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Feed intake measurement of cattle in the Tullimba R&D Feedlot

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Abstract

This report covers the RV9 to RV13 groups of Angus steers in cohort 3 which were in the Tullimba residual feed intake (RFI) test facility during the period 23/10/2014 to 01/04/2015.

A summary of cattle performance by group is as follows:

RV9: 114 Angus steers had their first full feed date on 23/10/2014 and finished in the feedlot on 4/01/2015 (72 trial days). They generally performed well and averaged around 16.3 kg/day feed intake with an average weight gain of 1.47 kg/day (range 0.96 - 2.03 kg/day) during their 72 day test period, after adaptation to the feeders.

RV10: 57 Angus steers had their first full feed date on 7/01/2015 and finished in the feedlot on 30/03/2015 (74 trial days). They generally performed well and averaged around 14.2 kg/day feed intake with an average weight gain of 1.53 kg/day (range 1.15 - 2.07 kg/day) during their 74 day test period, after adaptation to the feeders.

RV11: 76 Angus steers had their first full feed date at Tullimba on 19/01/2015 and finished in the feedlot on 13/04/2015 (75 trial days). They generally performed well and averaged around 13.2 kg/day feed intake with an average weight gain of 1.47 kg/day (range 0.80 - 2.01 kg/day) during their 75 day test period, after adaptation to the feeders.

RV12: 250 Angus steers had their first full feed date at Tullimba on 4/03/2015 and finished in the feedlot on 24/05/2015 (82 trial days). This group generally performed well and averaged around 14.6 kg/day feed intake with an average weight gain of 1.54 kg/day (range -0.40 - 2.41 kg/day) during their 82 day test period, after adaptation to the feeders

RV13: 97 Angus steers had their first full feed date at Tullimba on 1/04/2015 and finished in the feedlot on 14/06/2015 (75 trial days). RV13 generally performed well and averaged around 12.9 kg/day feed intake with an average weight gain of 1.54 kg/day (range 0.53 - 2.18 kg/day) during their 75 day test period, after adaptation to the feeders.

Retrieval of valid daily feed intake data allows robust estimates of RFI and EBVs. Feed intake and live weight data from manual weighing was reported to the breeder groups fortnightly and was be supplied to the Angus Society and BreedPlan via Jim Cook, AGBU. A digital copy of all project data (including metadata) was provided to MLA on memory sticks.

Executive Summary

The Tullimba feedlot facility has installed Growsafe feeders that allows the estimation of the feed use efficiency (RFI) of beef cattle on *ad lib* feedlot rations. Individual cattle have their feed intakes and liveweights measured over a period of at least 70 days. These phenotypic measurements form part of the Beef Information Nucleus (BIN) program of research.

This project involved the testing of 590 Angus steers from October 2014 until April 2015. There were 5 groups (RV9 – RV13) with an average start weight of 535 kg, average end weight of 644kg and an average daily gain of 1.52 kg/day.

A summary of the performance of each group is as follows:

RV9: 114 Angus steers averaged around 16.3 kg/day feed intake with an average weight gain of 1.47 kg/day (range 0.96 - 2.03 kg/day) during their 72 day test period, after adaptation to the feeders.

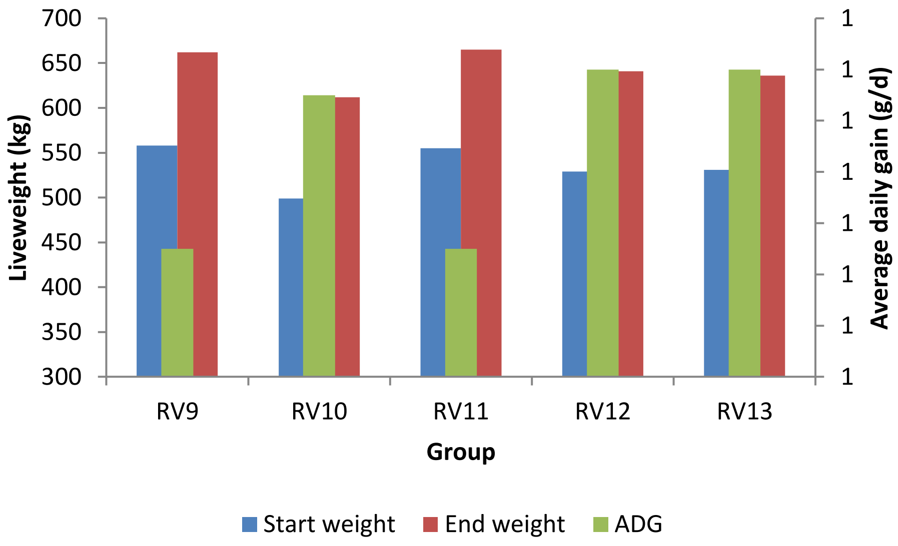
RV10: 57 Angus steers averaged around 14.2 kg/day feed intake with an average weight gain of 1.53 kg/day (range 1.15 - 2.07 kg/day) during their 74 day test period, after adaptation to the feeders.

RV11: 76 Angus steers averaged around 13.2 kg/day feed intake with an average weight gain of 1.47 kg/day (range 0.80 - 2.01 kg/day) during their 75 day test period, after adaptation to the feeders.

RV12: 250 Angus steers averaged around 14.6 kg/day feed intake with an average weight gain of 1.54 kg/day (range -0.40 - 2.41 kg/day) during their 82 day test period, after adaptation to the feeders

RV13: 97 Angus steers averaged around 12.9 kg/day feed intake with an average weight gain of 1.54 kg/day (range 0.53 - 2.18 kg/day) during their 75 day test period, after adaptation to the feeders.

Estimates of RFI and EBVs were supplied to the Angus Society and BreedPlan by AGBU. A digital copy of all project data (including metadata) was provided to MLA.



Start and end liveweights and weight gain of each group.

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1 Background

1.1 RFI test facility

1.1.1 RFI

Residual feed intake (RFI, also called ‘ net feed intake ’ or NFI in Australia) is a measure of feed use efficiency. Net feed intake refers to its derivation as actual feed intake net (or less) of expected feed intake for bodyweight (BW) maintained and average daily gain (ADG) by an animal over a test period. In beef cattle, RFI is usually calculated as the difference between the actual feed intake by an animal over a test period minus that expected or predicted based on its size and growth rate (Herd et al. 2003a). An animal with a lower feed intake than expected is considered more effi cient. Heritability of RFI in growing cattle ranges from low to moderate (Arthur and Herd 2006; Arthur and Herd 2008, 2012). Selective breeding for low-RFI animals offers the potential to produce progeny that will eat less with no compromise in size or growth performance (Archer et al. 1999). Feed is the largest recurring input cost in a feedlot operation. However, the opportunity to improve profitability in the feedlot through animal breeding for lower RFI is dependent not only on the existence of genetic variation in RFI, but also on the magnitude of genetic associations with other key production traits. For feedlot cattle, these traits include growth rate, feed conversion ratio (FCR), and carcass and meat quality traits, many with tight market specifications and penalties for non- compliance. Positive genetic correlations between RFI and subcutaneous fat depth have been reported in young Angus bulls and heifers (Arthur et al. 2001), and in feedlot-fed steers and heifers (Robinson and Oddy 2004 ; Barwick et al. 2009; Wolcott et al. 2009), indicating that breeding for low RFI may be expected to reduce levels of subcutaneous fat. Genetic merit of cattle for breeding purposes is described by estimated breeding values (EBV; BREEDPLAN 2010), with trial RFI-EBV first becoming available in Australia in 2002 in the Angus breed (Angus Society of Australia 2002), and BREEDPLAN RFI-EBV becoming available at the end of 2013 for Angus cattle (Herd et al. 2014).

Providing feed to animals is a major cost input inalmost any animal production system. The pig and poultry industries have made significant improvements in feed efficiency (Luiting, 1991). The provision of feed is also a major cost in beef production, and improvement of the output of beef per unit of feed used over the whole production system would be of significant economic benefit. National genetic improvement programs for beef cattle need to also consider avenues for reducing inputs in order to improve efficiency and profitability. There is considerable individual animal variation in feed intake above and below that expected or predicted on the basis of size and growth rate (e.g., mice: Archer et al. 1998; poultry: Luiting and Urff 1991; pigs: Foster et al. 1983; cattle: Archer et al. 1999b).

1.1.2 Genetic Variation in Feed Efficiency of Beef Cattle

Feed intake is generally correlated with output traits, and therefore examination of feed intake or production outputs in isolation from each other usually provides little or no indication of the efficiency of production. Cottle (2011) explored whether RFI could be used to indirectly select for lower methane production in Angus via a multi-trait index approach.

Evidence for genetic variation in indices of feed efficiency, including RFI, published for beef cattle up to 1996 was reviewed by Archer et al. (1999b). Since then, genetic variation in RFI has been reported in Australia (Arthur et al., 2001b), Britain (Herd and Bishop, 2000), Canada (Liu et al., 2000), and France (Renand et al., 1998). The efficiency of a beef production system depends on the summation of many traits that include feed intake of both the breeding herd and slaughter generation, growth traits, and other cow traits, such as mature size and reproductive rate (Archer et al., 1999b). Selection for lower RFI measured postweaning has the potential to lead to a reduction in the intake of young cattle and of cows, with no compromise in growth performance or increase in cow size. This is not the case for selection to reduce feed:gain ratio (F:G) in which the genetic correlation with growth rate can lead to an increase in cow size and feed intake, which is not always desirable (Archer et al., 1999b).

1.1.3 Genetic Correlations

It was early recognised that individual hens with the same BW require different amounts of feed for the same level of production (Byerly 1941). In growing beef cattle, Koch et al. (1963) found BW maintained and ADG affect feed requirements and suggested that feed intake could be adjusted for BW and weight gain, effectively partitioning feed intake into two components: 1) the feed intake expected for the given level of production and 2) a residual portion. The latter was used to identify animals which deviated from their expected level of feed intake, and was heritable (0.28 ± 0.11), with efficient animals having lower (negative) RFI. RFI can also be used to detect differences in the efficiency of feed utilization not revealed by ADG or F:G, because of the correlation between these traits (Okine et al. 2001).

The most comprehensive study of the responses to selection on postweaning RFI in beef cattle is that conducted by NSW Agriculture at the Agricultural Research Centre, Trangie, NSW Australia, between 1993 and 2001 (Arthur et al. 2001a; 2001b). Archer et al. (1999b) summarised estimates of genetic variation in RFI of growing cattle. Low values for the heritability of RFI appear to reflect higher measurement error (e.g., Herd and Bishop, 2000; CRC, 2001). Improving herd production efficiency through RFI also depends on genetic correlations with other key production traits such as carcass and meat quality traits at slaughter, and mature size, feed intake, milk production, and lifetime reproductive performance of cows. There is evidence for a genetic association of low RFI (high efficiency) with lower fatness (increased lean). If this genetic correlation with fatness is expressed in progeny destined for slaughter or in daughters entering the cow herd, then selection for low RFI might affect market suitability and reproductive performance of the progeny. Results from divergent selection on postweaning RFI found no change in subcutaneous fat depths in progeny in weanling tests (Herd et al. 1997), no compromise in meeting market specifications by feedlot steers (Richardson et al. 1998), and no change in subcutaneous fat depths in cows (Arthur et al. 1999). Arthur et al. (2001d) reported RFI genetic correlations in Charolias were high between weanling and yearling tests (0.75 ± 0.12). Results from a single generation of divergent selection on postweaning RFI demonstrate favorable correlated changes in RFI and F:G in feedlot steers (Richardson et al. 1998). Genetic correlations between post- weaning RFI and mature cow size are low or zero, indicating that breeding to improve feed efficiency in growing animals though selection against postweaning RFI need not be accompanied by an increase in cow size. This is not the case if selection to reduce postweaning F:G is employed because of the stronger genetic correlation of postweaning F:G with cow size (−0.29 ± 0.24, Herd and Bishop 2000; and −0.54, Archer et al. 2002).

The genetic correlation between postweaning RFI with feed intake by the cow is high and with RFI of the cow very high (0.64 and 0.98, respectively; Archer et al., 2002). The genetic correlations for postweaning F:G with cow feed intake and cow F:G appear to be low (0.15 and 0.20; Archer et al., 2002) suggesting that selection to reduce postweaning F:G to likely to be accompanied by only small reduction in cow feed intake and F:G. These genetic correlations indicate that selection against postweaning RFI has the potential to lead to a reduction in feed intake by cows with little change in cow size, thus improving the efficiency of the cow herd. This is an important advantage over selection for increased postweaning growth or decreased F:G that can be accompanied by an increase in cow size, which is not always desirable. Reduction in physical activity, at least within the confines of the test environment, has been shown for low-RFI animals (e.g., laying hens: Luiting et al. 1991; pigs: De Haer et al. 1993; young beef bulls: Richardson et al. 1999). RFI allows comparison between individuals differing in level of production during the measurement period possibly due to variation in basic metabolic processes. For example, genetic variation in maintenance energy requirement per kilogram of metabolic BW is closely associated with genetic variation in RFI in young Hereford bulls (genetic correlation 0.93 ± 0.06; Herd and Bishop 2000). In a typical beef cattle herd, the feed energy for maintenance represents 60 to 75% of the total energy requirements of individual breeding cows, and the cost of maintaining cows is clearly an important factor in determining the efficiency and profitability (Archer et al., 1999b).

However, the correlation between RFI measured in a feedlot on *ad lib* feed with RFI on pasture with restricted feed intake is low (Herd et al. 2011). This suggests the RFI results from Tullimba may only be useful for lot feeding performance at the end of the cattle life production cycle. The high cost of RFI measurement and such interactions with feed type and level may limit its use in breeding schemes (Lanna 2009).

1.1.3 Predictive Value of RFI

In Australia, a standards manual has been produced by the Australian Performance Beef Breeders Association, representing breed societies, and forms the basis of a national accreditation scheme to ensure that standardized and accurate data are generated for genetic analyses (Exton, 2001).

Measurement of feed intake with current technology is expensive and difficult (Cottle 2013) so the cost - benefits of RFI are questionable. The length of a RFI test and the amount of data collected needs to be optimized to reduce the cost of testing animals. The current recommendation to the Australian industry for a 70-d RFI test is based on the results reported by Archer et al. (1997). They showed that for British breed cattle tested for RFI, with feed intake recorded daily and animal BW measured weekly, that while 35 d was adequate to measure feed intake, 70 d was required to accurately measure growth and RFI. Archer and Bergh (2000) analyzed data from centralized tests in South Africa for young bulls from five breeds and four biological types to conclude that while a test of between 42 and 56 d was sufficient for measurement of growth rate, feed intake required 56 to 70 d to measure accurately, and RFI required around 70 to 84 d. For RFI tests conducted following Australian standards, if the accuracy in measuring growth could be improved, then it might be possible to reduce the length of the RFI test, with an increase in the number of animals that can be tested per year (Archer et al., 1999a). More frequent weighing of cattle can improve the accuracy of measurement of growth (Archer et al. 1999a; Graham et al. 1999; Tatham et al. 2000) and thereby reduce the length of the standard 70-d RFI test. The US Beef Improvement Federation recommends RFI be calculated from 70-d tests preceded by a 21-d adjustment period, similar to Australia. Culberston et al. (2015) recently concluded that average daily DMI values from a 42-d test ($P < 0.0001$) and RFI values from a 56-d test ($P <$

0.0001) adequately predict DMI and RFI when compared to a 70-d test and suggested that testing periods of 42 d for determining DMI and 56 d for RFI could reduce testing costs and result in collection of data on a larger number of animals per year, in turn resulting in more data for genetic evaluation.

Cattle may be tested for RFI either at centralized test facilities or on-farm. Archer et al. (1999b) reviewed the merits of both test regimens. An issue common to both approaches is the influence of pretest environmental affects on subsequent test performance. Archer et al. (1999b) recognized two approaches might be used to remove differences due to the previous history, one biological and the other statistical. A common pretest adjustment phase can be used to biologically remove differences between animals measured in a test group. Age of dam is an environmental factor known to influence liveweight and growth of young cattle. Arthur et al. (2001d) showed that while age of dam affected ADG, feed intake, F:G, and final BW, it did not affect RFI in weanling tests on Charolais bulls.An alternative approach is to restrict comparisons between animals to those raised in the same environment from conception to measurement (i.e., in the same contemporary group), as currently occurs with other traits recorded in BREEDPLAN (Skinner and Sundstrom 1997). The Australian standards manual requires a minimum pretest adaptation period of 21 d and testing of animals in contemporary groups. The Angus groups on test at Tullimba come from different properties. Comparisons of RFI may be less influenced by pretest environmental affects than are growth-related traits. For example, Herd and Bishop (2000) showed that RFI over a performance test was not affected by differences in pretest rearing treatments, whereas growth related traits, such as start-of-test BW and end-of-test BW, and, in some years, ADG and F:G were affected.

2 Projective Objectives

2.1 Collect data

To collect individual animal feed intake and weight data for Beef Information Nucleus (BIN) projects, and other MLA co-funded R&D projects.

2.2 Store data

To collect and store this data as well as other data generated by GrowSafe and other recording equipment. This data to be stored in a database accessible by UNE researchers subject to Clause 8.9 of the Agreement.

2.3 R&D

To conduct R&D using this data, subject to Clause 8.9 of the Agreement.

3 Methodology

3.1 Cattle Groups

Approximate number and sex of cattle in Cohort 3 (Angus terminology) to be tested for residual feed intake (RFI) using Growsafe equipment at the Tullimba.feedlot:

RV9 Group	117 Angus steers
RV10 Group	75 Angus steers
RV11 group	60 Angus steers
RV12 group	105 Angus steers
RV13 group	240 Angus steers

Approximate date of entry to feed period:

RV9 Group	22-Oct-2014
RV10 Group	17-Dec-2014
RV11 Group	22-Feb-2015
RV12 Group	08-Mar-2015
RV13 Group	22-Feb-2015

Payment is based on $2/head/day for trial periods (7+~75 days) in feeders.

4 Results

4.1 RV groups average perfomance

4.1.1 RV9

Feedlot pens 12, 13, 14

Head count = 116 – 2 sick = 114

First full feed date = 23/10/2014
Last full feed date = 4/01/2015
Number of full feed days = 84

Trial First full feed date = 4/11/2014
Trial Last full feed date = 14/01/2015

Trial Start Wt Date = 4/11/2014
Trial End Wt Date = 15/01/2015
Number of Trial days = 72

Average Feed Intake (g) = 16,266	(11,924 – 19,970)
Average Start Weight (kg) (Fitted) = 558	(410 - 628)
Average End Weight (kg) (Fitted) = 662	(491 - 764)
Average of ADG (kg) = 1.47	(0.96 - 2.03)

4.1.2 RV10

Feedlot pen 15

Head count = 57

First full feed date = 7/1/2015
Last full feed date = 29/3/2015
Number of full feed days = 82

Trial First full feed date = 15/1/2015
Trial Last full feed date = 29/3/2015

Trial Start Wt Date = 15/1/2015
Trial End Wt Date = 30/3/2015
Number of Trial days = 74

Average Feed Intake (g) = 14,298	(8,551 – 17,526)
Average Start Weight (kg) (Fitted) = 499	(442 - 572)
Average End Weight (kg) (Fitted) = 612	(539 - 682)
Average of ADG (kg) = 1.53	(1.15 - 2.07)

4.1.3 RV11

Feedlot pen 14

Head count = 76 - 2 sick = 74

First full feed date = 19/1/2015
Last full feed date = 12/4/2015
Number of full feed days = 84

Trial First full feed date = 28/1/2015
Trial Last full feed date = 12/4/2015

Trial Start Wt Date = 28/1/2015
Trial End Wt Date = 13/4/2015
Number of Trial days = 75

Average Feed Intake (g) = 13,249	(10,034 – 15,913)
Average Start Weight (kg) (Fitted) = 555	(462 - 664)
Average End Weight (kg) (Fitted) = 665	(569 - 793)
Average of ADG (kg) = 1.47	(0.80 - 2.01)

4.1.4 RV12

Feedlot pens 4, 5, 6, 12 and 13

Head count = 250 – 2 sick = 248

First full feed date = 4/3/2015
Last full feed date = 24/5/2015
Number of full feed days = 82

Trial First full feed date = 12/3/2015
Trial Last full feed date = 24/5/2015

Trial Start Wt Date = 12/3/2015
Trial End Wt Date = 24/5/2015
Number of Trial days = 74

Average Feed Intake (g) = 14,556 (6,833 – 19,615)
Average Start Weight (kg) (Fitted) = 529 (409 - 646)
Average End Weight (kg) (Fitted) = 641 (496 - 792)
Average of ADG (kg) = 1.54 (-0.40 - 2.41)

4.1.5 RV13

Feedlot pens 7, 15

Head count = 75

First full feed date = 1/4/2015
Last full feed date = 14/6/2015
Number of full feed days = 75

Trial First full feed date = 7/4/2015
Trial Last full feed date = 14/6/2015

Trial Start Wt Date = 7/4/2015
Trial End Wt Date = 15/6/2015
Number of Trial days = 69

Average Feed Intake (g) = 12,926 (8,389 – 16,687)
Average Start Weight (kg) (Fitted) = 531 (411 - 641)
Average End Weight (kg) (Fitted) = 636 (489 - 774)
Average of ADG (kg) = 1.54 (0.53 - 2.18)
These results for each group are shown graphically below.

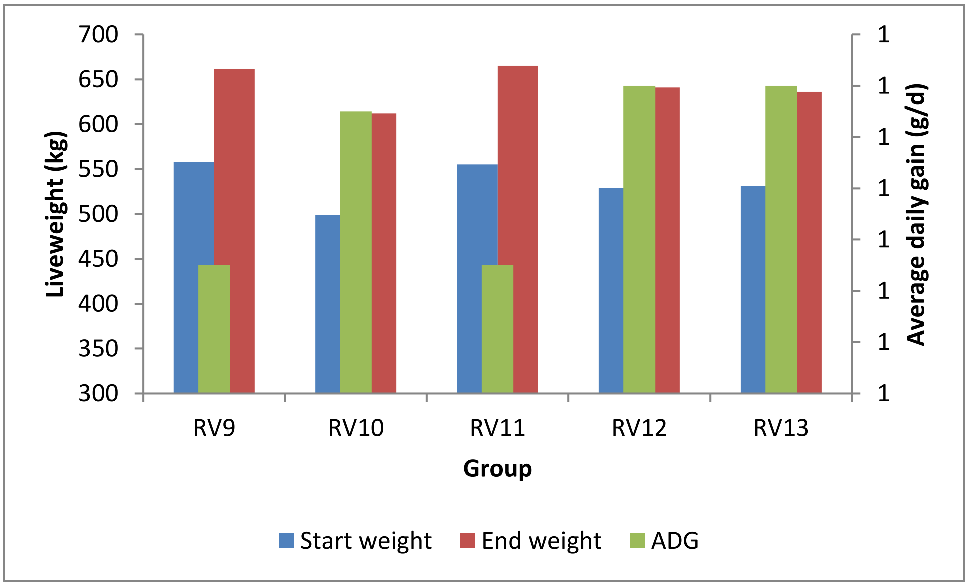

Figure 1. Start and end liveweights and weight gain of each group.

5 Discussion

The project proceeded as planned though anticipated completion dates were later due to delays in feeder availability and Angus Society supply of cattle.

The cost per tonne of feed at Tullimba is higher than at Rangers Valley feedlot and this cannot be avoided due to the location of Tullimba, economies of scale and choice of local feed components. This issue was discussed at a meeting between UNE and MLA staff on May 13 2015. It was agreed that the feed cost difference between Tullimba and Rangers Valley of approximately $180K for cohorts 2 and 3 (Angus Society terminology) be paid to Rangers Valley equally by MLA, the Angus Society and Tullimba.

It was agreed that the future feed cost difference will be paid by MLA as a research cost and that this difference be closely and regularly monitored in future.

6 Conclusions/Recommendations

Future cohorts of Angus cattle be put through the Tullimba RFI facility with close monitoring of feed costs.

Make as much use of the raw data collected and stored for genetics R&D as possible.

Future BIN projects are to be assessed annually for co-funding by MLA and will need to meet the following criteria:

- Genotyped with a GGP or equivalent SNP chip
- Have additional phenotypes measured on the animals
- Meet data quality requirements (effective progeny, contemporary group structure, etc.)
- Are part of a larger breed collecting similar measurements
- Have progeny from a cross section of industry sires
- Can make background data (phenotypes and genotypes) available for use in MLA R&D

7 Key Messages

The Growsafe facility at Tullimba is a valuable industry resource for RFI testing

To be maintained, the facilty needs a regular flow of cattle though it to help fund any repairs and maintenance and for future upgrading of the facility.

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9 Appendix

9.1 Milestones

Milestone No.	Milestone	Due Date
1	Cohort 1 test period completed and data delivered to MLA and the project partner/s.	16-Jan-2015
2	Cohort 2 test period completed and data delivered to MLA and the project partner/s.	11-Mar-2015
3	Cohort 3 test period completed and data delivered to the project partner/s.	17-May-2015
4.	Cohort 4 test period completed and data delivered to the project partner/s.	31-May-2015
5	Cohort 5 test period completed and data delivered to the project partner/s.	17-May-2015
6	6.1 Final Report submitted to MLA 6.2 Digital copy of project data (including metadata) provided to MLA.	15-Jun-2015