that the 22-month-old rams have palatable meat before attempting to market carcasses or samples).

Damara Môn lamb/mutton would have to be Halal certified, labelled in English and Arabic, supplied fresh and supplies timed to periods of greatest demand (Festival dates listed above). The local slaughter house identified by Peter Williams does not practice halal slaughter so an alternative slaughter house needs to be found.

C. The specialist Premium Lamb market

Damara Môn has been promoted to a double Michelin star restaurant Ynyshir, near Machynlleth, Wales. No sales have yet been achieved. Peter Williams has also been investigating the box lamb concept. There are currently a number of premium brands of lamb available to the British consumer, some are listed below in Table 12.

Table 12. Lamb price comparison

Lamb origin	Cutlet £ Per kg	Leg of lamb £ Per kg	Point of Difference
Tesco (chilled)	£14.20	£14.00	Low Price
PGI Welsh Lamb (chilled)	£16.00	£15.00	Location, Quality
Waitrose Lamb (chilled)	£20.00	£15.00	Quality
Gower Salt Marsh Lamb (frozen)	£35.00	£20.00	Flavour, Location
Te Mana Lamb (NZ price frozen)	£34.50	£20.00	Eating Quality, health

Any premium lamb must have a point of difference. (POD). Te Mana lamb originates from NZ, from a specific breed of sheep that produce lamb with high intramuscular fat, high Omega3 content and a unique extremely tender melt in the mouth eating experience; Welsh lamb has PGI status, Gower Salt Marsh Lamb is reared on salt marshes (diet, flavour and location). Damara Môn needs to identify a POD; a unique eating experience which will increase demand for the product.

Damara are African genetics and therefore unique to all other breeds of lamb available to the British consumer. A composite breed in Australia that contains 37.5% African genetics has a unique fat composition that translates as low melting point fat. Research conducted by Tattykeel Australian White Pty Ltd and the CSIRO Australia, concluded that 75% (F2) Tattykeel Australian White lambs had an average fat melting point of 37 degrees Celsius whereas the fat of lambs of other breeds generally melts between 42-48 degrees Celsius. The lower melting point fat confers a unique and luxurious eating experience, greater tenderness and higher levels of Omega3 fats that equates to health benefits.

According to Graham Gilmour, of Tattykeel Australian White Pty Ltd, “Our pure-bred lambs’ melting points are showing a range between 28 and 39 degrees, with an average of 34 degrees.” Tattykeel Australian White have launched a brand of lamb “MARGRA LAMB” which carries these meat-eating qualities. https://www.margralamb.com/our-story/

It is possible that Damara Môn may also have a unique fat composition that could concur low melting point fat, a unique flavour, tenderness, luxurious eating experience and health benefits. The fat composition POD of the 50%, 75% (75% lambs due to lamb in April 2022) and pure-bred Damara Môn should be researched and documented. Tissue biopsies for analysis for low melting point fat can be obtained from the longissimus dorsi muscle and collected from live sheep under sedation and local anaesthetic by a veterinary surgeon. See

"MARGRA Lamb Eating Quality and Human Health-Promoting Omega-3 Long-Chain Polyunsaturated Fatty Acid Profiles of Tattykeel Australian White Sheep: Linebreeding and Gender Effects" (Google Scholar – free access). The Food technology Centre at Llangefni could be approached to conduct the necessary laboratory analyses.

Taste panel trials where consumers are asked to score different crosses of Damara Môn on meat quality attributes; tenderness, juiciness, flavour, aroma and overall liking should be conducted. The taste panel trials would need to target a cross section of potential consumers including members of the Islamic community.

D. Cost of Production / Production and Supply of Damara Môn

Damara Môn F1 ewes are less prolific than the standard Welsh crossbred ewe and the Damara F1 lamb grows more slowly than the Welsh Texel cross prime lamb. If a meat-eating quality POD is identified in the Damara F1, then the increased cost of production only relates to the slower growth of the Damara Môn F1.

If, however the POD is not clearly evident until the F2, then the cost of production is further increased due to the lower prolificacy of the Damara F1 ewe. If the POD is present in the F1 it would then be advisable in the future to trial the production of 37.5% Damara Môn by crossing Welsh ewes with F2 rams and then test the progeny for the presence of the POD. The F1 & F2 are easier and cheaper to farm, if the demand for Damara Môn increases, the supply of rams in quantity for breeding will be easier and cheaper, if the F2 Damara Môn ram over Welsh ewe suffices.

Establishing the correct Damara Môn supply chain requires knowledge of the ideal slaughter product - F1 versus F2 versus 37.5%, entire male, castrate/ewe, the ideal age and carcass weight of the slaughter animal. The Islamic market may require very different product specifications than the specialist premium lamb market. Once these product specifications have been identified, the cost of producing this/these products can be worked through. Considerable forward planning will be required in order to have sufficient lamb/mutton available for sale at the appropriate time.

If the Islamic market is to be catered for, production will need to match peak demand which in 2023, 2024 and 2025 occurs during the months of March, April and June. Product with the correct specification would need to be available during these months. With traditional lambing taking place in March – April the product supplied would be hogget. There are costs involved in retaining lamb over the winter to cater for the Islamic market.

The Islamic market may fit well with the premium lamb market (which may prefer a younger lamb under 12 months of age) as the Islamic market could be used to mop up lambs not sold into the premium lamb market.

If the lamb produced is not able to be sold for the premium required to make the project viable, a significant loss may be incurred as the British lamb/hogget market may only purchase the left-over stock at a significant discount to the cost of production. Who would bear this loss, the Damara Môn lamb producers (Bedwyr Jones and Peter Williams) or the marketing organisation? Conversely if insufficient lamb is available to satisfy demand, the investment of time, energy and money into the promotion of Damara Môn may be wasted.

Premium lamb products Te Mana lamb and Gower Salt Marsh lamb are marketed frozen. Gower Salt Marsh Lamb is shipped using the WoolCool insulation concept. Being able to market frozen lamb simplifies the slaughter and storage of the final lamb product but does add the cost of maintaining a freezer store. It is likely that the Islamic market will require chilled product.

Mating occurs in November so POD research (tissue analysis and consumer taste trials), Islamic consumer market research and cost of production pipeline decisions should be completed by the end of October 2022.

A decision must be taken soon if F1 and F2 male Damara lambs born in April are to be castrated or not. The meat quality of rams older than 12 months may be compromised by the presence of skatole in the fat - "ram taint". This is not a problem with entire male lambs under 12 months of age but may be a problem in the 27 x 22-month-old F1 Damara rams.

The brand "Damara Môn" should be registered/trademarked. A Damara Môn business needs to be established for accounting purposes, to enable accurate costings to be identified and to take advantage of grants and R&D Tax Relief.

Week old crossbred Damara lambs and a recipient ewe

Damara ram with Damara cross hoggets and Texel cross ewes.

September Damara ET programme			
	Donors	4	
DAY	**DATE**	**TIME**	**DONORS**
0	Friday, August 16, 2019 (By Wed AM)	**Any**	**Insert CIDR**
10	Monday, August 26, 2019	**AM**	**Add CIDR**
11	Tuesday, August 27, 2019	**7:00 AM** **6:00 PM**	**3.0 mL Follitropin** **1.0 mL Estrumil** **2.5 mL Follitropin**
12	Wednesday, August 28, 2019	**7:00 AM**	**2.0 mL Follitropin**
		6:00 PM	**1.5 mL Follitropin**
13	Thursday, August 29, 2019	**7:00 AM** **10:00 AM** **6.00pm** **6.00pm** **6.00pm**	**1.0 mL Follitropin** **1.0 mL Follitropin** **1.0 mL Pregnocol (PMSG)** **Pull CIDR**
14	Friday, August 30, 2019	**7:00 AM**	**0.5 mL Follitropin**
			Add teaser ram
		6:00 PM	**0.5 mL Follitropin if not on heat**
15	Saturday, August 31, 2019	**8:00 AM** **4:00 PM**	**AI Donors Fresh semen** **RE AI Donors Frozen Semen**
20	Thursday, September 05, 2019	**5:00 PM**	**Starve Donors**
21	Friday, September 06, 2019	**8:00 AM**	**Flush Donors and freeze embryos**

APPENDIX 2. RECIPIENT IMPLANT PROGRAMME 2019

Peter Williams	Frozen Embryo Implant Programme	
DATE	**TIME**	**RECIPIENTS**
Sunday, November 03, 2019	**Any Time**	**Bolus recipients with Iodine, Selinum & Cobalt** EG: Agrimin 24.7 Smart Trace for breeding ewes. **NO Copper**
Friday, November 08, 2019	**Any Time**	**Add teaser rams to ewes**
Tuesday, November 19, 2019	**Any Time**	**Insert CIDRS** **Remove Teasers**
Friday, November 29, 2019	**Anytime**	**Inject 1ml Estrumate**
Sunday, December 01, 2019	**8:00 PM**	**Pull CIDRS** **Inject 2.0mL PMSG intramuscular** **Add raddled teaser rams**
Tuesday, December 03, 2019	**8:00 AM**	**Remove or mark recipients on heat and record**
Wednesday, December 04, 2019	**12:00 PM**	**Remove or mark recipients on heat and record** **Recipients not marked are unsuitable for implantation**
Sunday, December 08, 2019	**Afternoon**	**Starve recipients**
Monday, December 09, 2019	**4:00 PM**	**Implant recipients**
Monday, December 16, 2019	**Any Time**	**Add Chaser ram**

Note:

Do not programme any ewes that are lame, skinny or excessivley daggy when compared to the group.

Put ewes onto good grass when sponges are inserted

Keep recips stress free after implanting.

The crucial dates are the first 3 weeks following implanting.

APPENDIX 3. EMBRYO THAW PROTOCOL

Thawing 6 day Embryos Frozen in Glycerol

- Ensure that recipients have been on a rising plane for the 3 weeks prior to transfer. This is vital for an excellent result. Recipients must NEVER be in a negative energy situation.
- Ensure that selenium is adequate. If in doubt bolus recipients 2 months before implanting
- CIDR/Sponge pull from recipients should be 08:30 8 days prior to transfer.
- Inject 200 – 400 IU PMSG at time of CIDR/Sponge pull.
- Add teaser males with harnesses to ewes.
- Remove ewes marked by the teaser males 34 and 48 hours after CIDR/Sponge pull.
- Use ewes that are capable of cycling naturally at the time of embryo transfer, or use Regulin (implant 55 days prior to embryo transfer).
- Embryos transferred into unmarked ewes may not the pregnancy rate of embryos transferred into ewes identified as being in heat 24-48 hours after CIDR/Sponge pull.

EXAMPLE

- CIDRS/Sponges in 27/28th March
- CIDR/Sponge Pull 08:30 10th April
- Remove ewes identified as being on heat on 11th April 18:30 and 12th April 08:30.
- Transfer anytime 18th April

METHOD

- Water bath (clean water) prepared to 30°C, working in room temperature of 18 - 24°C.
- Set the warm plate at 30C.
- Make up a 4 well dish with thawing solutions.
- Label dish with donor ID.
- Remove straw from LN2, hold in air for 8-10 seconds then in 30°C water for 45 seconds. Carefully wipe all water off straw with clean swab/paper towel.
- Remove plug and keep to check identity of embryos.
- Expel embryos into sterile petri-dish.

Stepwise Removal of 10% Glycerol (1.5M)

Purchase Vetoquinol 3 step Glycerol thaw media.

1. 6% (1M) Glycerol + 10.3% (0.3M) Sucrose (**Thaw 1**) for 5 minutes.
2. 3% (0.5M) Glycerol + 10.3% (0.3M) Sucrose (**Thaw2**) for 5 minutes.
3. 10.3% (0.3M) Sucrose (**Thaw 3**) for 5 minutes.
4. Place in Hold for 5 mins prior to transfer

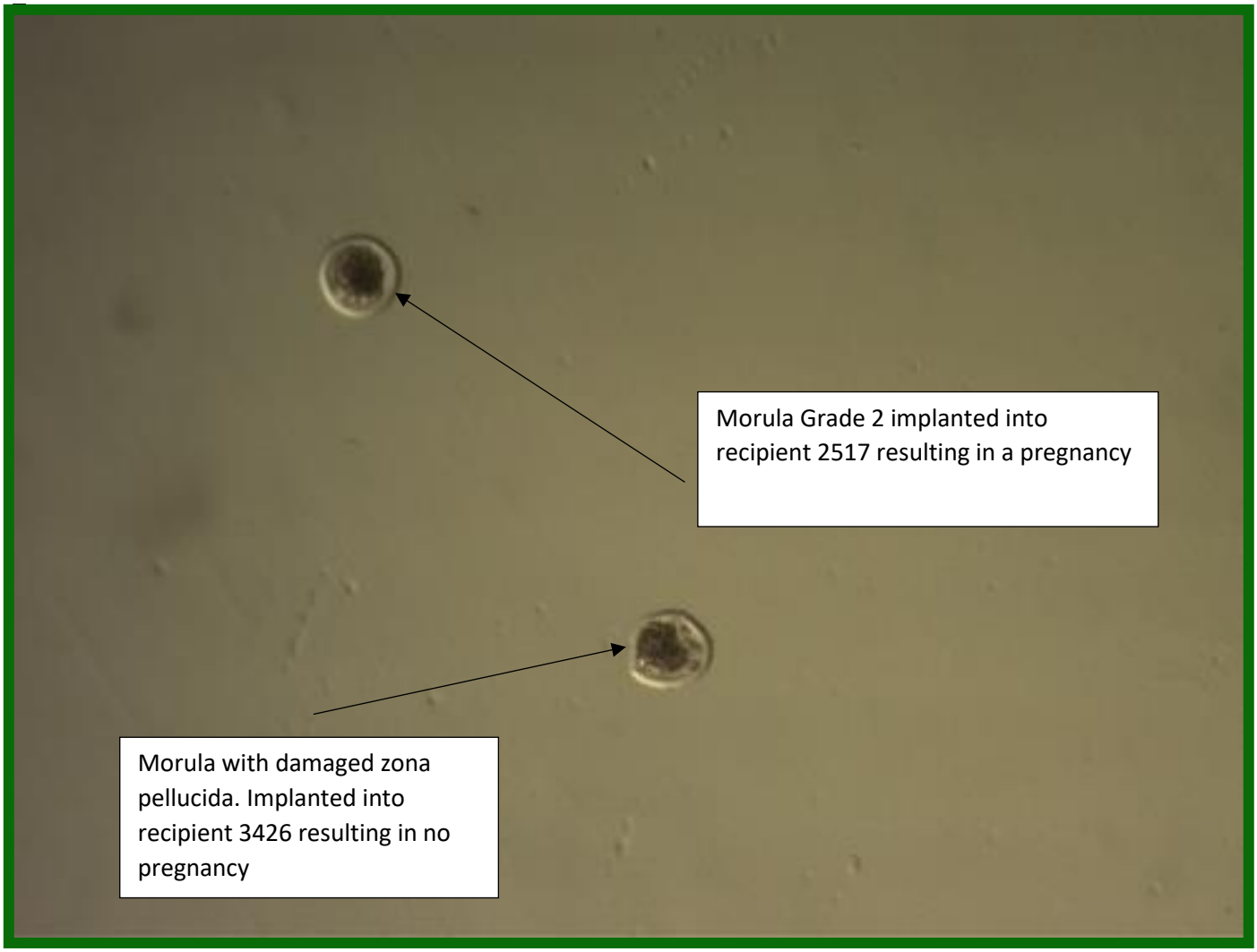
Farmgene Ltd
Ensdon House
Montford Bridge
Shrewsbury
SY4 1EJ
07813 010386

IMPLANT DATA

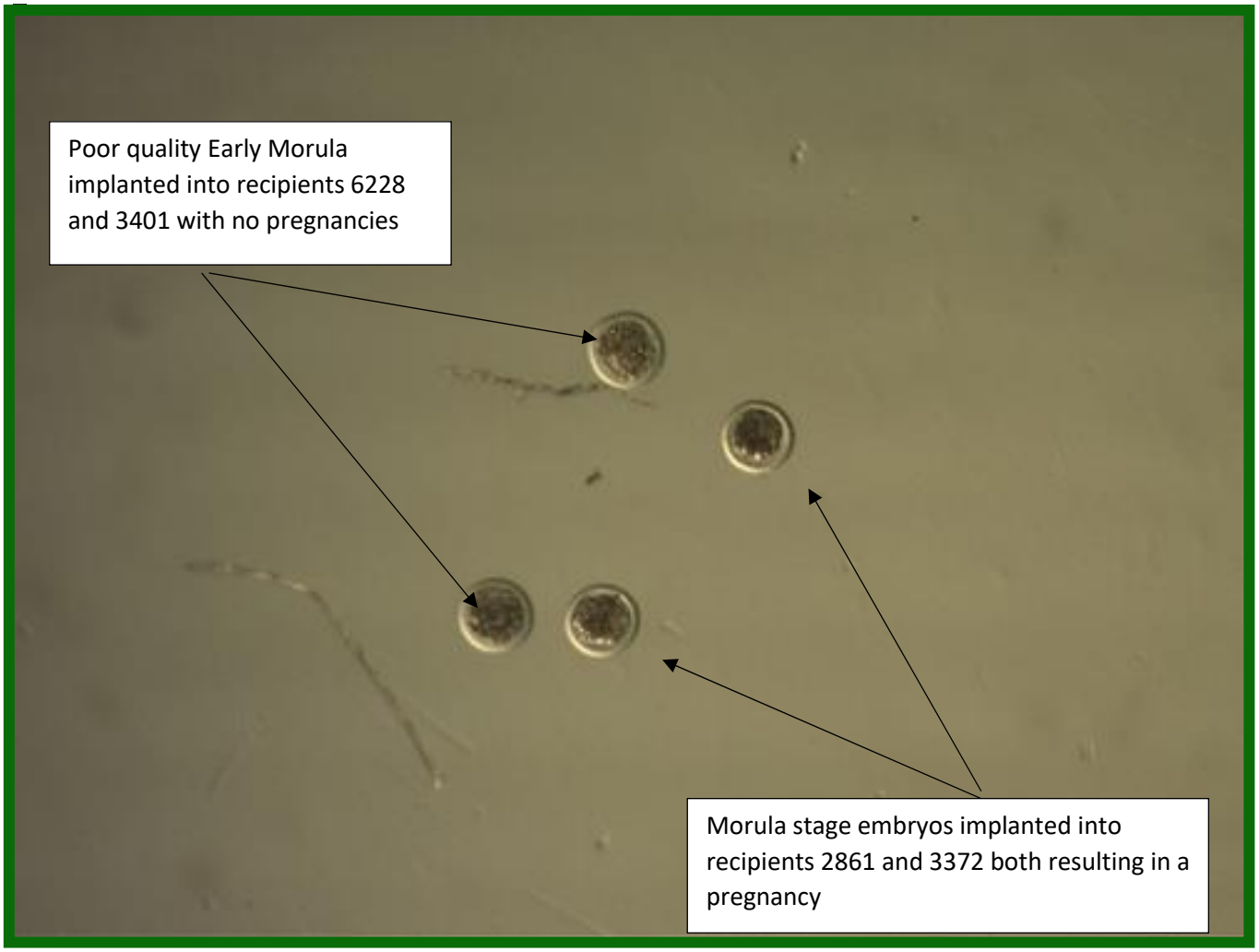
Client:	Peter Williams		**Date:**	10/12/2019		
Address:			**Postcode:**			
Vet :	IM	Embryologist :	IM			

Donor	Sire	Recipient	Implant Grade 1	Implant Grade 2	Marked	Comment
160228	140151	826071196303193	EM			Photo # 1, 2,3
160228	140151	826070392103366		EM		
160228	140151	3209		EM		
160228	140151	826070392103373		EM		
150168	170306 - Paul	826070392103424	LM			
150168	170306 - Paul	4681	LM			
160256	140151	826071196306152	EM			Photo # 4
160240	170306 - Paul	4405	MO			
160240	140151	826070392103371	MO			
160256	170306 - Paul	826071196302861	MO			Photo # 5
160256	170306 - Paul	826071196306228		EM		
160256	170306 - Paul	826070392103372	MO			
160256	170306 - Paul	826070392103401		EM		
160256	170306 - Paul	826070392103426	MO3			Photo 6
160256	170306 - Paul	826070392102517	MO2			Photo 6

APPENDIX 5. Photo 6 (See Implant data)



APPENDIX 6. Photo 5. (See Implant Data)



APPENDIX 7. Semen Quality Assessment criteria

Semen is thawed at 37.5C and examined under a coverslip using phase contrast at x 100 and x 200 magnification.

A sample is also assessed using the CASA. Semen is then classified as either Gold, Silver, Bronze or Not For Sale (NFS). NFS semen is that which is usually destroyed but retained under exceptional circumstances where the ram is extremely valuable and a limited amount of semen has been collected. NFS semen is usually replaced at some point with better quality semen.

Gold:

38%Progressive motility

98% Normal Progressive Motility

88% final normal morphology (so taking into account DH, CM and teratoids)

less Than 1% PD in PM population (values here ae no greater than 0.6)

less than 2% of each individual abnormality in PM population

Silver:

34%Progressive Motility

95% Normal Progressive Motility

85% final normal morphology

Less than 4%PD in PM population

Less than 5% of each individual abnormality in PM population

Bronze:

>30%PM

>90% NPM

>80% final normal morphology

Less than 4% PD in PM population

Less than 8% of each individual abnormality in PM population

APPENDIX 8. EWE AI PROGRAMME 2019

PETER WILLIAMS AI PROGRAMME DECEMBER 2019		
Fferm Bodrwnsiwn		
Ty Croes		
Anglesey		
LL63 5SF		
Telephone:		
Number	40	Breed:
DATE	**TIME**	**TASK**
Monday, November 18, 2019	**Any time**	**Add teaser rams to ewes**
Sunday, November 24, 2019	**Any time**	**Insert CIDRS**
Notes:		**Remove Teasers**
Flush ewes on good pasture until sponges are removed		
If using double sponging please tie strings together		
Please ensure that all semen orders and back up semen have been emailed to abi@farmgene.com		
Saturday, December 07, 2019	**9:00 AM**	**Pull CIDRS**
		Give 2mL PMSG into muscle
		Add raddled teaser rams
Sunday, December 08, 2019	**5:00 PM**	**Starve ewes for AI**
		Let rams being used on AI day each
		serve one of their ewes once
Monday, December 09, 2019	**1:00 PM**	**AI Ewes**
		Frozen Semen
Monday, December 16, 2019	**Any Time**	**Add Chaser rams to AI ewes**
Please ensure that semen is ordered at least 2 weeks before AI day.		
Semen orders can be texted to Abi at 07855262308 or emailed to abi@farmgene.com		

APPENDIX 9. AI DATA, 14th December 2019

Farmgene Ltd
Ensdon House
Montford Bridge
Shrewsbury
SY4 1EJ
07813 010386

FARMGENE
artificial breeding services
www.farmgene.com

AI DATA SHEET

Client:	Peter Williams		**Date: 14/12/2019**	**Programmed @**	On Farm
Address:				**Post Code:**	
	Vet: IM	Tech: IT	**Cidrs or Sponges:**	Sponges	
Breed	**Ewe ID**	**Ram**	**Fresh/Frozen**	**Semen quality**	
Welsh Mule	4546	140151	FROZEN	35%	
Welsh Mule	2576	140151	FROZEN	35%	
Welsh Mule	3367	140151	FROZEN	35%	
Welsh Mule	2645	140151	FROZEN	35%	
Welsh Mule	2473	140151	FROZEN	35%	
Welsh Mule	2600	140151	FROZEN	35%	
Welsh Mule	3429	140151	FROZEN	35%	
Welsh Mule	2583	140151	FROZEN	35%	
Welsh Mule	2603	140151	FROZEN	35%	
Welsh Mule	2341	140151	FROZEN	35%	
Welsh Mule	2589	140151	FROZEN	35%	
Welsh Mule	3354	140151	FROZEN	35%	
Welsh Mule	2641	140151	FROZEN	35%	
Welsh Mule	4577	140151	FROZEN	35%	
Welsh Mule	4476	170306	FROZEN	35% TREMOR	
Welsh Mule	3416	170306	FROZEN	35% TREMOR	
Welsh Mule	5402	170306	FROZEN	35% TREMOR	
Welsh Mule	4116	170306	FROZEN	35% TREMOR	
Welsh Mule	2592	170306	FROZEN	35% TREMOR	
Welsh Mule	4482	170306	FROZEN	35% TREMOR	
Welsh Mule	4220	170306	FROZEN	35% TREMOR	
Welsh Mule	4435	170306	FROZEN	35% TREMOR	
Welsh Mule	2593	170306	FROZEN	35% TREMOR	
Welsh Mule	6194	170306	FROZEN	35% TREMOR	
Welsh Mule	4501	170306	FROZEN	35% TREMOR	
Welsh Mule	2626	170306	FROZEN	35% TREMOR	

APPENDIX 10. Damara Embryo Flush & Freeze Programme

Peter Williams - Damara Ewe ET			
DATE	**TIME**	**DONORS**	
Thursday, November 11, 2021	**Any Time**	**Add teaser rams to ewes**	
Thursday, November 18, 2021	**AM any time**	**Insert 1 x CIDR** **Remove Teasers**	
BRING DONORS TO FARMGENE FRIDAY 26TH NOVEMBER READY FOR PROGRAMME			
Sunday, November 28, 2021	**Any Time** **Any Time**	**Change CIDR** **Inject Donors Only 1.0ml Estrumate**	
Monday, November 29, 2021	**7:00 PM**	**5.0 mL Follitropin** **2 mL PMSG**	
Wednesday, December 01, 2021	**2:00 PM**	**Pull CIDR** **Add raddled teaser ram**	
Thursday, December 02, 2021	**7:00 PM**	**1.0 mL Receptal** **Starve donors for AI**	
Friday, December 03, 2021	**9:00 AM** **5:00 PM**	**AI donor ewes with fresh semen** **Re AI Donors**	- - -
Sunday, December 05, 2021	**Anytime**	**Add CIDR DONORS ONLY**	
Wednesday, December 08, 2021	**Afternoon**	**Starve Donors and Recipients** **Starve donors on shavings not straw**	
Thursday, December 09, 2021	**All day**	**Flush & Freeze @ Centre**	

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