Feeding the Genes

An independent short report on interactions between feeding system and dairy cow genetics

Dairy Australia
Your Levy at Work

Australian Dairy Herd Improvement Scheme

Key Findings from Feeding the Genes

Do genetics really matter in all feeding systems?

Yes. Selecting high APR sires has benefits in all feeding systems used in Australia*.

Can farmers gain from choosing semen from high genetic merit bulls in all feeding systems?

Yes. There is a production benefit in ALL feeding systems. An interaction between genetic merit and feeding system exists, so the benefits of greater genetic merit do vary between feeding systems. In Holstein cows, the response from selecting high APR sires is greatest in herds using more intensive feeding systems (hybrid and total mixed ration).

Are cows with high genetic merit less likely to last in the herd in some feeding systems than in others?

No. In all feeding systems*, the daughters of higher APR sires are just as likely (if not more likely) to last in the herd as long as daughters of lower APR sires. This dispels the myth that high genetic merit cows are less likely to last in herds.

Not only do they last as long, the daughters of higher APR sires produce more milk. This dispels the view that the benefits of high genetic merit cows are not realised in herds which use a low bail or a total mixed ration (TMR) feeding system.

Does the semen of high genetic merit bulls cost much more than that of other bulls?

No. The semen of the top 50 APR bulls listed in the Good Bulls Guide does not necessarily cost more than that of other bulls.

* All 5 feeding systems were studied in Holsteins and low bail, mod.-high bail and PMR systems in Jerseys.

So, regardless of feeding system, herd managers should select high APR sires whose Australian Breeding Values are aligned with the breeding objectives for their herd. These bulls are listed in the Good Bulls Guide.

About Feeding the Genes

The Feeding the Genes study investigated interactions between dairy cow genetics and feeding systems on milk production and the cow's ability to last in the herd.

The study drew upon data from 505 commercial Australian dairy herds, using a wide range of feeding systems. Both Holstein and Jersey cows were represented in the study.

The measures of genetics used in the study were the Australian Profit Ranking (APR) and Australian Breeding Values (ABVs) for specific traits.

Background

The Australian Profit Ranking (APR) was introduced by the Australian Dairy Herd Improvement Scheme (ADHIS) in 2001 as a national selection index for dairy sires and cows. Based on a combination of nine traits that influence farm profitability, the APR estimates the relative genetic profitability of different animals and enables the ranking of bulls and cows. Since April 2010, APRs have been calculated with an updated formula which places more emphasis on daughter fertility, survival and mastitis resistance. Breeding values for a range of traits are estimated using Australian Breeding Values (ABVs). The Good Bulls Guide is an independent publication, produced twice a year, which includes lists of bulls based on their APR and ABVs for key traits.

Herd managers desire cows that both produce well and 'last', so both milk production and cow longevity (survival) are important. These traits and their interaction with feeding systems was the focus of this study.

Feeding systems

A diverse range of feeding systems are used across the Australian dairy industry. Dairy Australia uses five categories to classify feeding systems.

AUSTRALIA'S FIVE FEEDING SYSTEMS

1. **Low bail**
   Grazed pasture + other forages + up to 1.0 tonne grain/concentrates fed in bail.
2. **Moderate-high bail**
   Grazed pasture + other forages + more than 1.0 tonne grain/concentrates fed in bail.
3. **Partial mixed ration (PMR)**
   Pasture grazed for most or all of year + partial mixed ration on feed pad with or without grain/concentrates fed in bail.
4. **Hybrid**
   Pasture grazed for less than nine months per year + partial mixed ration on feed pad with or without grain/concentrates fed in bail.
5. **Total Mixed Ration (TMR)**
   Cows fed total mixed ration; zero grazing.

The need

The ABVs that are used to calculate APRs are based on animal performance using pooled data from Australian herds fed in a diverse range of feeding systems. However advisors and farmers work with individual farms and some question the relevance of the Australian Profit Ranking in their situation.

Several studies have been conducted in research herds to explore the interaction between genetic merit and feeding. However, these studies did not compare cows across all feeding systems used in Australia. Numerous large scale studies have compared cows of varying genetic merit in commercial herds with various environments yet few have compared cows of varying genetic merit between feeding systems; and these large scale comparisons have never been conducted using Australian herds.

This study addressed the need for a scientifically rigorous study to assess the effects of increased genetic merit within commercial Australian dairy herds using different feeding systems.

Dairy herd managers do not need to feed high levels of supplements to benefit from selecting high APR sires.

The study

The Feeding the Genes study investigated the relationship between dairy genetics (as measured by APR and ABVs for specific traits) and feeding systems by assessing their effects on:

- **Milk production:** whether cows of higher genetic merit achieve higher milk yield than cows of lower genetic merit within each of the feeding systems used in Australia.
- **How long cows last:** whether cows of higher genetic merit are more (or less) likely to last than cows of lower genetic merit within each feeding system.

The two indicators used to identify cows that last were:

- The percentage of cows that re-calved by 20 months. Cows that have not re-calved by 20 months are quite likely to be culled. This is therefore a measure of survival in the herd.
- The percentage of cows with short lactations (i.e. less than 120 days). A large proportion of cows with short lactations are likely to have had health problems at or around calving that seriously affected their milk production.

The effects of genetics and feeding systems were assessed separately in Holstein and Jersey cows.

An additional analysis was undertaken to compare the recommended retail prices of semen for Holstein bulls with varying APR.

Methods

A retrospective cohort study was conducted using data from 505 Australian herds. Each herd's feeding system was identified through a questionnaire completed by herd managers. Cow, lactation, and sire data were sourced from ADHIS for cows in these herds.

Changes in 305-day milk production (volume, fat, and protein yield) were estimated for each 50 unit increase in the cow's sire's APR and for each 10 unit increase in cow's ABVs for specific traits.

Holstein and Jersey cows were analysed in separate models.

The effects of APR and ABV on milk production were assessed using multilevel linear models with lactations nested within cows, and cows nested within herds (i.e. herd and cow were random effects).

The percentage of cows that re-calve by 20 months and the percentage of cows with short lactations (<120 days) were assessed using logistic models with a random effect of herd.

The herds

The enrolled herds were from all Australian states. They were predominantly seasonal or split-calving.

Relatively few dairy herds in the study were using PMR, hybrid or TMR feeding systems. The moderate to high bail feeding system was the most common by far, being used by about two-thirds of herds. Within herds, feeding system was quite consistent across years.

Holstein cows contributed 250,857 lactations and Jersey cows contributed 43,941 lactations.

Milk yields for Holstein cows averaged 7,389 litres (range: 6,121 litres for those using the low bail feeding system to 9,471 litres for those using TMR).

For both breeds, there was greater variability in sire APRs within herds than between herds. For Holstein cows, sire APRs were lower in herds using the PMR, hybrid and TMR feeding systems compared to low and moderate to high bail feeding systems.

Genetics, feeding systems and cows that last

In all feeding systems, the daughters of higher APR sires produce more milk than daughters of lower APR sires. This dispels the myth that herd managers need to feed high rates of supplements or mixed rations to benefit from selecting high APR sires.

In all feeding systems, cows with higher ABVs for milk, fat and protein produce more. This dispels the view that the benefits of high ABVs are not realised in herds using a low bail feeding system or a TMR feeding system. This finding supports the use of bulls listed in the Good Bulls Guide for all feeding systems.

The benefits of greater genetic merit vary between feeding systems (i.e. there is an interaction between genetic merit and feeding system). The response from selecting high APR sires is greatest in herds using more intensive feeding systems (hybrid and total mixed ration) but selecting high APR sires has benefits in all feeding systems.

Cows that last

HOLSTEINS AND JERSEYS

In all feeding systems, the daughters of higher APR sires are just as likely (if not more likely) to last in the herd as daughters of lower APR sires. This dispels the myth that cows with higher genetic merit (APR, ABVs) don't last in the herd.

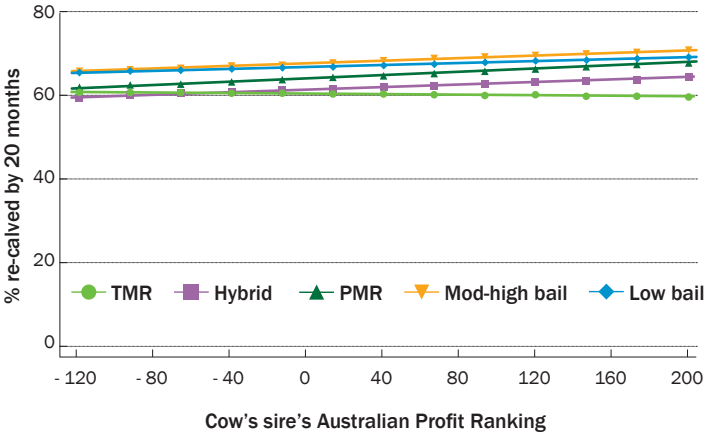
Percentage of cows that re-calve by 20 months

For Holsteins, daughters of higher APR sires were more likely than other cows to re-calve by 20 months, in all feeding systems except the TMR feeding system. In the TMR feeding system there was no marked effect of the cow's sire's APR on her likelihood of re-calving by 20 months.

For Jerseys, daughters of higher APR sires were more likely than other cows to re-calve by 20 months in low bail, moderate to high bail and PMR feeding systems. There were insufficient Jersey herds in the study with hybrid and TMR feeding systems to assess re-calving in these systems.

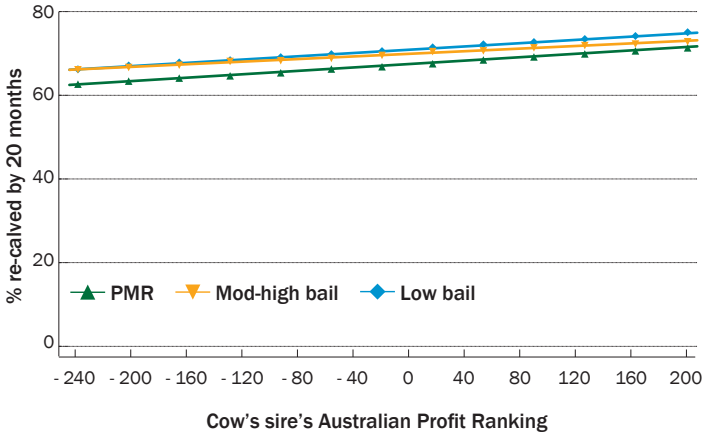
The higher percentages of daughters of high APR sires that re-calved by 20 months was partly due to less culling because of these cows' higher milk yield. However, even after accounting for differences in milk production, percentages that re-calved by 20 months were similar or slightly higher for daughters of high APR sires relative to other sires.

Figure 1: Daughters of high APR Holstein sires last in the herd in all feeding systems.



▲ Estimated percentages of cows that recalved by 20 months by cow's sire's Australian Profit Ranking for lactations from Holstein cows by feeding system, adjusted for the cow's maternal grandsire's Australian Profit Ranking.

Figure 2: Daughters of high APR Jersey sires last in low bail, mod-high bail and PMR feeding systems.



▲ Estimated percentages of cows that recalved by 20 months by cow's sire's Australian Profit Ranking for lactations from Jersey cows by feeding system, adjusted for the cow's maternal grandsire's Australian Profit Ranking.

Percentage of cows with a short lactation

For both Holsteins and Jerseys, cows with high APR sires were no more likely to have a short lactation than other cows.

Genetics, feeding systems and production

HOLSTEINS

Effects of APR

Holstein daughters of higher APR sires produce more milk volume, fat and protein over 305 days in every feeding system, with the greatest impact in the TMR feeding system (Table 1).

For each 50 unit increase in the cow's sire's APR, milk volume increased by 54 to 80 litres in the low bail, moderate-high bail, PMR and hybrid feeding systems, and 110 litres in the TMR feeding system.

Fat yield increased by 1.5 to 3.5 kg in the low bail, moderate-high bail, PMR and hybrid feeding systems and 5.7 kg in the TMR.

Protein yield increased by 2.6 to 4.0 kg in the low bail, moderate-high bail, PMR and hybrid feeding systems, and 5.1 kg in the TMR feeding system. These effects are shown in Figure 3.

Effects of ABV

While the APR is an estimate of an animal's genetic merit for profitability, ABVs estimate genetic merit for specific traits such as milk volume, fat and protein yield.

In all feeding systems Holstein cows with higher ABVs for milk, fat and protein produced more. This dispels the myth that the benefits of high ABVs are not realised in herds using a low bail feeding system or a TMR feeding system and supports the use of bulls found in the Good Bulls Guide for all feeding systems.

The effects were smallest in the low bail feeding system and largest in the TMR. For each 10 unit increase in the cow's ABV for milk, the estimated milk volume increases were 7.2 litres in the low bail feeding system, about 9 litres in the moderate-high bail, PMR and hybrid feeding systems and 12.1 litres in the TMR feeding system.

Estimated fat yield increases varied from 6.3 kg in the low bail feeding system to 11.8 kg in the TMR feeding system for every 10 unit increase in ABV for fat kg.

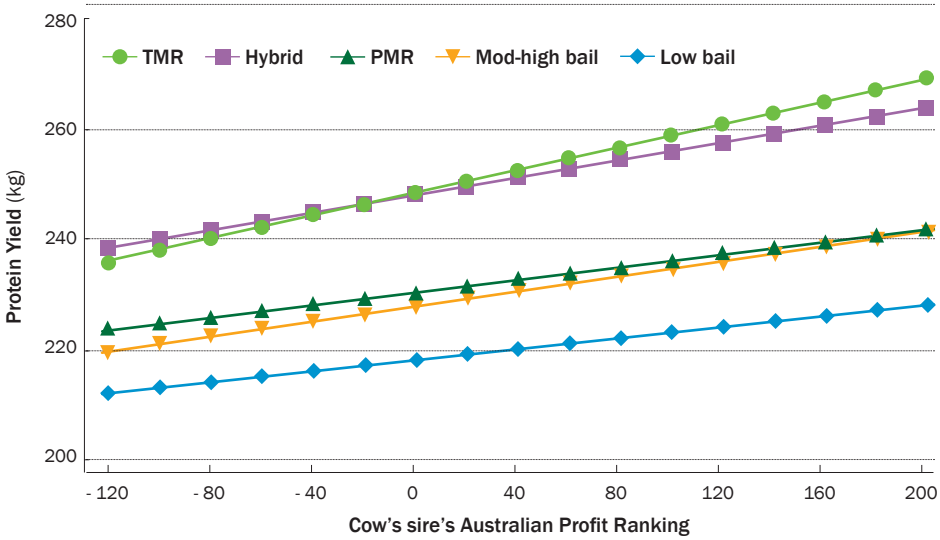
Protein yield increase estimates varied from 7.6 kg in the low bail feeding system to 17.0 kg in the TMR feeding system for every 10 unit increase in ABV for protein kg.

Table 1: Holstein daughters of higher APR sires produce more (volume, fat and protein) over 305 days in every feeding system. Figures show the effects of each '50 unit increase in APR with 95% confidence intervals.

Milk production variable	Feeding system				
	Low bail	Mod-high bail	PMR	Hybrid	TMR
Milk volume (l)	**56.2** (40.9 to 71.5)	**68.0** (60.4 to 75.6)	**53.7** (39.8 to 67.7)	**79.7** (58.8 to 100.6)	**109.9** (75.1 to 144.8)
Fat yield (kg)	**2.6** (2.0 to 3.2)	**2.5** (2.2 to 2.8)	**1.5** (1.0 to 2.0)	**3.5** (2.7 to 4.3)	**5.7** (4.4 to 7.1)
Protein yield (kg)	**2.6** (2.1 to 3.1)	**3.4** (3.2 to 3.6)	**2.9** (2.5 to 3.4)	**4.0** (3.3 to 4.6)	**5.1** (4.0 to 6.2)

▲ **The estimated effects of cow's sire's APR on 305-day milk production for lactations from Holstein cows by feeding system, adjusted for the cow's maternal grandsire's APR (95% confidence interval).** Coefficients represent estimated change in milk production variable per 50 unit increase in the cow's sire's Australian Profit Ranking; coefficients were adjusted for age at calving; herd and cow within herd were fitted as random effects

Figure 3: Daughters of higher APR sires achieve greater production of milk and components regardless of the feeding system used.



▲ Predicted 305 day protein yields by cow's sire's APR for lactations from Holstein cows by feeding system, adjusted for the cow's maternal grandsire's APR.

JERSEYS

Effects of APR

For Jerseys, reliable comparisons were only possible across the low bail, moderate-high bail and PMR feeding systems. As for Holsteins, the higher a Jersey cow's sire's APR, the more milk volume, fat and protein she produced, in all three feeding systems (Table 2). For fat and protein, the estimated increases were quite a lot smaller for the low bail feeding system than for the moderate-high bail and PMR feeding systems.

Effects of ABV

While the APR is an estimate of an animal's genetic merit for profitability, ABVs are an estimate of genetic merit for specific traits such as milk volume, fat and protein yield.

In each of the low bail, moderate-high bail and PRM feeding systems, Jersey cows with higher ABVs for milk, fat and protein yield produced more. This dispels the myth that the benefits of high ABVs are not realised in herds using the low bail feeding system.

The effects of increases in a Jersey cow's ABVs for milk volume, fat and protein yield were smaller for the low bail feeding system than for the moderate-high bail and PMR feeding systems. For each 10 unit increase in the cow's ABV for milk, the estimated milk volume increases were 5 litres in the low bail feeding system, and about 7 to 8 litres in the moderate-high bail and PMR feeding systems.

The estimated fat yield increases varied from 6.0 kg in the low bail feeding system to 7.5 to 9.1 kg in the moderate-high bail and PMR feeding systems for every 10 unit increase in the cow's ABV for fat kg.

Protein yield increase estimates varied from 5.3 kg in the low bail feeding system to 8.8 to 9.3 kg in the moderate-high bail and PMR feeding systems for every 10 unit increase in the cow's ABV for protein.

Table 2: Jersey daughters of higher APR sires produce more (volume, fat and protein) over 305 days in every feeding system. Figures show the effects of each '50 unit increase in APR with 95% confidence intervals.

Milk production variable	Feeding system		
	Low bail	Mod-high bail	PMR
Milk volume (l)	**42.1** (25.3 to 59.0)	**55.9** (46.6 to 65.1)	**49.5** (23.5 to 75.4)
Fat yield (kg)	**2.6** (1.8 to 3.4)	**3.4** (3.0 to 3.9)	**3.7** (2.4 to 5.0)
Protein yield (kg)	**2.0** (1.3 to 2.6)	**2.8** (2.5 to 3.1)	**2.9** (1.9 to 3.8)

▲ **The estimated effects of cow's sire's APR on 305-day milk production for lactations from Jersey cows by feeding system* adjusted for the cow's maternal grandsire's APR (95% confidence interval).** Coefficients represent estimated change in milk production variable per 50 unit increase in the cow's sire's Australian Profit Ranking; coefficients were adjusted for age at calving; herd and cow within herd were fitted as random effects

Semen prices

The recommended retail prices for straws of Holstein bulls listed in the Good Bulls Guide were compared by bull APR. There was no relationship between semen price and APR. On average, semen from bulls in the top 50 cost slightly less than that of the group of bulls ranked 51 to 100.

So based on results from the current study, regardless of feeding system, herd managers using artificial breeding (most herd managers in Australia) should select only high APR sires whose semen price is appropriate and whose ABVs are aligned with the breeding objectives for their herd.

Rank	Recommended retail prices
1st to 50th	**$27** ($14-90)
51st to 100th	**$28** ($15-110)
101st to 150th	**$20** ($10-35)
151st to 200th	**$27** ($14-75)
201st to 250th	**$22** ($10-80)
251st to 300th	**$21** ($8-50)
Below 300	**$24** ($10-110)

▲ Average (range) of recommended retail prices in April 2013 for bulls in the Profit list in the April 2013 Holstein Good Bulls Guide by rank on Australian Profit Ranking

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Harris Park Group

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Australian Dairy Farmers