final report

Project code: L.PDS.1711

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Date published: 31 January 2021

PUBLISHED BY
Meat and Livestock Australia Limited
Locked Bag 1961
NORTH SYDNEY NSW 2059

L.PDS.1711: Improving Heifer Productivity by Integrating FTAI into Commercial Cow Enterprises

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

Executive summary

This Producer Demonstration Site (PDS) was designed to demonstrate the measurable financial benefits of integrating FTAI, including synchronization, into commercial heifer mating programs. It was recognized that synchronizing heifers in order to mate them to FTAI at the beginning of a producer's chosen breeding season would provide the enrolled heifers more breeding opportunities within a controlled breeding season, improving pregnancy rates as well as their eventual calving distribution. Heifers that calve early within their scheduled calving season and with less need for calving assistance would be more likely to wean more and heavier calves and have improved rebreeding outcomes when rejoined for their second mating and beyond. Fixed time AI can also provide access to bulls with both higher accuracy and BREEDPLAN Estimated Breeding Values (EBV's) for improved calving ease, shortened gestation lengths, lower birth weights and better growth compared to the EBV's of most of the bulls traditionally sourced within the area from bull sales. Lastly it was postulated that due to the AI sire's superior EBV's and the inherent and obvious advantage conferred by synchronization, the proportion of heifers that conceive to AI would be expected to enjoy a reduction in dystocia, calf mortality, and heifer mortality, as well as calve earlier and produce heavier calves for their age than the calves sired from most of the bulls used for natural service within both groups enrolled in the PDS.

Enrolled producers randomly chose half of their replacement heifers and synchronized them to be AI'd by FTAI on their preferred mating start date and introduced bulls to the remaining heifers on the same date. The producer then reintroduced the AI'd heifers to their naturally mated siblings ten days later for the duration of the natural mating season.

Seven properties enrolled in the PDS in 2017, three properties continued in 2018, two properties continued in 2019, and three new properties enrolled in 2019 for a total of 15 groups of trial heifers on ten properties over three years. Seasonal conditions prevented some producers from continuing and curtailed further enrolment. Other producers pulled out of the trial early wishing to forego the trial subsidy and to instead enrol all their heifers in a FTAI program going forward prior to the conclusion of the program.

The enrolled heifers at each property were pregnancy tested at least six weeks after the bulls were removed and the gestational ages of the pregnancies were estimated when possible. A comparison of raw averages showed a trend for pregnancy rates to be superior within the FTAI integrated group on 11 of the 15 enrolled groups of heifers. The average improvement per site was 3.1% fewer non-pregnant heifers within the FTAI integrated group. There were 0.8% fewer non-pregnant heifers within the FTAI integrated group when the entire dataset was combined. A statistical analysis of the entire available data set revealed a trend ($p = 0.14$) towards the integration of FTAI resulting in an improved pregnancy rate.

Each core producer monitored their enrolled heifers through the calving season. Each producer attempted to record the exact calving date for each enrolled heifer. If the calving date of a heifer was missed, her data was removed from the data set. Any dystocia, calf mortality, or heifer mortality associated with each individual heifer was recorded. As was expected, primarily as a result of synchronization, and partially as a result of the shorter Gestational Length (GL) EBV's amongst the AI sires, the calving distribution was improved amongst the FTAI integrated heifers. Combining the dataset from all locations recorded, 63.8% of the heifers within the FTAI integrated groups had calved on or before the expected calving start date, compared to 21.6% of their naturally mated siblings. On average, the heifers from the FTAI integrated groups calved 8.1 days in advance of their siblings. A statistical analysis of the entire available data set revealed that the mean calving date relative to

expected calving date differed significantly ($p < .01$) between the FTAI integrated group vs. the syndicate mated.

Approximately 70% of the calves within the FTAI integrated heifer groups were sired from the FTAI program. As expected, likely due to the use of AI sires with exceptional calving ease EBV's, dystocia statistics were improved amongst the FTAI integrated heifers at most sites. Dystocia rates, calf mortality rates, and heifer mortality rates were 5.8%, 2.8% and 0.3% amongst the FTAI integrated heifers compared to 7.4%, 5.5% and 1.3% amongst their naturally mated siblings respectively. A statistical analysis of the entire available data set revealed a trend ($p = 0.09$) towards the integration of FTAI resulting in an improvement in dystocia, a significant difference ($p < 0.05$) towards the integration of FTAI resulting in a reduction in calf mortality and a trend ($p = 0.11$) towards the integration of FTAI resulting in a reduction in heifer mortality.

Weaning weights were opportunistically collected from seven of the 15 enrolled groups from sites where producers were able to accurately identify the dams of the calves at weaning. All seven groups showed a weaning weight advantage, ranging from six to 21.5 kgs, amongst the calves born from the FTAI integrated heifers versus those from their naturally mated siblings. When the data from all seven sites were combined, the average improvement in the weaning weights of calves born from the FTAI integrated heifers was 13.4kgs compared to the calves born to their naturally mated siblings. A statistical analysis of the entire available dataset revealed that the weaning weights were statistically significant ($p < 0.01$). The calves born from the FTAI integrated groups were on average 8.1 days older due to synchronisation and the use of sires with shortened gestational length EBV's. The remaining benefit could likely be attributed to the superior growth EBV's of the AI sires.

The enrolled heifer's subsequent pregnancy rates were measured and compared. 13 groups of heifers were analysed, nine of which demonstrated an improvement in subsequent pregnancy rate. The average of the measured improvement per individual site was a 4.5% better pregnancy rate within the proportion of cows which had been enrolled in the FTAI program as heifers compared to those which had been naturally mated. When the entire dataset of the 13 groups was combined, the advantage of integrating a FTAI program into the heifer mating program rendered an average improvement in their subsequent pregnancy rate of 2.7%. A statistical analysis of the entire available data set did not show that the improvement in subsequent pregnancy rate was statistically significant ($p = 0.24$).

A cost comparison between integrating FTAI vs traditional natural syndicate mating was calculated by capturing all AI costs for each individual site in the first year of the program and with a presumption of utilizing back up bulls at a reduced rate of 2% vs 3%. The calculated additional cost per locality of integrating FTAI and backing up the AI program with 2% bull cover over their entire replacement heifer population varied from an additional $3.21 to $60.03 with an average additional cost of $22.66 per pregnancy compared to the cost of natural mating with 3% bull cover. The variability in cost was primarily due to the variation in bull power needed between producers. Some producers would have been unable to reduce their bull requirements by integrating FTAI, and hence integrating FTAI conferred no bull cost savings. In consultation with enrolled core producers the estimated cost of additional labour associated with integrating FTAI was estimated to be an additional $12 per pregnancy. The total average additional cost of integrating FTAI was therefore estimated to be approximately $35 within the first year of the trial.

In consultation with the core producers, values/costs were assigned to heifer pregnancy status, dystocia interventions, calf mortalities, heifer mortalities, kilograms of calf weaned, and pregnancies associated with rebreeding. Using the percentages derived from combining the entire available dataset for each category of the PDS and the estimate of expenses incurred, an estimate of a return

on investment for the average core producer from the intervention within this PDS was approximated to be $90.00 per pregnant heifer. The estimated financial benefit varied between producers as expected.

The ongoing results of the trial have been widely distributed to local producers through ASHEEP communications, through the state via a number of field days and in printed media, and the first year's preliminary data nationally at Beef 2018 in Rockhampton. Ongoing opportunities to distribute the findings of the trial will be explored and continue to be implemented after the close of the trial. Dr. Bergman is scheduled to present the final findings at Beef 2021 in Rockhampton in May.

Across the entire Southern agricultural region of Australia, and indeed anywhere in Australia where beef cattle are control mated, the results of this trial could stand to significantly benefit producers who haven't previously integrated FTAI into their heifer mating programs. The PDS has demonstrated that integrating FTAI and utilizing sires with appropriate EBV's into heifer mating programs has potential to improve heifer pregnancy rates, improve dystocia parameters, improve subsequent pregnancy rates, and wean more kilograms of calf per mated heifer.

Integrating Fixed Time AI has the ability to set a producer's heifers up to succeed, setting them on a path to enhanced future profitability, potentially paying dividends for several subsequent joinings. Simultaneously, the process allows producers the opportunity to invest in the best possible genetics for their best genetics, their heifers. Artificial Insemination has long been considered an expense by most beef producers, but this trial should conclusively demonstrate that integrating FTAI into commercial heifer mating programs is a sound investment capable of generating solid returns financially, whilst simultaneously able to improve both the herd's structure and genetics.

Additional program assistance was graciously provided by Vetoquinol who provided a subsidy to the cost of the intravaginal progesterone releasing devices, or Cue-Mates, by ABS who subsidized the cost of five of the AI sires used over the course of the PDS, and by Precision Genetics who subsidized the cost of one of the AI sires. Statistical analysis was completed by both Drs. Cliff Lamb of the University of Texas A and M and Josh Aleri of Murdoch University.

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1 Background

Local producers had accepted that even when managed optimally, heifers are more prone to dystocia and wean lighter calves than other parities and typically suffer poorer subsequent pregnancy rates when re-joined post calving.

This PDS was designed to demonstrate the financial benefits of integrating fixed time artificial insemination (FTAI) into commercial heifer mating programs. It was recognized that heifers which calve early within their scheduled calving season and with less need for calving assistance would be more likely to wean more and heavier calves and have improved rebreeding outcomes when re-joined for their second mating and beyond. It was also recognized that oestrus synchronization and FTAI could provide access to bulls with both higher accuracy and superior Breedplan Expected Breeding Values (EBV's) for calving ease, shortened gestation lengths, and growth compared to the EBV's of most of the bulls traditionally sourced within the area from bull sales. As a result of the AI sire's EBV's, the proportion of heifers which conceive to AI will be expected to enjoy a reduction in dystocia, calf mortality, and heifer mortality, as well as calve earlier and produce heavier calves for their age than the calves sired from most of the bulls used for natural service. Lastly, it was recognized that synchronization for the FTAI program could also provide heifers more service opportunities within a fixed joining compared to heifers naturally mated, resulting in improved pregnancy rates.

2 Project Objectives

2.1 Contract Objectives

By December 2020, in the Esperance region of WA this project will:

1. Demonstrate on at least 20 properties (core producers) that tighter joining periods via adoption of FTAI and the use of genetically superior sires can:
    a. Reduce dystocia indicators in maiden heifers by an average of 40% (e.g. 6% vs 10% dystocia, 2.4% vs 4% calf mortality, 0.6% vs 1% heifer mortality)
    b. Reduce empty rate in short mated heifers by 30% e.g. from 15% to 10%
    c. Reduce empty rate in the heifers subsequent mating by 20%

2. Result in at least 50% of core producers continuing to adopt tighter joining periods via adoption of FTAI and the use of genetically superior sires in their commercial heifer breeding program post the project.

3. Increase awareness and knowledge of heifer management strategies to reduce the prevalence of dystocia in maiden heifers by at least 75% of observer producers attending demonstration sites / field days, with 20% indicating they will adopt the practice.

2.2 Aspirational Objectives

The primary project objective was to prove that implementing synchronized FTAI programs as part of a commercial producer's heifer mating program could increase pregnancy rates, reduce dystocia statistics, improve weaning weights and increase subsequent pregnancy rates by positively influencing the calving distribution through the advantage of implementing a synchronization program and the inclusion of AI sires chosen for shortened gestational length EBV's, potentially leading to years of improved reproductive efficiency. Simultaneously, the secondary goal was to capture both the measurable costs and returns associated with the intervention in order to financially demonstrate that integrating FTAI programs into heifer mating programs is capable of generating a return for producers. Lastly, the final goal was to reinforce the importance of ensuring replacement heifers obtain a reasonable critical mating weight (CMW).

3 Methodology

Enrolled producers were asked to weigh and ensure that all replacement heifers were individually ID'd prior to the commencement of the trial.

Producers enrolled half of their replacement heifers in a Fixed Time AI program with the goal of artificially inseminating them on their preferred mating start date, simultaneously introducing bulls to the remainder of their replacement heifers for natural joining.

Producers reintroduced the heifers which had been enrolled in the FTAI program to their siblings ten days after artificial insemination allowing them access to the same bulls as their siblings for the remainder of the producer's chosen breeding season. Producers managed the heifers as a single management group for the remainder of the trial, through calving, rebreeding and weaning.

Pregnancy data was collected via ultrasound diagnosis a minimum of six weeks after the bulls were removed. All pregnancies undetected by ultrasonography were manually palpated. All empty animals were identified and when possible the gestational age of the foetuses was estimated.

All pregnancy data, including AI sires was collated. The individual ID's of the heifers were resequenced in numeric order and given to the producer to simplify recording calving information or other comments throughout the remainder of the trial.

Once calving commenced, producers recorded calving dates for individual heifers as well as any dystocia statistics.

Rebreeding data was collected at pregnancy testing following each heifer groups subsequent mating.

Weaning weight data was collected from producers which had been able to identify the dams of individual calves.

Pre and Post PDS Surveys were filled out by the original core producers.

Observer producers were surveyed via mail out.

Field day participants were surveyed prior to and following a field day at which the PDS was discussed.

All data was analysed and summated.

4 Results

4.1 Pre-Program Dystocia and Pregnancy Rate Survey

Heifer conception rates, rebreeding rates, dystocia levels, calf mortality, and heifer mortality are exceptionally variable from season to season due to a wide range of environmental and genetic factors. The following estimates were derived from retrospective data from 6 of our local producers all of which engaged in the PDS.

Table 1. Core Producer annual dystocia incidence estimates.

	AVG	A	B	C	D	E	F
Dystocia	**9%**	6-12%	10%	0-10%	0-40%	5-10%	5-10%
Calf mortality associated with calving	**7%**	6%	5-8%	2-11%	0-25%	2.5-5%	5-6%
Heifer mortality associated with calving	**2%**	1-2%	5%	0-1%	0-5%	1-2%	1%

Estimated District Average Heifer Conception Rate 90%

Estimated District Average 2nd Calver Conception Rate 85%

4.2 Pre-Mating Weight Comparison

All producers were asked to weigh their heifers prior to the mating program. Most producers complied, and some data was lost. The cumulative data demonstrated an improvement in pregnancy rate amongst animals over 300 kilograms prior to mating, reinforcing the importance of attaining appropriate critical mating weights prior to joining. 90.6% of the weighed heifers had achieved a pre-mating weight of over 300 kgs. Heifers with premating weights below 300 kgs were observed to have lower pregnancy rates. A statistical analysis of the entire available data set revealed a trend ($p = 0.09$) towards premating weight having an impact on pregnancy status. This is illustrated in Table 2 and Figure 1.

Table 2. Pregnancy Rate as a Function of Pre-Mating Weight.

Weight Class	Pregnant	Empty	Total	Pregnancy Rate
251-275 Kg	6	5	11	54.5%
276-300 Kg	37	14	51	72.5%
301-325 Kg	63	11	74	85.1%
326-350 Kg	115	18	133	86.5%
351-375 Kg	153	31	184	83.2%
376-400 Kg	107	22	129	82.9%
401-425 Kg	47	9	56	83.9%
426-450 Kg	14	5	19	73.7%
Total	542	115	657	82.5%

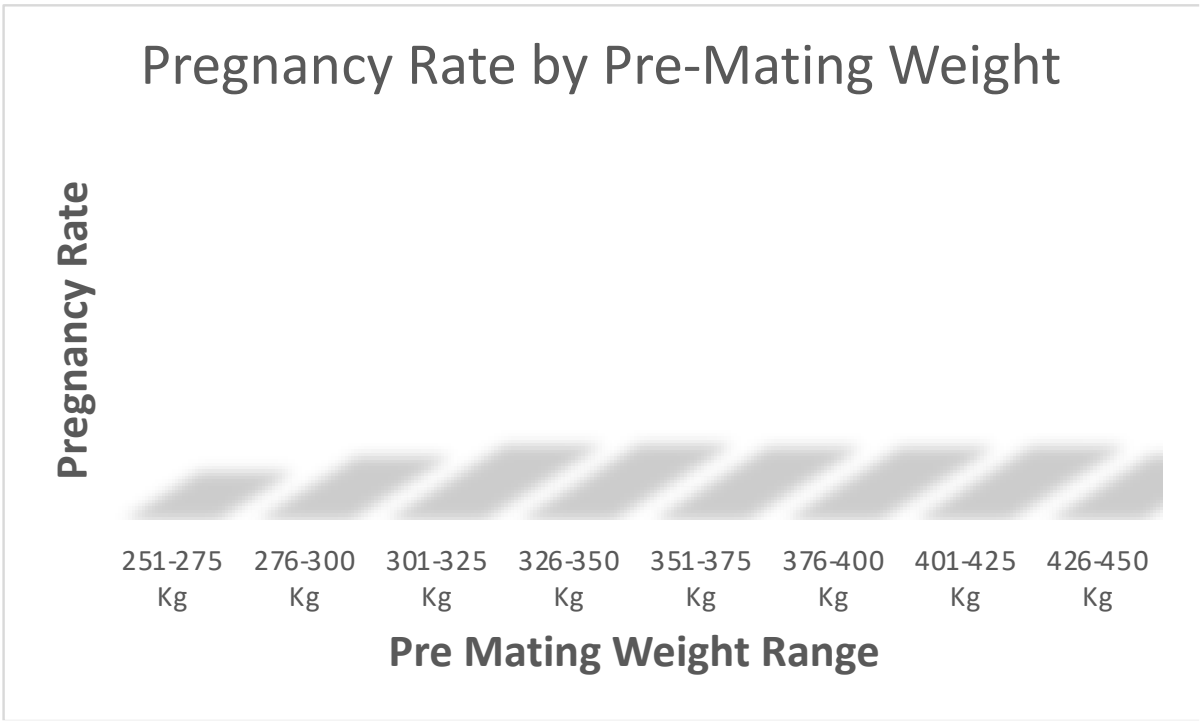

Figure 1. Pregnancy Rate as a Function of Pre-Mating Weight.

4.3 AI Sire vs. Natural Sire Data

Sire data was collected from three properties in the first year of the program to demonstrate the advantages achievable through selection of proven AI sires over sires traditionally sourced as unproven bulls from local sales. The EBV's from the bulls used at farm E, F, and G are summarized below and compared to the AI Sires used in the first year of the PDS. Both the bulls used for natural mating and the AI Sires were chosen for superior calving ease, low birth weight, and growth characteristics, however, the accuracy and the indexes of concern were superior amongst the AI sires as would be expected and as intended within the context of the PDS. The accuracy of AI sires is an important consideration when choosing sires to mitigate calving issues when integrating AI in commercial mating programs. Interestingly, Farm E suffered significant dystocia and calf mortality amongst the syndicate mated heifers within the first year compared to the FTAI integrated heifers, whilst the syndicate mated heifers from Farm F suffered very little dystocia, calf, or heifer mortality with very similar natural bull EBV's. It is apparent, as the trial design was intended, that AI sires with relatively extreme and high accuracy calving ease EBV's can improve outcomes even when other environmental conditions or the effect of maternal genetics contribute significantly to dystocia.

The EBV's, their ranking, and the accuracy of each EBV of the syndicate bulls from 3 properties and the AI sires used in 2017 are shown in Table 3. Each property's EBV's are also expressed in graphical form, as a percentile ranking, inclusive of most indices (Figure 2), for calving ease indices (Figure 3), and for growth indices (Figure 4).

Regarding the role of EBV's for Gestational Length influencing the calving histograms of individual properties, the reported average gestational length EBV of the syndicate sires was -5.3 compared to an average gestational length EBV of -7.9 for the AI sires, representing an Expected Breeding Value advantage of 2.6 days, of which half of the advantage would be expected to be realized, or 1.3 days.

The EBV's for 200 days and for 400 days were four and eight kilograms heavier respectively for the AI sires over the bulls used for natural mating. Half of the advantage would be expected to be passed on, perhaps contributing to an additional weight advantage of two and four kilos respectively. Calves were weaned between 200 and 400 days. It would be therefore be reasonable to attribute approximately two kgs of the weaning weight advantage assuming that 70% of the calves born from the FTAI integrated groups were sired by the AI sires.

Table 3. EBV's of the natural sires used from three different properties and the EBV's from the AI sires utilized in 2017.

Angus Sires																					
Farm E	**ABI**	**DOM**	**GRN**	**GRS**	**CE Dir**	**CE Dtrs**	**GL**	**BWT**	**200**	**400**	**600**	**MCW**	**Milk**	**DTC**	**SS**	**CWT**	**EMA**	**RIB**	**P8**	**RBY**	**IMF**
VLYK536	121	116	135	115	2.0	1.9	-4.9	3.3	44	72	94	76	11	-3.5	0.5	52	9.7	-1.1	-2.4	1.5	2.9
VLYK921	130	122	147	123	3.3	2.5	-5.8	2.3	48	83	109	101	15	-3.1	0.9	60	9.2	-1.3	-2.6	1.7	2.8
VLYL205	131	116	145	124	1.1	0.0	-3.4	4.3	54	91	123	101	25	-5.9	1.1	73	5.0	-1.4	-0.8	0.3	2.6
VLYL447	134	115	148	125	3.6	1.1	-4.8	2.3	44	80	107	88	22	-8.4	1.5	66	6.3	1.5	1.2	-0.5	2.8
Farm E Average	**129**	**117**	**144**	**122**	**2.5**	**1.4**	**-4.7**	**3.1**	**48**	**82**	**108**	**92**	**18**	**-5.2**	**1.0**	**63**	**7.6**	**-0.6**	**-1.2**	**0.8**	**2.8**
Average Ranking %	76%	75%	80%	74%	80%	66%	63%	76%	63%	50%	55%	52%	64%	60%	17%	59%	78%	33%	32%	60%	86%
Average Accuracy %					54%	47%	85%	71%	69%	71%	69%	67%	61%	41%	70%	61%	61%	62%	62%	58%	58%
Farm F	**ABI**	**DOM**	**GRN**	**GRS**	**CE Dir**	**CE Dtrs**	**GL**	**BWT**	**200**	**400**	**600**	**MCW**	**Milk**	**DTC**	**SS**	**CWT**	**EMA**	**RIB**	**P8**	**RBY**	**IMF**
VLYL310	125	113	141	116	2.3	-0.1	-2	2.7	41	77	97	75	20	-7.3	1.6	61	5.5	1.3	0.9	-0.7	3.3
VLYL392	131	120	147	121	2.4	0.2	-4.7	2.7	45	83	106	87	22	-6.2	1	70	7.3	-0.6	-1.5	0.9	2.8
VLYL398	134	120	149	125	1.6	-1.3	-4.2	3.4	47	85	110	88	20	-6.5	1.8	70	8.4	0.3	-0.5	0.6	2.8
VLYL443	136	119	157	125	2	-0.2	-2.9	3.6	47	86	117	98	20	-6.1	1.9	71	6.6	-1.2	-2.6	1	2.8
Farm F Average	**132**	**118**	**149**	**122**	**2.1**	**-0.4**	**-3.5**	**3.1**	**45**	**83**	**108**	**87**	**21**	**-6.5**	**1.6**	**68**	**7.0**	**-0.1**	**-0.9**	**0.5**	**2.9**
Average Ranking %	81%	77%	84%	74%	77%	34%	41%	77%	51%	55%	53%	43%	90%	87%	40%	76%	78%	48%	35%	52%	89%
Average Accuracy %					53%	46%	82%	72%	70%	70%	71%	67%	61%	43%	69%	61%	61%	63%	62%	58%	59%
Farm G	**ABI**	**DOM**	**GRN**	**GRS**	**CE Dir**	**CE Dtrs**	**GL**	**BWT**	**200**	**400**	**600**	**MCW**	**Milk**	**DTC**	**SS**	**CWT**	**EMA**	**RIB**	**P8**	**RBY**	**IMF**
WATL76	114	109	121	110	1.0	-1.0	-6.8	1.8	41	79	100	82	14	-5.2	3.1	61	6.2	1.1	-0.3	0.1	2.3
WATL45	110	109	106	113	2.9	3.4	-6.8	2.5	44	81	108	94	17	-3.0	2.2	63	5.1	-0.2	-0.1	0.9	1.1
WATL44	102	102	92	108	1.4	2.3	-4.0	4.0	43	77	102	88	20	-3.4	1.7	63	7.6	1.4	1.9	0.3	0.9
WATL43	121	115	129	119	3.3	1.3	-6.2	2.9	45	88	117	103	16	-2.8	1.7	59	4.2	-1.7	-0.6	0.8	1.9
WATL35	105	105	99	110	3.3	1.2	-8.9	3.5	46	81	112	96	15	-1.1	0.4	61	6.7	-1.2	-1.6	1.5	0.8
WATL20	110	109	106	112	3.0	3.7	-6.9	3.8	42	75	100	90	14	-2.9	1.4	59	7.6	-0.2	0.2	1.2	1.2
WATL9	106	103	116	103	0.6	-1.2	-5.1	3.3	44	86	112	98	16	-2.6	2.0	63	1.6	-1.4	-1.2	-0.3	2.5
WATK29	117	116	118	119	1.5	3.3	-5.8	2.1	52	89	116	83	19	-2.1	0.5	73	8.5	0.1	-2.5	0.9	1.8
WATK27	97	92	85	104	2.1	0.3	-6.4	3.5	45	78	114	86	20	-3.9	2.2	64	0.9	1.3	1.1	-0.7	0.7
Farm G Average	**109**	**107**	**108**	**111**	**2.1**	**1.5**	**-6.3**	**3.0**	**45**	**82**	**109**	**91**	**17**	**-3.0**	**1.7**	**63**	**5.4**	**-0.1**	**-0.3**	**0.5**	**1.5**
Average Ranking %	36%	41%	34%	42%	74%	61%	82%	77%	48%	49%	55%	50%	62%	27%	43%	57%	54%	47%	47%	52%	44%
Average Accuracy %					53%	46%	82%	72%	70%	70%	71%	67%	61%	43%	69%	61%	61%	63%	62%	58%	59%
AI Sires 2017	**ABI**	**DOM**	**GRN**	**GRS**	**CE Dir**	**CE Dtrs**	**GL**	**BWT**	**200**	**400**	**600**	**MCW**	**Milk**	**DTC**	**SS**	**CWT**	**EMA**	**RIB**	**P8**	**RBY**	**IMF**
HIOG18 General	161	133	187	147	5.1	4.0	-8.4	2.0	53	95	126	98	17	-8.4	2.3	78	8.4	1.5	0.1	-0.7	3.7
TFAL24 Leonardo Landfall	128	128	125	128	6.4	5.1	-9.5	-1.8	41	92	101	48	27	-6.1	1.2	60	6.1	3.0	2.9	-0.9	2.1
USA16764044 Broken Bow	123	120	124	124	3.2	4.6	-5.9	0.9	55	90	117	99	17	-2.3	1.2	67	7.7	-0.3	-0.6	0.7	2.0
2017 AI Sire Average	**137**	**127**	**145**	**133**	**4.9**	**4.6**	**-7.9**	**0.4**	**50**	**92**	**115**	**82**	**20**	**-5.6**	**1.6**	**68**	**7.4**	**1.4**	**0.8**	**-0.3**	**2.6**
Average Ranking %	80%	92%	70%	89%	96%	99%	92%	97%	71%	83%	67%	45%	78%	66%	38%	73%	83%	76%	65%	25%	75%
Average Accuracy %					86%	71%	98%	97%	94%	94%	94%	90%	86%	60%	92%	86%	84%	86%	85%	81%	84%

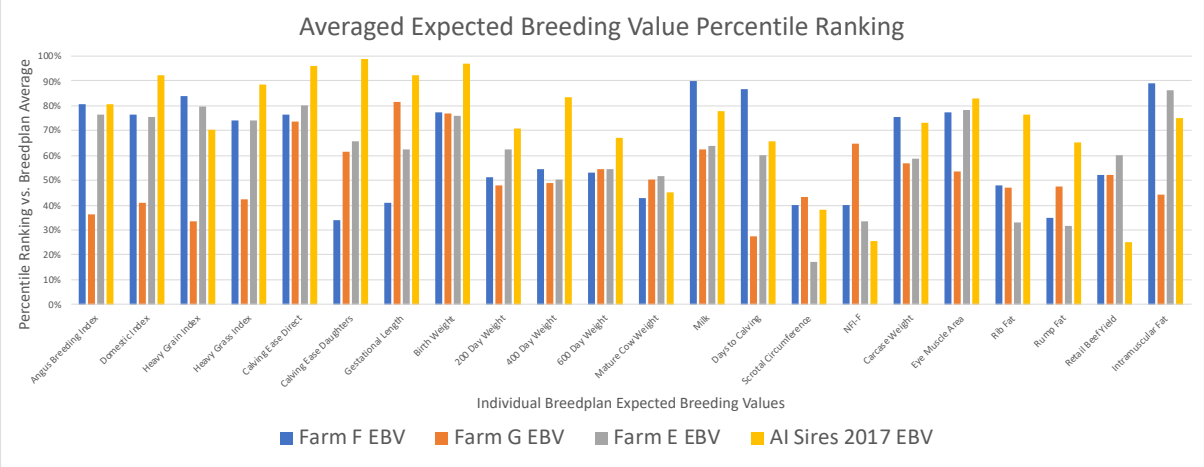

Figure 2. Averaged EBV's expressed as a percentile ranking comparing the average of the live cover bulls utilized on 3 different properties and the AI sires used in 2017

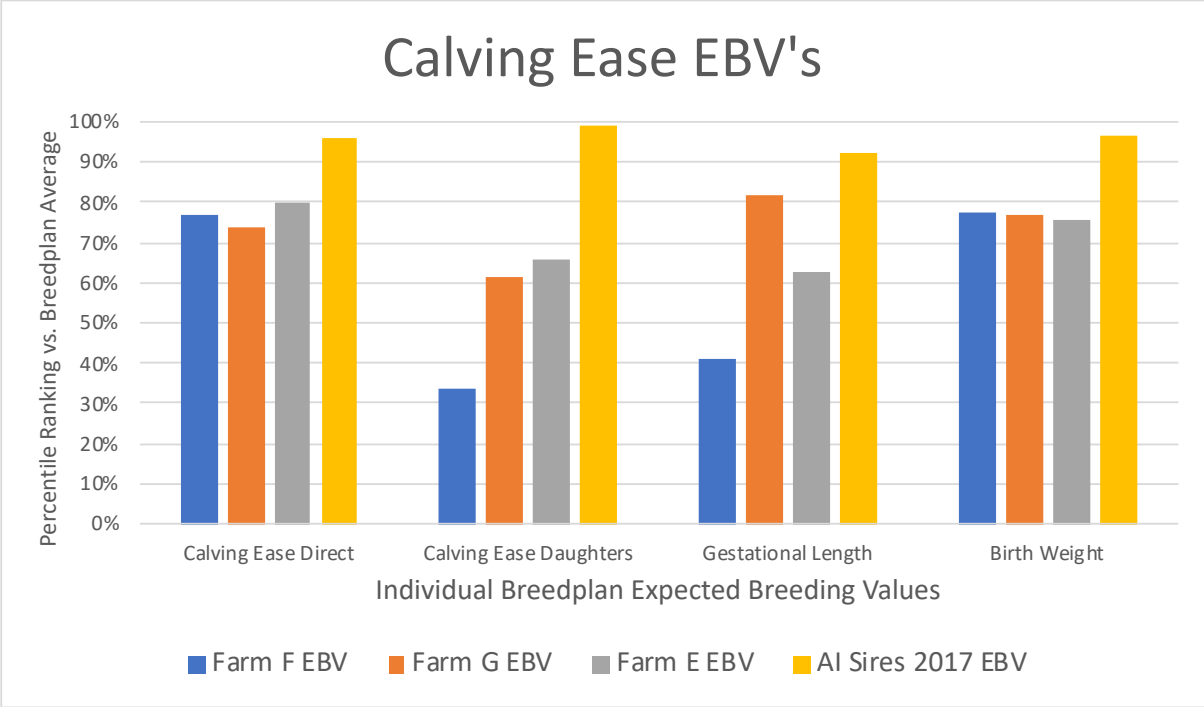

Figure 3. Calving Ease EBV's expressed as a percentile ranking comparing 3 properties and AI sires used in 2017.

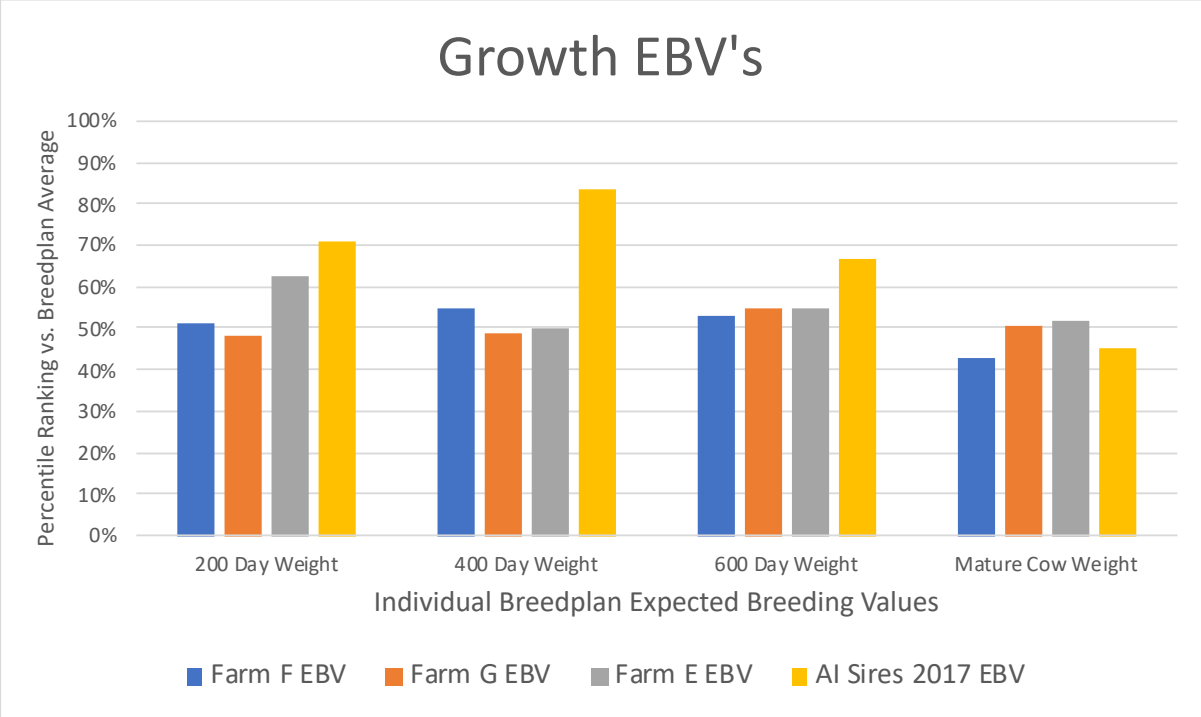

Figure 4. Growth EBV's expresses as a percentile ranking comparing 3 properties and AI sires used in 2017

4.4 Pregnancy Rate Data

The enrolled heifers at each property were pregnancy tested at least six weeks after the bulls were removed and the gestational ages of the pregnancies were estimated when possible. Pregnancy rates were superior within the FTAI integrated group on 11 of the 15 enrolled groups of heifers. The average improvement per site was 3.1% better pregnancy rates within the FTAI integrated group representing a relative reduction in the proportion of empties of 17.5%. When the entire dataset was combined, the advantage of integrating a FTAI program into the heifer mating programs was an improvement in pregnancy rate of 0.8% equating to a reduction in the relative reduction in the proportion of empty heifers of 4.6%. A statistical analysis of the entire available data set revealed a trend ($p = 0.14$) towards the integration of FTAI resulting in an improved pregnancy rate.

Table 4. Pregnancy Testing Results

	Integrated FTAI			Syndicate Mated			Difference	% Reduction in Empties
Farm	Preg Tested	Empty	% Empty	Preg Tested	Empty	% Empty		
A.1	173	28	16.2%	218	41	18.8%	2.6%	13.9%
B.1	19	0	0.0%	19	1	5.3%	5.3%	100.0%
C.1	25	6	24.0%	25	5	20.0%	-4.0%	-20.0%
D.1	25	3	12.0%	24	3	12.5%	0.5%	4.0%
E.1	71	16	22.5%	73	18	24.7%	2.1%	8.6%
F.1	58	5	8.6%	51	6	11.8%	3.1%	26.7%
G.1	102	11	10.8%	102	8	7.8%	-2.9%	-37.5%
A.2	177	33	18.6%	173	21	12.1%	-6.5%	-53.6%
F.2	45	3	6.7%	44	5	11.4%	4.7%	41.3%
G.2	85	14	16.5%	86	16	18.6%	2.1%	11.5%
A.3	174	35	20.1%	192	51	26.6%	6.4%	24.3%
G.3	118	25	21.2%	99	22	22.2%	1.0%	4.7%
H.3	106	28	26.4%	114	23	20.2%	-6.2%	-30.9%
I.3	15	1	6.7%	7	2	28.6%	21.9%	76.7%
J.3	14	1	7.1%	13	3	23.1%	15.9%	69.0%
Site Average			14.5%			17.6%	3.1%	17.5%
Combined Dataset	1207	209	17.3%	1240	225	18.1%	0.8%	4.6%

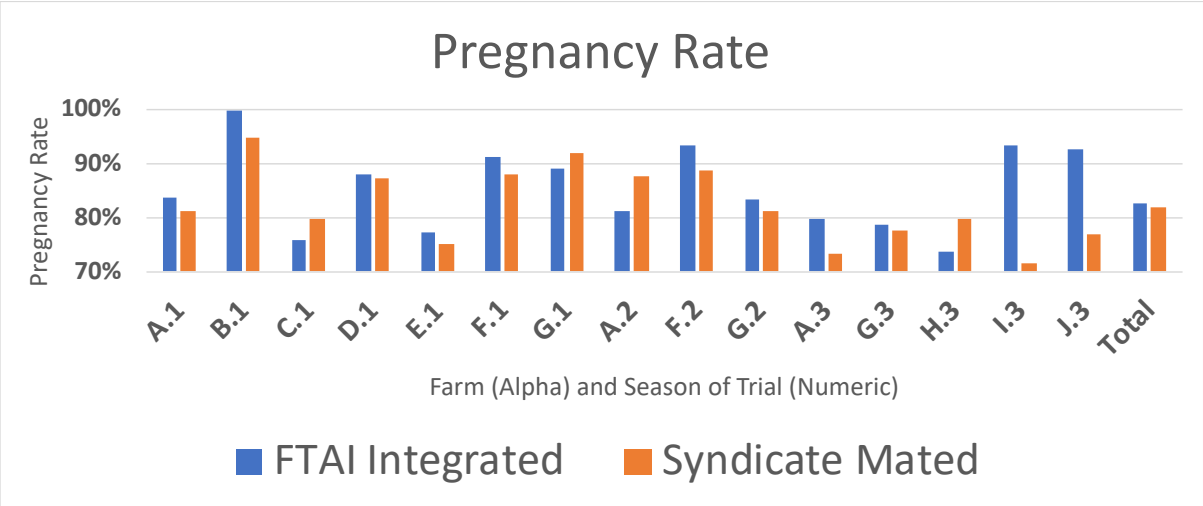

Figure 5. Pregnancy Testing Results

4.5 Calving Distribution Data

Each enrolled producer monitored their trial heifers through the calving season and attempted to record the exact calving date for each enrolled heifer. The calving distributions from each property involved in the trial over the three years were combined and the total number of calves that were born in reference to the expected calving start date (calculated as 283 days after the mating start date) on each property were plotted. As expected, the benefits of synchronization and the use of AI sires with EBV's for short gestational lengths was evident. 63.8% of the calves born in the FTAI integrated groups were born on or prior to the calculated calving start date vs. only 21.6% of the calves from the syndicate mated groups. The proportion of calves born were statistically significant ($p < 0.01$) until day 28 of the expected calving season between the two groups. Overall, the

recorded heifers from the FTAI integrated groups calved a statistically significant ($p < 0.01$) average 8.1 days ahead of their recorded siblings.

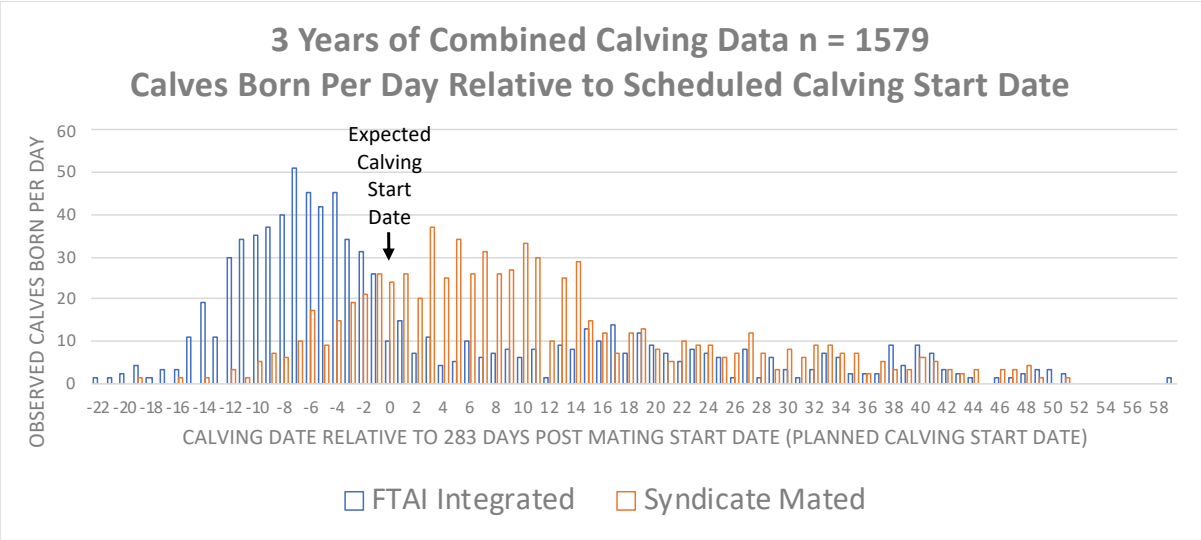

Figure 6. Calving Distribution

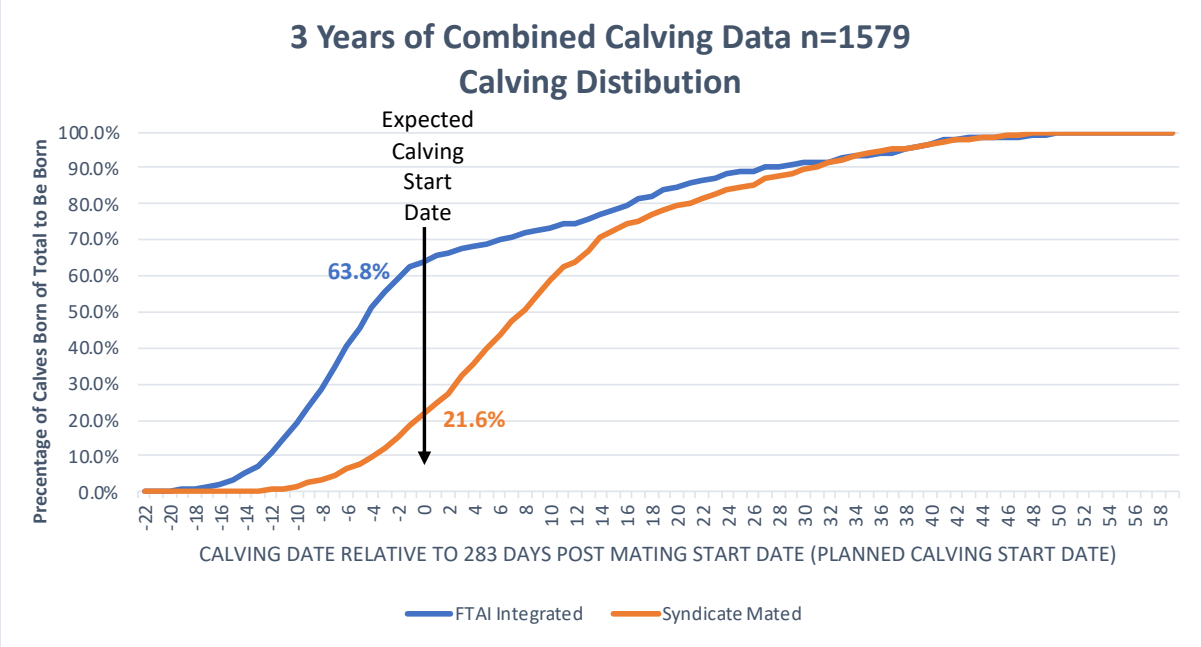

Figure 7. Calving Distribution "Survival Curve".

4.6 Dystocia Rate Data

Dystocia statistics were collected by each individual producer for most of the individual heifers enrolled within the trial. Any heifer which required calving assistance, that died, or that lost its calf while calving was categorized as experiencing dystocia. The average site measured a dystocia rate of 4.9% amongst the heifers enrolled in the FTAI integrated group vs a rate of 10.0% amongst their siblings. This amounted to an actual average reduction in the rate of dystocia of 5.1% or a relative reduction of 51.1% fewer dystocia events comparatively amongst the heifers enrolled in the FTAI

program. Analysing the combined dataset, heifers enrolled in the FTAI program suffered 5.8% dystocia vs. 7.4% amongst their naturally mated siblings representing an actual reduction of 1.63% in total dystocia events across all of the heifers from the 15 replicates, resulting in a relative reduction of the proportion of heifers suffering dystocia of 21.9% comparatively. Statistical analysis of the entire available data set revealed a statistical trend (p = 0.09) towards the integration of FTAI resulting in an improvement in dystocia rates.

Table 5. Dystocia statistics

	Integrated FTAI			Syndicate Mated			Dystocia Reduction	Dystocia % Reduction
Farm	Observed Calvings	Dystocia	% Dystocia	Observed Calvings	Dystocia	% Dystocia		
A.1	128	13	10.2%	147	10	6.8%	-3.4%	-50.0%
B.1	19	0	0.0%	18	0	0.0%	0.0%	0.0%
C.1	19	0	0.0%	20	4	20.0%	20.0%	100.0%
D.1	22	1	4.6%	22	7	31.8%	27.2%	85.5%
E.1	29	2	6.9%	21	6	28.6%	21.7%	75.9%
F.1	42	1	2.4%	31	0	0.0%	-2.4%	-100.0%
G.1	89	5	5.6%	88	4	4.6%	-1.0%	-21.7%
A.2	131	4	3.1%	135	2	1.5%	-1.6%	-106.7%
F.2	41	2	4.9%	34	0	0.0%	-4.9%	-100.0%
G.2	73	4	5.5%	70	6	8.6%	3.1%	36.0%
A.3	110	8	7.3%	109	7	6.4%	-0.9%	-13.2%
G.3	76	3	3.9%	55	6	10.9%	7.0%	63.8%
H.3	79	7	8.9%	85	9	10.6%	1.7%	16.3%
I.3	10	1	10.0%	4	0	0.0%	-10.0%	-100.0%
J.3	12	0	0.0%	10	2	20.0%	20.0%	100.0%
Site Average			4.9%			10.0%	5.1%	51.1%
Combined Dataset	880	51	5.80%	849	63	7.42%	1.63%	21.9%

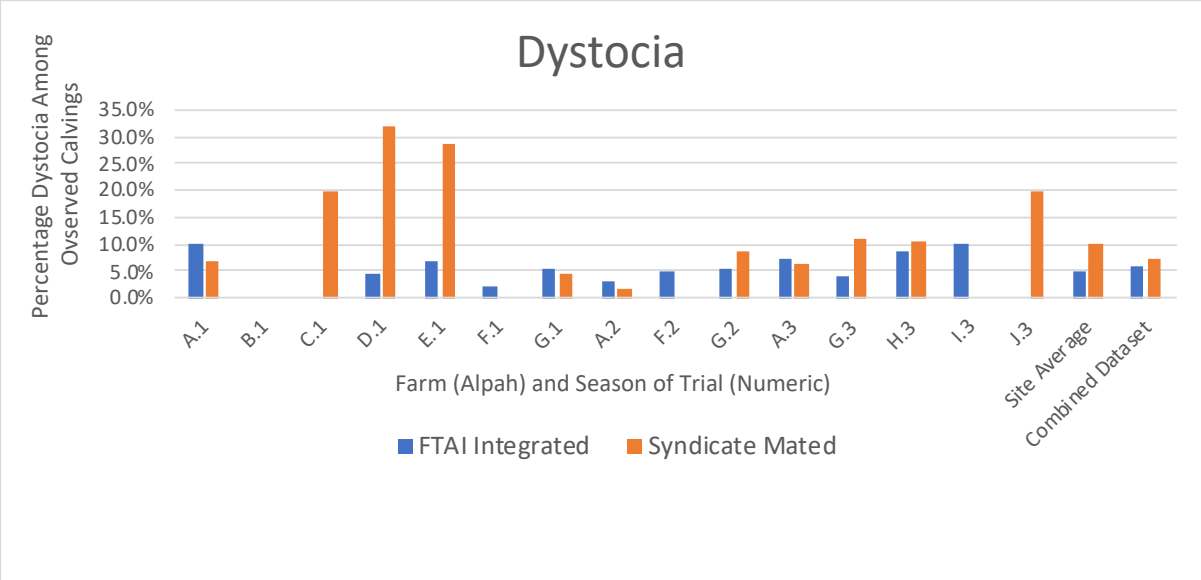

Figure 8. Dystocia statistics

4.7 Calf Mortality Rate Data

Dystocia related calf mortality statistics were collected by each individual producer for the individual heifers enrolled within the trial. The average of the calf mortality statistics from each site revealed a 2.7% rate of calf mortality amongst the heifers enrolled in the FTAI group versus 6.7% amongst those naturally mated, a 4.1% difference, or roughly a 60% reduction amongst those which were AI'd. Analysing the combined dataset, calves from heifers enrolled in the FTAI program suffered a mortality rate of 2.8% vs. 5.5% amongst the calves born from the naturally mated heifers representing an actual reduction of 2.7% across the combined statistics of all of the calves from the 15 replicates, or a reduction of 48.7% comparatively. The differences in calf mortalities were found to be statistically significant ($p < 0.05$) between the two groups, favouring FTAI Integration.

Table 6. Calf mortality statistics.

	Integrated FTAI			Syndicate Mated			Mortality Reduction	Mortality % Reduction
Farm	Observed Calvings	Calf Mortality	% Calf Mortality	Observed Calvings	Calf Mortality	% Calf Mortality		
A.1	128	8	6.3%	147	10	6.8%	0.6%	8.1%
B.1	19	0	0.0%	18	0	0.0%	0.0%	0.0%
C.1	19	0	0.0%	20	2	10.0%	10.0%	100.0%
D.1	22	1	4.5%	22	3	13.6%	9.1%	66.7%
E.1	29	0	0.0%	21	3	14.3%	14.3%	100.0%
F.1	42	0	0.0%	31	0	0.0%	0.0%	0.0%
G.1	89	4	4.5%	88	6	6.8%	2.3%	34.1%
A.2	131	2	1.5%	135	1	0.7%	-0.8%	-106.1%
F.2	41	2	4.9%	34	1	2.9%	-1.9%	-65.9%
G.2	73	2	2.7%	70	4	5.7%	3.0%	52.1%
A.3	110	2	1.8%	109	5	4.6%	2.8%	60.4%
G.3	76	1	1.3%	55	6	10.9%	9.6%	87.9%
H.3	79	2	2.5%	85	4	4.7%	2.2%	46.2%
I.3	10	1	10.0%	4	0	0.0%	-10.0%	-100.0%
J.3	12	0	0.0%	10	2	20.0%	20.0%	100.0%
Site Average			2.7%			6.7%	4.1%	60.4%
Combined Dataset	880	25	2.84%	849	47	5.54%	2.70%	48.7%

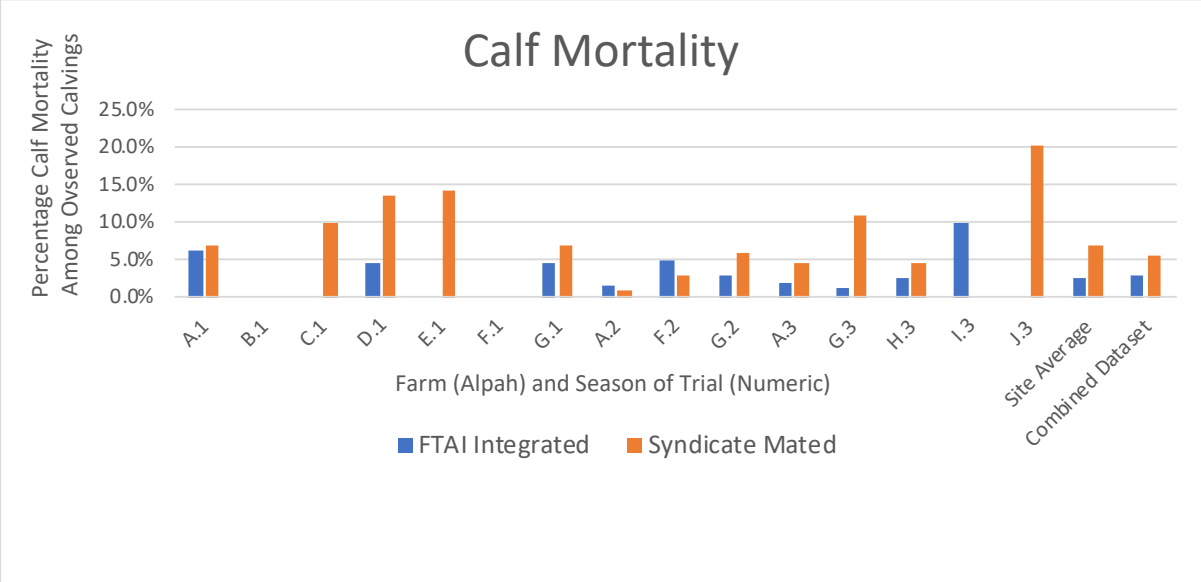

Figure 9. Calf mortality statistics.

4.8 Heifer Mortality Rate Data

Dystocia related heifer mortality statistics were collected by each individual producer for their heifers enrolled within the trial. The average of the heifer mortality statistics from each site revealed a 0.2% rate of heifer mortality amongst the heifers enrolled in the FTAI group vs. 2.6% amongst those naturally mated, a 2.4% difference, or roughly a 94% reduction amongst those which were AI'd. Analysing the combined dataset, heifers enrolled in the FTAI program suffered a mortality rate of 0.3% vs. 1.3% amongst the naturally mated heifers representing an actual reduction of 1% across the combined statistics of all of the heifers from the 15 replicates, or a reduction of 73.7% comparatively. Statistically, there was a trend ($p = 0.11$) for FTAI Integration to reduce the proportion of heifer mortality.

Table 7. Heifer mortality statistics.

	Integrated FTAI			Syndicate Mated				
Farm	Observed Calvings	Heifer Mortality	% Heifer Mortality	Observed Calvings	Heifer Mortality	% Heifer Mortality	Mortality Reduction	Mortality % Reduction
A.1	128	2	1.6%	147	2	1.4%	-0.2%	-14.8%
B.1	19	0	0.0%	18	0	0.0%	0.0%	0.0%
C.1	19	0	0.0%	20	0	0.0%	0.0%	0.0%
D.1	22	0	0.0%	22	2	9.1%	9.1%	100.0%
E.1	29	0	0.0%	21	0	0.0%	0.0%	0.0%
F.1	42	0	0.0%	31	0	0.0%	0.0%	0.0%
G.1	89	0	0.0%	88	1	1.1%	1.1%	100.0%
A.2	131	1	0.8%	135	0	0.0%	-0.8%	-100.0%
F.2	41	0	0.0%	34	0	0.0%	0.0%	0.0%
G.2	73	0	0.0%	70	0	0.0%	0.0%	0.0%
A.3	110	0	0.0%	109	0	0.0%	0.0%	0.0%
G.3	76	0	0.0%	55	4	7.3%	7.3%	100.0%
H.3	79	0	0.0%	85	0	0.0%	0.0%	0.0%
I.3	10	0	0.0%	4	0	0.0%	0.0%	0.0%
J.3	12	0	0.0%	10	2	20.0%	20.0%	100.0%
Site Average			0.2%			2.6%	2.4%	94.0%
Combined Dataset	880	3	0.34%	849	11	1.30%	0.95%	73.7%

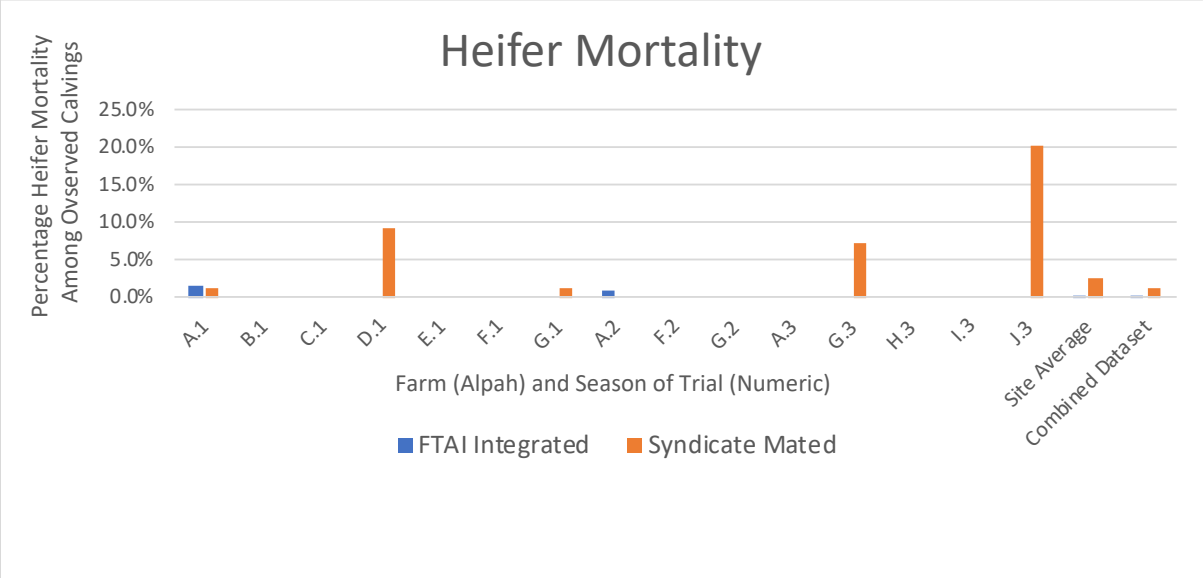

Figure 10. Heifer mortality statistics.

4.9 Weaning Weight Data

Weaning weights were opportunistically collected from seven of the 15 enrolled groups from sites where producers were able to accurately identify the dams of the calves at weaning. All seven groups showed a weaning weight advantage, ranging from six to 21.5 kgs, amongst the calves born from the FTAI integrated heifers vs. those from their naturally mated siblings. The average weaning weight

advantage per property was 15.0 kgs. When the data from all seven sites were combined, the weaning weights of calves born from the FTAI integrated heifers were 13.4kgs heavier than those born from their naturally mated siblings. When analysed statistically, the weaning weights of the calves born from the FTAI Integrated heifers were significantly ($p < 0.01$) heavier than those from the syndicate mated heifers. The average birthdate of the calves delivered from the heifers enrolled in the FTAI integrated group was 8.1 days earlier than the birthdate of the calves born from the naturally mated group. A large proportion of the weaning weight advantage could therefore be attributed to the advantage of the inclusion of synchronization in the FTAI Integrated heifer mating programs. Additionally, the superior EBV's of the AI sires in regard to gestational length, 200 day, and 400-day weights could have contributed further.

Table 8. Weaning weight comparison.

	FTAI Integrated		Syndicate Mated		Difference
	Number	Average Weight	Number	Average Weight	
Farm D.1	20	305	18	285.7	19.3
Farm F.1	42	345	31	329.5	15.5
Farm G.1	75	335.1	81	329.1	6
Farm F.2	39	313.9	34	303.9	10
Farm G.2	64	313.6	62	293	20.6
Farm I.3	11	282	5	270	12
Farm J.3	11	281.5	6	260	21.5
Site Average	262	310.9	237	295.9	15.0

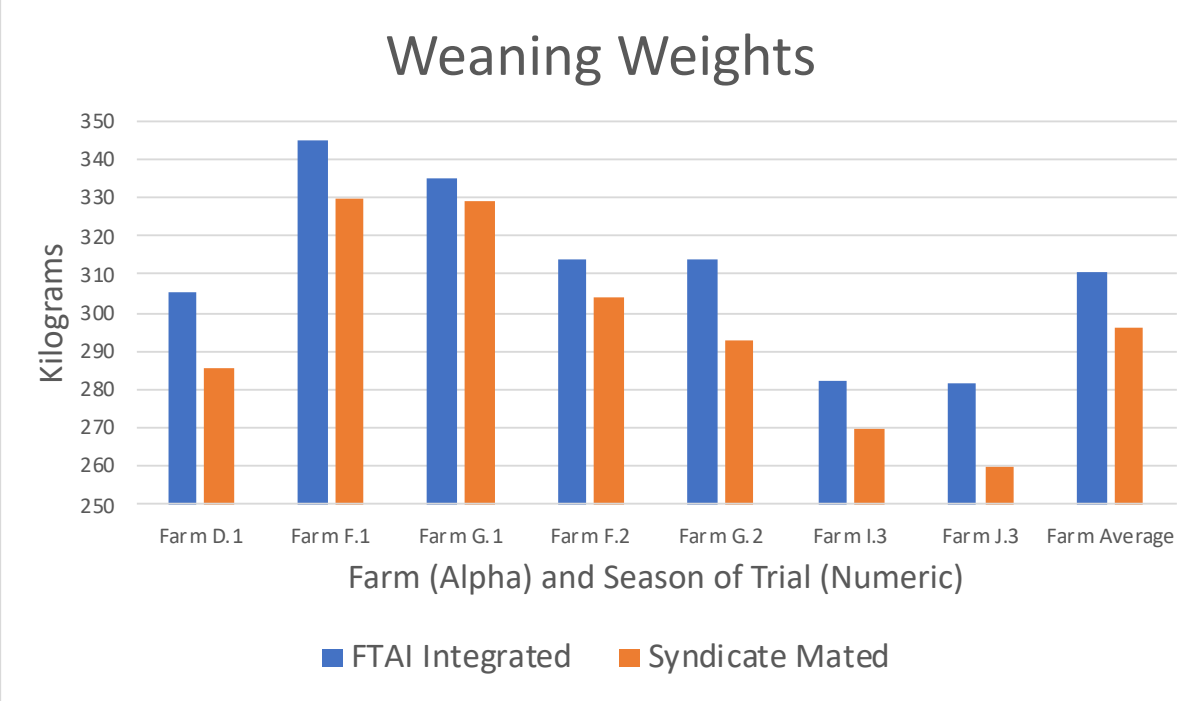

Figure 11. Weaning weight comparison.

4.10 Subsequent Pregnancy Rate Data

The enrolled heifer's subsequent pregnancy rates were measured and compared. 13 groups of heifers were analysed. Nine of the 13 groups demonstrated an improvement in subsequent pregnancy rate

amongst the cows enrolled in the FTAI integrated group as heifers. The average of the proportion of empty cows per site was 9.6% amongst the cows which were AI'd as heifers compared to 14.2% amongst those which were only naturally mated. The average of the measured improvement per individual site was 4.5% fewer non-pregnant cows within those which had been enrolled in the FTAI program as heifers compared to those which had been naturally mated, representing a relative reduction in the proportion of empty cows of 31.9%. When the entire dataset of the 13 groups was combined, the advantage of integrating a FTAI program into the heifer mating program rendered an average improvement in their subsequent mating of 2.7% fewer empty cows, representing a relative reduction in the proportion of empty cows of 21.4%. There was no measurable statistical difference between the two groups (p = 0.24).

Table 9. Rebreeding Data.

	FTAI Integrated			Syndicate Mated			Difference	% Reduction in Empties
Farm	Joined	Empty	% Empty	Joined	Empty	% Empty		
A.1	126	6	4.8%	145	9	6.2%	1.4%	23.3%
C.1	21	3	14.3%	21	4	19.0%	4.8%	25.0%
D.1	22	0	0.0%	22	1	4.5%	4.5%	100.0%
E.1	55	3	5.5%	55	11	20.0%	14.5%	72.7%
F.1	34	6	17.6%	37	5	13.5%	-4.1%	-30.6%
G.1	86	6	7.0%	83	7	8.4%	1.5%	17.3%
A.2	138	29	21.0%	148	34	23.0%	2.0%	8.5%
F.2	40	7	17.5%	35	4	11.4%	-6.1%	-53.1%
G.2	70	3	4.3%	54	11	20.4%	16.1%	79.0%
A.3	123	8	6.5%	137	10	7.3%	0.8%	10.9%
H.3	78	8	10.3%	82	6	7.3%	-2.9%	-40.2%
I.3	12	2	16.7%	5	0	0.0%	-16.7%	-100.0%
J.3	11	0	0.0%	7	3	42.9%	42.9%	100.0%
Site Average			9.6%			14.2%	4.5%	31.9%
Combined Dataset	816	81	9.9%	831	105	12.6%	2.7%	21.4%

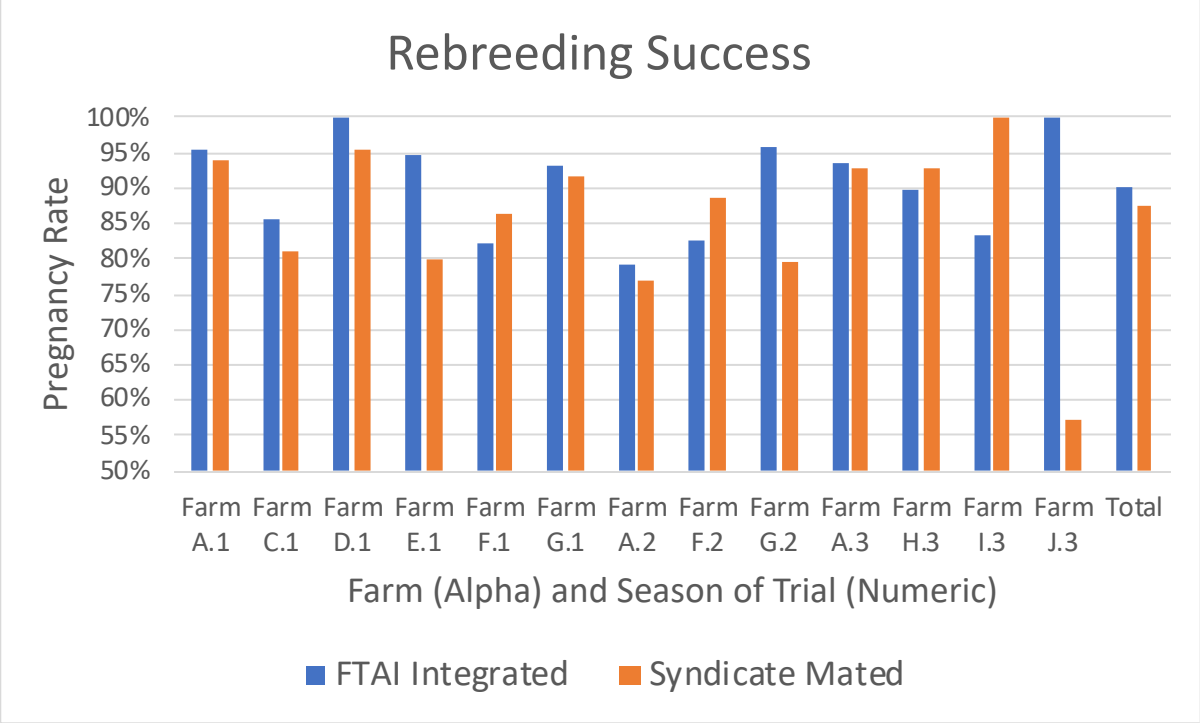

Figure 12. Rebreeding Data.

4.11 Cost Comparison

The cost comparison of mating either naturally or integrating FTAI was initially modelled. An estimate was generated modelling average costs for a FTAI program and modelling expected conception rates. A second model calculated the estimated costs of either FTAI integrated or syndicate mating program for each of the original seven core producers utilizing the actual data collected from their individual sites including all AI expenses prior to subsidisation. The number of bulls used in each individual model was based upon the total number of heifers that would have been mated per site. Within the model, larger producers enjoyed a greater advantage in bull power savings and their travel component was distributed over a larger group of heifers, reducing their additional FTAI cost compared to smaller producers.

4.11.1 Natural Mating Bull Cost Estimation

As part of the PDS, we were asked to model the potential difference in mating costs between natural mating and natural mating preceded by one round of FTAI.

The average Angus bull purchased in Australia in 2017 averaged $7634 (Beef Central, December 7, 2018). The average Angus bull is used for three seasons, and has an approximate estimated salvage value of $2,000, assuming he is not unfit for slaughter. Each bull conservatively consumes as much as 1.5 cow/calf units, representing an additional opportunity cost to a producer. Each additional bull a producer owns essentially displaces 1.5 cows, assuming an 82% pregnancy rate overall (average of pregnancy rate from FTAI and syndicate mated groups in trial), the bull's annual opportunity cost would be equivalent to an opportunity loss of 1.23 calves. Weaned calf values as of Jan 2021 are approximately $1200 ($4 per kg x 300kg) per calf. A bull's estimated annual costs are therefore purchase costs less salvage value divided by expected longevity plus running costs.

$7634(Purchase Price)-$2,000(Cull Value))/3(Expected Longevity) = $1878 (Bull Annual Purchase Price Cost)

($7634 - $2000.00)/3 = $1878.33 = Bull's Annual Purchase Cost

1.5 cow/calf units x 82% (expected pregnancy rate) x $4.00 (current price per kg for weaned calves) x 300kg (conservative weaning weight average for district) = $1476 (Bull Annual Running Opportunity Costs)

1.5 x 82% x $4.00 x 300kg = $1476.00 = Bull's Annual Running Opportunity Cost

$1878.33 (Bull Annual Purchase Price Cost) + $1476 (Bull Annual Running Opportunity Costs) = $3354.33 (Bull Total Annual Costs)

$1878.33 + $1476.00 = $3354.33 = Bull's Total Annual Cost

If we divide a bulls annual running cost of $3354 by a booking of 33 heifers at 3% we come up with an annual bull cost of approximately $100.00 per heifer joined.

$3354 (Bull Total Annual Costs) x 3% (Joining Rate) = $100.62 (Bull Cost per Heifer Mated)

$3354 x 3% = $100.62 = Bull's Cost per Heifer Mated

4.11.2 FTAI Cost Estimation

The potential cost difference between strictly naturally mating or by the inclusion of a single round of FTAI was modelled theoretically to provide context to the modelling developed from measured true costs derived from the PDS.

The cost to a producer of implementing one round of FTAI using a new intra vaginal progesterone device would cost approximately $20 in pharmaceutical costs and potentially as much as $10 in professional fees, not including travel. If the semen used was available at $20 per straw (common price for commercially used Angus sires), the total cost of one round of AI would be approximately $50 per heifer AI'd plus travel and producer labour.

Some producers may choose to mate sufficient heifers to preclude the need for utilizing a backup bull, however most producers would not be satisfied with the overall conception rate from a single round of FTAI. Bulls backing up FTAI programs can be used at a reduced rate of 2%.

If the heifers are initially AI'd utilizing FTAI and 2% back up bulls are implemented rather than at 3% then 2/3 of the bull requirements would cost 2/3 of the previously calculated bull cost of $100.00 or roughly $67 per heifer mated. The total mating cost of integrating one round of FTAI utilizing back up bulls at 2% would therefore be $50 + $67 or $117.00 per heifer mated.

Estimated Cost of Natural Cover @ 3% = $100.00

Estimated Cost of Integrating FTAI + Natural Mating Back Up @ 2% = $117.00

Estimated Additional Cost of Integrating FTAI, not including technician travel and producer labour = $17.00

4.11.3 Trial Based Cost Comparison of Integrating FTAI vs Syndicate Mating

The real time results from the first year of the trial were used to estimate the average mating costs and the relative costs per pregnancy had the producers which had enrolled in the PDS chosen instead to either exclusively syndicate mate or to integrate FTAI across their entire heifer population.

The average Australian Angus bull price from 2017 of $7,634, broken down to an annual cost of $3354 (as above) was used to calculate the cost associated with bull requirements of either 3% or 2% for syndicate vs FTAI integrated mating respectively. Actual drug costs per site per head AI'd in 2017 including travel (but without factoring in left over product and the value of reusable intravaginal devices which would be carried over to the next year) was calculated per producer. Finally, using measured conception rates from 2017 for the two options for each individual site, the costs per heifer mated (with all subsidies removed) and per pregnancy of the two management strategies were able to be compared as though they had been implemented in entirety for the entire heifer population of each producer involved in the PDS in 2017. The average additional cost of integrating FTAI for the average core producer across all of their heifers would have been $22.66 per pregnancy, but varied widely from $3.21 to $60.03. Some producers incurred extra costs through extra travel, by not benefitting from a reduction in bull power, or due to increased fixed costs being distributed over a smaller population of heifers (i.e. large travel bill distributed over a small group of heifers).

Table 10. Mating Cost Comparison

FTAI Integrated	Potential Heifers Mated	Trial Pregnancy Rate	Bull Requirements @ 2%	Total Annual Bull Costs	Bull Cost per Head Mated	AI Costs per Head Mated	FTAI Integrated Mating Cost per Heifer Mated	FTAI Integrated Mating Cost per Pregnancy	Cost Difference
A	391	83.80%	8	$26,832.00	$68.62	$53.40	$122.02	$145.61	$18.84
B	38	100.00%	1	$3,354.00	$88.26	$64.87	$153.13	$153.13	$60.03
C	50	76.00%	1	$3,354.00	$67.08	$62.81	$129.89	$170.91	$3.21
D	49	88.00%	1	$3,354.00	$68.45	$73.42	$141.87	$161.21	$4.76
E	144	77.50%	3	$10,062.00	$69.88	$48.10	$117.98	$152.23	$28.50
F	109	91.40%	2	$6,708.00	$61.54	$46.53	$108.07	$118.24	$13.58
G	204	89.20%	4	$13,416.00	$65.76	$56.17	$121.93	$136.70	$29.71
Site Average					$69.94	$57.90	$127.84	$148.29	$22.66
Syndicate Mated	Potential Heifers Mated	Trial Pregnancy Rate	Bull Requirements @ 3%	Total Annual Bull Costs	Bull Cost per Head Mated	AI Costs per Head Mated	Syndicate Mating Cost per Heifer Mated	Syndicate Mating Cost per Pregnancy	Cost Difference
A	391	81.20%	12	$40,248.00	$102.94	$0.00	$102.94	$126.77	-$18.84
B	38	94.80%	1	$3,354.00	$88.26	$0.00	$88.26	$93.10	-$60.03
C	50	80.00%	2	$6,708.00	$134.16	$0.00	$134.16	$167.70	-$3.21
D	49	87.50%	2	$6,708.00	$136.90	$0.00	$136.90	$156.45	-$4.76
E	144	75.30%	4	$13,416.00	$93.17	$0.00	$93.17	$123.73	-$28.50
F	109	88.20%	3	$10,062.00	$92.31	$0.00	$92.31	$104.66	-$13.58
G	204	92.20%	6	$20,124.00	$98.65	$0.00	$98.65	$106.99	-$29.71
Site Average					$106.63	$0.00	$106.63	$125.63	-$22.66

4.12 Estimated Return on Investment of Integrating FTAI in Commercial Heifer Mating Programs

One of the objectives of the PDS was to develop a cost/benefit ratio or return on investment (ROI) of integrating the intervention of including FTAI into commercial heifer mating programs. There was considerable variation between properties with respect to individual factors excluding the apparent weaning weight advantage. The model to construct an estimate of the ROI of integrating FTAI was based on the combined available dataset from all the properties, however it is recognized that each individual farm's return would be variable. The cost/benefit of individual outcomes were estimated in consultation with a group of core producers. Utilizing data from the PDS an estimate of the potential return on investment of integrating FTAI including the benefit of synchronization into commercial heifer mating programs was calculated. An estimate of the potential return on investment of integrating FTAI over the average producer enrolled in the first year of the PDS was calculated at close to $90.00 for less than a $35.00 investment or a 260% return on investment. Half of the modelled benefit was attributed to the statistically significant improvement in weaning weights attributable to the benefit of synchrony and the EBV's of the AI sires in regard to both gestational length and weaning weights.

Table 11. Modelled Return on Investment Calculation

Measured Parameter	FTAI Integrated	Syndicate	Difference	Potential Value	Cost	Return
Average Mating Cost	$148.29	$125.63	($22.66)	($22.66)	$22.66	
Labour Costs in Man Hours Per 100 Head AI'd	40 Hours	0.00	($40.00)	$30.00/hr	$12.00	
Heifer Empty Rate	17.30%	18.10%	0.80%	$100.00		$0.80
Dystocia Events	5.80%	7.42%	1.62%	$200.00		$3.24
Calf Mortality	2.84%	5.54%	2.70%	$500.00		$13.50
Heifer Mortality	0.34%	1.30%	0.96%	$2,000.00		$19.20
Weaning Weights of Calves (5 Producers)	310.9 Kg	295.9 Kg	15.0 Kg	$4.00		$60.00
Rebreeding Empty Rate (1st Calvers)	9.90%	12.60%	2.70%	$1,000.00		$27.00
Estimated Costs and Returns Per Pregnant Heifer in FTAI Group Not Including Genetic Improvement:					$34.66	$123.74
					Profit:	$89.08

4.13 Core Producer Pre and Post Survey

The original core producers were surveyed prior to and after the close of the PDS. A series of questions were asked to gauge their opinion regarding the value of integrating FTAI into their heifer mating programs. The questions were:

1. Integrating FTAI can reduce the incidence of calving trouble in my heifers.
2. Integrating FTAI can improve my heifer conception rate.
3. Integrating FTAI can improve my heifer rebreeding rate (proportion of heifers that get back in calf to successfully calve as a three year old.)
4. Integrating FTAI can increase my kilograms of calves weaned.
5. Integrating FTAI is affordable.
6. Integrating FTAI is profitable.
7. Integrating FTAI saves me labour costs.
8. Integrating FTAI makes my calving season easier.
9. Integrating FTAI quietens my heifers overall.
10. Integrating FTAI give me greater bull purchasing flexibility.

11. After the trial finishes I will continue to integrate FTAI into my heifer program.

The results of the survey demonstrated strong and consistent improvement in the opinions of each of the individual core producers relating to the demonstration. In fact, all the surveyed producers committed to continuing to implement FTAI in the future.

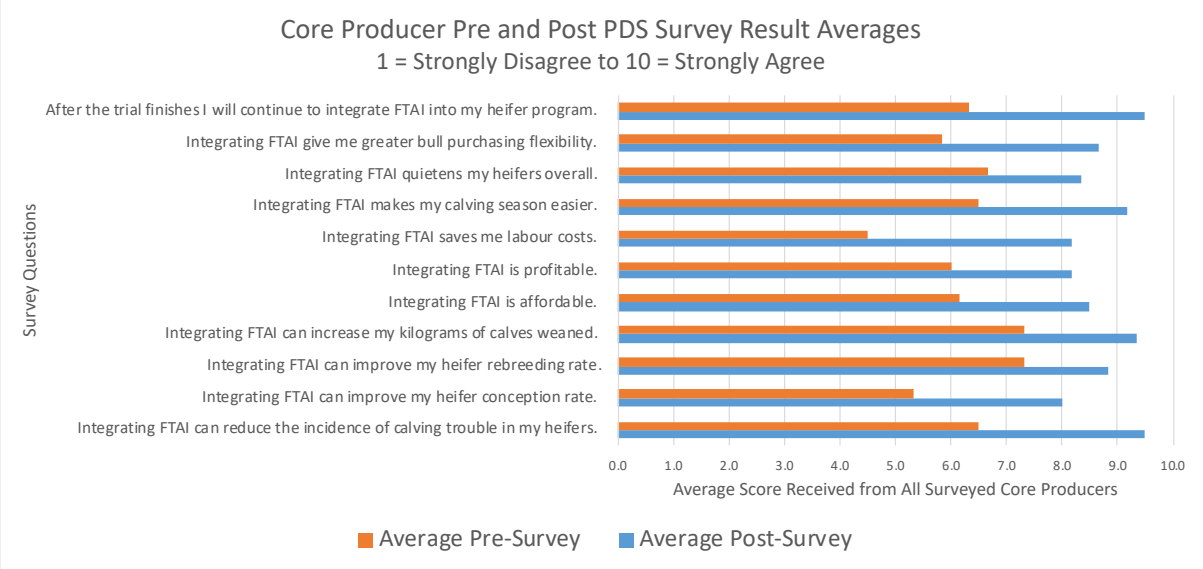

Figure 13. Original Core Producer Pre and Post PDS Survey

4.14 Observer Producer Surveys

4.14.1 Pre and Post Training Survey ASHEEP Spring Field Walk 12/9/2019

Observer producers attending an ASHEEP Spring field walk were surveyed prior to and after listening to a PDS update. 34 producers filled out the pre-survey, 30 filled out the post survey. The results showed an uptake of information delivered and an improvement in the proportion considering integrating FTAI into their heifer mating programs in the future as a result of the information received. 44.1% of the surveyed producers indicated they wished to implement FTAI into their heifer mating programs in the future prior to the field day, some of which may have been influence by past experience or by familiarity with the PDS. After the field day, 70% of the respondents indicated they wished to adopt the practice in the future. This demonstrated an improvement of 29% from the single field day, exceeding our aspirational goal of influencing 20% of observer producers to adopt the practice.

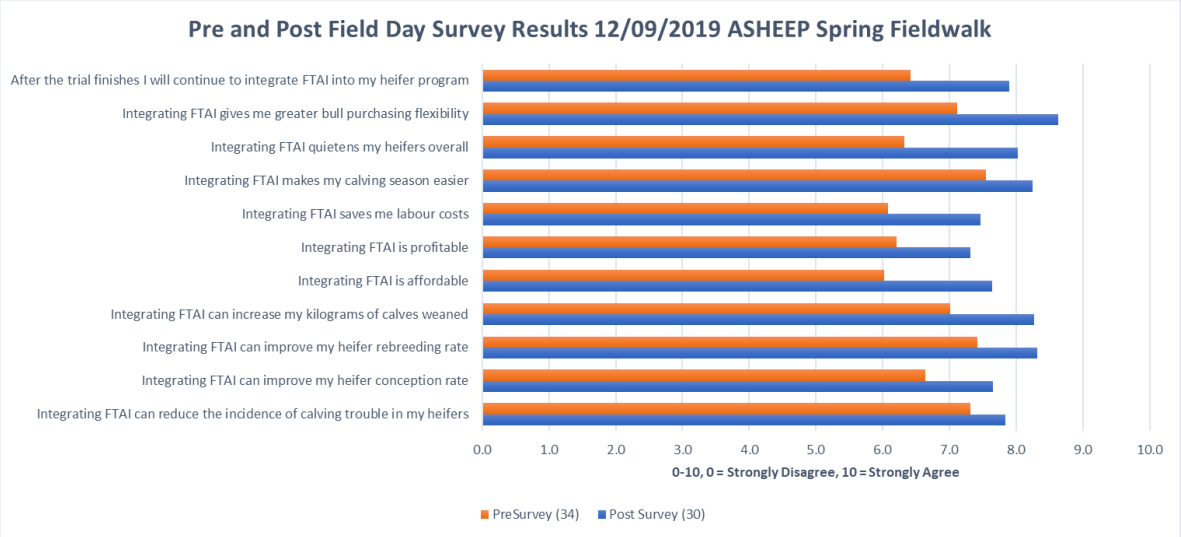

Figure 14. Observe Producer Pre and Post Field Day Survey

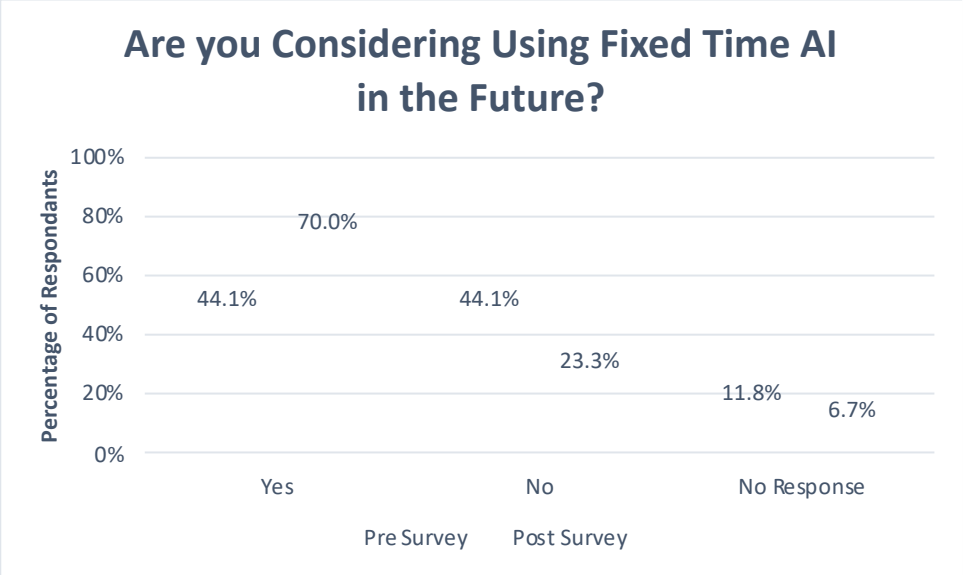

Figure 15. Observer Producer Pre and Post Field Day Survey

5 Discussion

5.1 Objectives

This PDS was designed to demonstrate the value of integrating fixed time artificial insemination (FTAI) into the heifer breeding programs of commercial beef producers. The PDS was expected to demonstrate a comparative improvement in conception rates, reduce dystocia, reduce calf mortality, reduce heifer mortality and improve rebreeding rates. It was expected that the intervention would also improve the weaning weight of calves born from the FTAI integrated group compared to those born from natural syndicate mating. The project was also designed to emphasize the value of both ensuring adequate heifer premating weights and of condensing the calving pattern of first-time calving heifers.

Specifically, our objectives were:

By December 2020, in the Esperance region of WA this project will:

1. Demonstrate on at least 20 properties (core producers) that tighter joining periods via adoption of FTAI and the use of genetically superior sires can:
    a. Reduce dystocia indicators in maiden heifers by an average of 40% (e.g. 6% vs 10% dystocia, 2.4% vs 4% calf mortality, 0.6% vs 1% heifer mortality)
    b. Reduce empty rate in short mated heifers by 30% e.g. from 15% to 10%
    c. Reduce empty rate in the heifers subsequent mating by 20%

2. Result in at least 50% of core producers continuing to adopt tighter joining periods via adoption of FTAI and the use of genetically superior sires in their commercial heifer breeding program post the project.

3. Increase awareness and knowledge of heifer management strategies to reduce the prevalence of dystocia in maiden heifers by at least 75% of observer producers attending demonstration sites / field days, with 20% indicating they will adopt the practice

The goal of the project was to engage 20 core producers throughout the three years of the project. Due to a range of circumstances, we failed to meet our objective as we were unable to secure 20 producers. The timing of the approval process prevented some producers from engaging in the first year, climactic situations prevented some producers from participating in the second and third year, and a number of producers pulled out of the program to integrate FTAI across all their heifers instead. We had made a decision to only enrol producers which had not AI'd previously, perhaps we should have allowed those with past experiences with FTAI to enrol in order to improve the dataset. Regardless, we were able to enrol some of the larger area producers including our single largest client, mating 3500 cows, and overall producer compliance was good. The PDS was run with seven core producers in year one, three of which participated in year two, two of which remained in year three accompanied by three new producers. In total there were ten producers representing 15 individual mating opportunities over three years. All the original seven producers except two pulled out by the third year with the intention of integrating FTAI over their entire future heifer replacement groups. The remaining two also intend to continue integrating FTAI in their herds now that the trial is completed. Over the three years, approximately 2,400 heifers were mated within the PDS.

The project showed that on average the integration of FTAI utilizing calving ease sires was able to reduce dystocia indicators across all three parameters on average (dystocia, calf mortality, and heifer mortality) meeting our objectives. The objective was to "demonstrate on… properties that adoption of FTAI and the use of genetically superior sires can… reduce dystocia indicators in maiden heifers by an average of 40%..." The average farm demonstrated a reduction in dystocia of 51%, of calf mortality of 60.4%, and of heifer mortality of 94%. By combining all of the heifers into a single dataset, dystocia, calf mortality, and heifer mortality were reduced by 21.9%, 48.7%, and 73.7% respectively. Dystocia and heifer mortality statistics tended to favour the heifers enrolled in the FTAI Integrated group with p values of 0.10 and 0.11 respectively. Calf mortality statistics favoured heifers enrolled in the FTAI integrated group with a p value of less than 0.05.

The project demonstrated an improvement in pregnancy rate as a result of the intervention, however we failed to meet our objective of reducing the proportion of empty heifers within the FTAI integrated heifers compared to their naturally mated siblings by 30%. Eleven of the 15 sites demonstrated an improvement in pregnancy rate at pregnancy test. The average farm enjoyed a 17.5% reduction in the proportion of empty heifers whilst the combined dataset revealed a

reduction of 4.6% comparatively, short of our goal of 30%. Overall pregnancy rates tended to favour the integration of FTAI with a p value of 0.14.

Our objective had been to demonstrate a 20% reduction in the proportion of the heifers which had been enrolled in the FTAI program that failed to rebreed at their subsequent mating post calving. We were able to achieve our objective of demonstrating a strong and significant improvement in the rebreeding success of the heifers enrolled in the FTAI integrated group compared to those syndicate mated. The average farm enjoyed a relative improvement of 31.9% in the proportion of animals which failed to rebreed successfully whilst the combined dataset demonstrated a 21.4% improvement. However, the statistical analysis did not demonstrate a difference between treatments ($p = 0.24$).

As a result of synchronization, and as intended, the project showed a statistically significant improvement in the calving distribution over the first 28 days of the calving season, resulting in the majority of the heifers from the FTAI integrated group calving well in advance of the heifers from the control (syndicate) mated group. In most instances the calves conceived from AI calved in advance of the scheduled calving start date, presumptively due to the selection of sires with EBV's for short gestational length. The heifers enrolled in the FTAI integrated group calved statistically ($p < 0.01$) earlier by 8.1 days. It is presumed that the improvement in rebreeding rate was primarily driven by the observed improved calving distribution and secondarily by the relative reduction in dystocia within the FTAI integrated heifers.

Though not in the trial design, we were able to collect weaning weights from seven of the 15 sites and demonstrated a significant ($p < 0.01$) weaning weight advantage amongst the calves born from the FTAI integrated groups primarily due to the intended timing advantage of synchronizing the heifers to be AI'd on the mating start date. The weighted average weaning weight advantage amounted to 13.4Kgs.

Encouraging producers to monitor and act upon their heifer premating weights has been successful on the back of a long history of extension to that effect. Reinforcing this knowledge, heifers enrolled in the trial which were mated under 300Kgs experienced lower pregnancy rates than their heavier siblings. The trial demonstrated that premating weight tended to have a statistical impact on fertility ($p = 0.09$).

One of the primary goals of the PDS and our last objective had been to encourage uptake of the management practices trialled amongst the core producers. Four of the seven original core producers opted to pull out of the second year of the trial intending to implement the practices outlined within the PDS across their entire heifer mating programs in lieu of ongoing subsidization. A fifth core producer opted out after the second year to implement the intervention across their entire heifer population going forward. The two remaining original core producers both intend to continue to integrate FTAI into their heifer mating programs now that the trial is concluded. One of the three new participants in year three intends to continue integrating FTAI going forward. One of the remaining two new participants believes using bulls is easier and the other did not show strong advantages within his own program. Recognizing that none of the core producers had planned to utilize FTAI in their heifer mating programs or had AI'd previously prior to the PDS, this is an astounding result.

Survey work was completed, both through the address list of ASHEEP and through the producer address list of Swans Veterinary Services. Pre and post surveys were completed at a field day covering the PDS and its findings.

Extension work has continued both in Esperance, at the state level in WA, at the national level at Beef Week in Rockhampton and with further opportunities underway. Verbal feedback from attendees has been very encouraging. It would appear that the PDS has the potential to have national significance for southern beef enterprises.

5.2 Outcomes

Our contract included a list of aspirational outcomes listed below. Each of the aspirational outcomes was achieved to our satisfaction.

OUTCOMES
The outcomes of this project include-

- Adoption of dystocia reduction strategies
- Reduced level of dystocia indicators by 40% in maiden heifers
- Improved heifer rebreeding success by 20%
- Greater understanding of strategies available to reduced dystocia in maiden heifers.
- Increased skills of producers
- Greater uptake of integrating FTAI into commercial cow herds
- A better understanding of the opportunities that exist in acquiring higher accuracy and higher indexing bulls through AI.
- Greater appreciation of the role of synchrony in improving calving patterns.
- Greater awareness of strategies to improve heifer rebreeding success.
- Greater appreciation of the role of mating weight in breeding success.

5.3 KASA

The producers involved in the PDS have demonstrated that they have the **Knowledge** and **Skills** to implement FTAI programs into their heifer mating programs and that their **Attitude** towards FTAI is significantly improved, indeed most of them have **Aspirations** to continue implementing FTAI into their heifer mating programs in the future within their production systems. We can't be happier with the outcomes of the intervention, and from the survey work, neither can our core producers.

6 Conclusions/recommendations

This PDS has demonstrated to a number of Esperance producers that within a southern beef breeding production system, integrating Fixed Time Artificial Insemination into commercial producer's heifer mating programs can improve dystocia parameters, can improve rebreeding rates, can improve weaning weights and is not only affordable but profitable. When we could reduce dystocia and improve the calving distribution, the heifers enrolled in the FTAI program were recognized at a great advantage to their naturally mated siblings. The benefits associated with calving early and without calving intervention can be expected to continue to pay dividends for several subsequent joinings, improving pregnancy and weaning weights annually for several seasons.

The results of the PDS were analysed statistically at a basic level using the combined data from individual sites by Dr. Cliff Lamb at the University of Texas A and M and Dr. Josh Aleri of Murdoch University. Dr. Lamb believes further statistical analysis utilizing individual data may generate greater measurable differences between the treatment groups and he is willing to co-publish the results should they be worthy of publication.

Future research and development could see this PDS replicated in other southern enterprises or in northern enterprises where controlled mating occurs. The development of simple, predictable FTAI protocols coupled with the availability of inexpensive high accuracy sires with excellent Breedplan EBV's could be a catalyst for a breeding revolution within the Australian commercial beef sector. The benefits could be reaped by producers and beef consumers alike.

Improving both the reproductive efficiency and the genetics of individual herds is the key to improving the profitability of individual producers and the value chain that they service. The results of this PDS have demonstrated a potential opportunity for beef producers throughout Australia. We were able to document trends towards improvement in every aspect of the beef production system related to reproductive efficiency. The findings are both palatable and digestible, capable of being delivered at field days, through web events, or in printed media. Delivered succinctly and clearly, the results of this trial have the ability to initiate change, a change that could revolutionize the way we mate heifers here in Australia.