Efficiency and High Production- can they co-exist?

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Defining Efficiency

Beef cows need to be efficient from many perspectives, meaning definitions related to single traits can be misleading. Efficiency is a multi-trait selection effort. If only one trait defines the efficient aspect of the cow, then high production may be compromised somewhere else. Take the dairy cow, for example, while she may excel in high production for milk, she is certainly not excelling in high fertility or structural correctness of feet and legs for any extended period of time. High production must persist over a period of time - longevity, and with beef cows more than 6 years is acceptable. As cow/calf beef producers, you know the cost to raise replacement heifers is considerable so structurally sound females with extended reproductive lives are valuable.

Traditionally, livestock producers would likely agree pounds of calf weaned per cow exposed, calf weaning weight as a % of the cow weight or feed:gain are measures of efficiency. These factors can be translated into the resulting $/lb weaned calf to establish profitability of a cow herd.

Let's be clear, your definition of efficiency sets the stage for this debate.

We should also not forget efficient beef should be sustainable beef. After a year and a half of negotiations, a global definition for sustainable beef has been approved by 96% of the Global Roundtable for Sustainable Beef (GRSB) members. They have agreed it's socially responsible, environmentally sound, and economically viable; and it must come from systems that prioritize planet, people, animals, and progress.

The cow herd of 2007 is more efficient compared to the cow herd of 1997 as the same amount of beef now requires:

- 70% of the animals,
- 81% of the feed,
- 88% of the water,
- 67% of the land
- resulting in a 16% decrease in the carbon footprint of beef

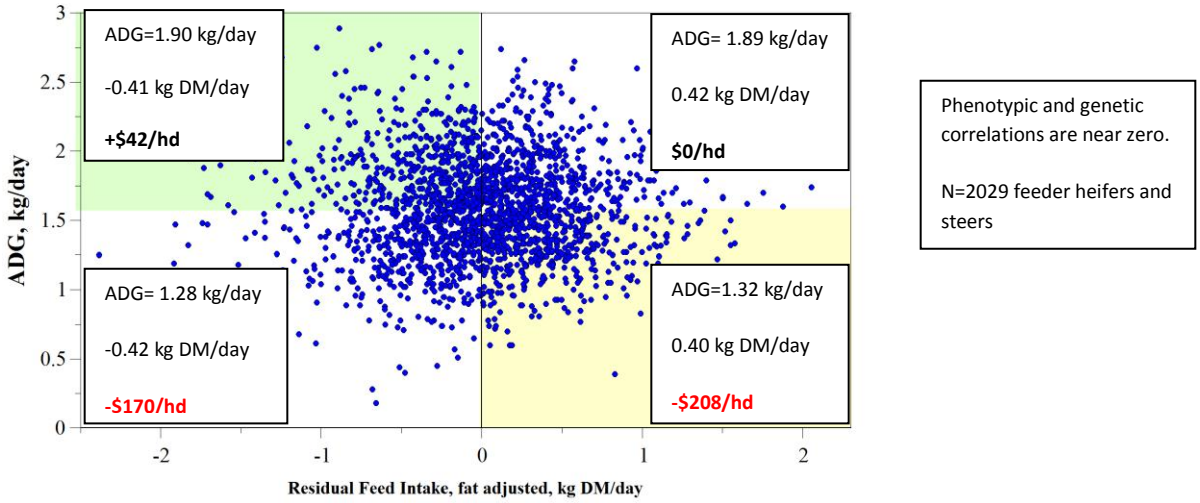
(Capper 2011, Animal Frontiers)

What defines an efficient beef cow?

The common factors in the cow efficiency debate are fertility, size and dry matter intake. Fertility is largely about management and nutrition. Assuming we balance our cow herd with our resources (feed, labour, health protocols etc.) we would expect to get a live calf from every cow exposed to a bull in a reasonable time period of 45-60 days. The next factor, size, tells us that bigger cows can raise bigger calves – to a point. Larger cattle eat more and ultimately have higher feed intakes and costs of production.

It is the final factor, dry matter intake that looks at the inputs rather than outputs. Cattle, regardless of size, can be measured with the trait of residual feed intake (RFI). RFI is defined as the difference between an animal's actual energy intake and its' expected energy intake based on the animal's maintenance requirements and levels of production. Thus, feed efficient animals which have negative or low RFI values, consume less feed than expected without compromising their production level. RFI does not favour larger animals that gain more. It is independent of body weight and growth, meaning you can find feed efficient animals that also gain well. The quadrants of feed efficiency and gain are shown below (Figure 1). Selecting animals with the genetics of those in the upper left quadrant and to cull those in the lower right should be our goal.

Figure 1. Correlation between growth and animal size



Note: same feeder cost and price, transportation, vet, medicine, interest, yardage, death loss and marketing costs. (Arthur et al., 2001; Basarab et al., 2003; Crews et al., 2003; Jensen et al., 1992 and Basarab et al., 2013)

Once you decide on cow breed size combinations for your operation (Dexters or Angus or Simmentals etc.), you are left with ensuring they raise a decent calf and that they are feed efficient to reduce your costs of production. These are the factors that make the cow herd efficient overall – translating to performance and profitability.

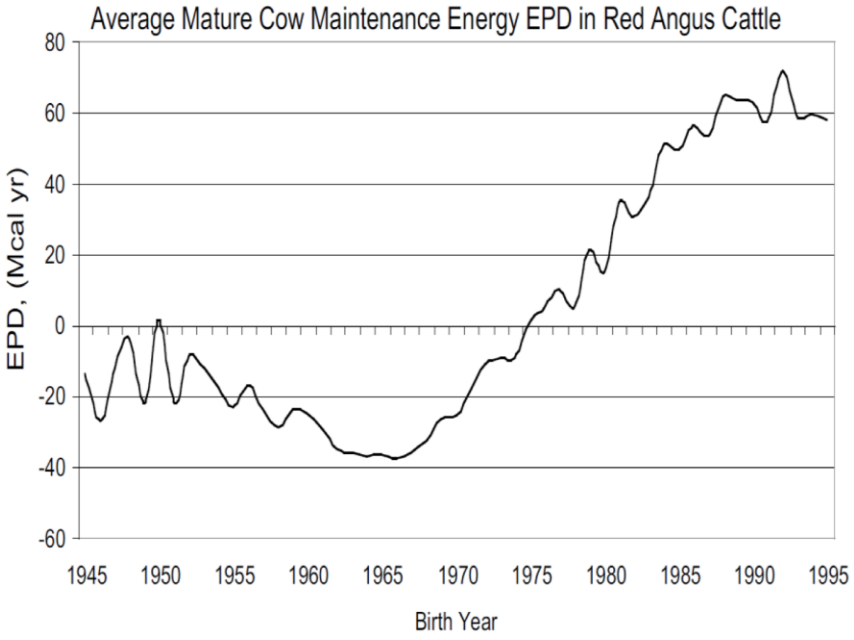
It is critical that you understand that RFI and feed:gain are not the same thing. Selection for animals with higher growth rates (ADG) without consideration of their feed intake inevitably

leads to a population of cattle with increased maintenance requirements, higher feed requirements and intake, resulting in animals with higher manure, methane and carbon dioxide production – less efficient and less sustainable.

Is there an ideal cow size?

While cows have been increasing in body size over the last 30 years, and consequently their calf weaning weights and carcass size also increased, their maintenance requirements have also increased dramatically (Figure 2). The period between 1980 and 1995 shows an increase that could be depicted by trends in the show ring at that same time. Larger framed, taller hip height animals dominated the breed shows and that increase in size meant an increase in feed intake. Most cattle producers attributed larger size to less efficient cattle and so the movement to more moderately framed cattle began by the early 2000's. However, size is not the only driving factor to potentially increase efficiency. There are small inefficient cattle just as there are large efficient cattle and knowing which are which is near impossible to tell without a test for RFI.

Figure 2. Red Angus cow size over 50 years

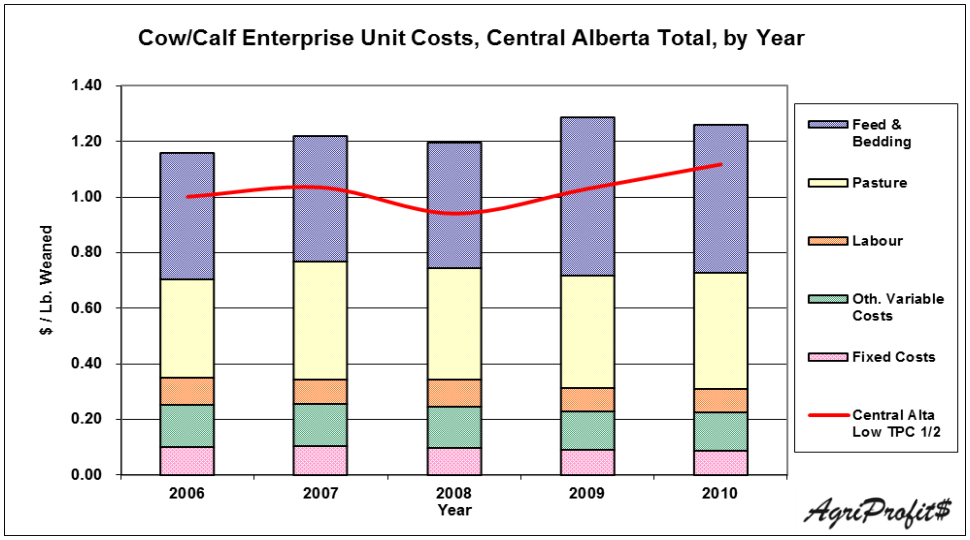


(Adapted from Evans et al. 2002)

Costs of production

When 56-71% of the total cost of production for cow-calf operations is associated with feed, bedding and pasture, and maintenance requirements of breeding cattle make up 65-75% of the total dietary energy costs, it results in over 40% of your costs of production being impacted by feed efficiency (Figure 3, ARD 2012). Only through genetic selection for those animals with improved feed efficiencies will profitability in the cow herd improve once costs of production have been streamlined.

Figure 3. Cow calf enterprise unit costs, Central Alberta total by year 2008-2010



(ARD, 2012)

Effect of heritability and age on efficiency and high production

Making faster progress through genetic selection for RFI will only be possible if the trait is moderately heritable and does not negatively influence other traits of economic importance. Moderately heritable traits are defined as those within the range of 0.25 to 0.45 meaning the heritability of RFI is comparable to traits like feed intake (0.40), live weight (0.40), milk yield (0.35) and average daily gain (0.30); traits you already consider to select high production cattle.

The RFI test is generally done on animals after weaning but not less than 240 days of age and not more than 390 days of age. Within a feeding contemporary group, animals should have start of test ages within a 60 day range. Because these tests are done at a relatively young age, we need to have confidence they accurately depict how a cow will perform later in life. The question of repeatability has been explored as animals tested as heifers are compared again as mature cows (Table 1) (Basarab and Baron, 2014). Generally, feed efficiency rankings persist throughout the lifetime of a cow. However, the diet on which the heifer is tested should represent the diet on which she is managed in later life to accurately reflect RFI ranking. Feed efficiency tests done on high grain rations with heifers subsequently managed under forage and range conditions will not be as accurate as those tested on high forage rations. It is not uncommon for RFI results to undergo some re-ranking but it is accepted that the top 1/3 and the bottom 1/3 of cattle will likely maintain their RFI ranking while some changes can occur in the middle 1/3.

Table 1. **Repeatability of RFI in heifers to cows**

RFI measured as a heifer – preliminary data

Traits	High	Low
RFI kg DM/day		
Number of females	12	11
8-12 month old heifers	0.365	-0.373
4-7 year old cows	0.459	-0.375

Heifers fed 90:10 barley silage:barley grain, free choice

Cows fed 70:30% grass hay:barley straw cube, restricted to gain at 0.25-0.50 kg/day

Feed savings: Heifers: 0.74 kg DM/day x $0.15/kg DM x 365 = $40/heifer/year

Cows:0.83 kg DM/day x $0.15/kg DM x 365 = $46/cow/year

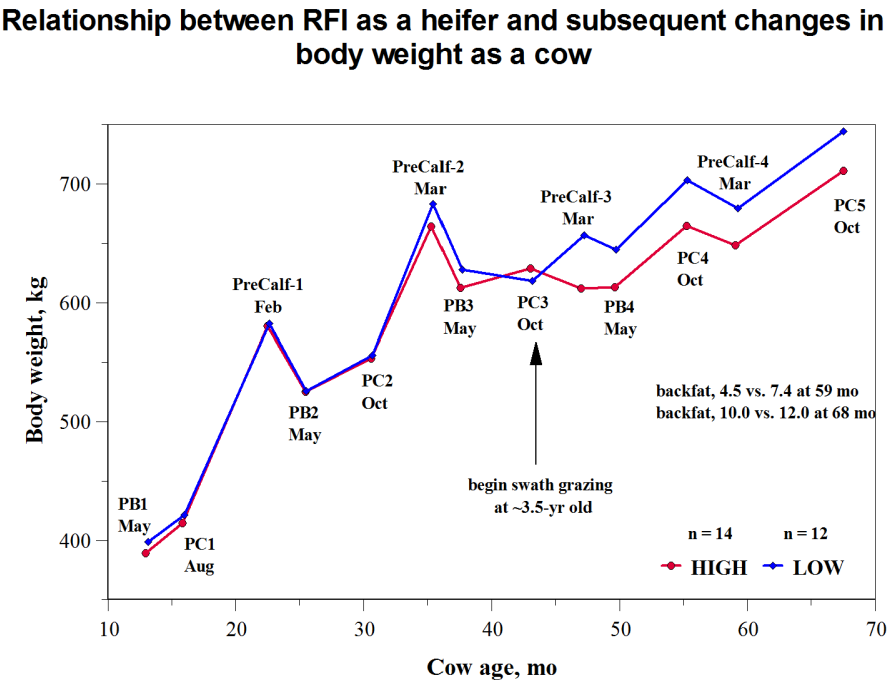
(Basarab and Baron, 2014)

Performance under resource limitations

Efficient cows are also thought to be those cows which are “easy keepers”. However, without knowing the RFI ranking of an animal and with visual appraisal alone, you will be unable to tell which of your easy-keepers are in fact feed efficient and which have the big appetites. During times of extreme weather or feed resource limitations, the inefficient cattle may decrease production (backfat, body weight and milk) more so than the feed efficient cows. However, when feed resources are sufficient and weather less intense, it may be difficult to assess feed efficient from feed inefficient cattle without RFI.

In cold weather, efficient -RFI cows actually maintain themselves in better body condition score with no differences in productivity compared to their inefficient +RFI herd mates. Figure 4 shows data agreeing with the findings that –RFI cows gained more body fat and body weight than +RFI cows when both groups swathed grazed forages for the first time in Canadian winters where night time temperatures dropped below -20C and animals grazed through the snow from November to March. –RFI cows were 30-35 kg heavier and 2-3 mm fatter than +RFI cows. Similar results were reported in a study that measured finishing RFI in yearling heifer and steer progeny and then examined their dam’s body weight and backfat thickness retrospectively over 10 production cycles (Basarab et al. 2007). In that study, dams that produced - RFI progeny consistently averaged 2-3 mm more back fat thickness over the 12th and 13th ribs and lost less weight during early lactation (pre-calving to pre-breeding) than dams that produced + RFI progeny, thus indicating that the lower maintenance requirement of - RFI cows results in the accumulation of body fat or the loss of less body fat and weight during stressful environmental periods.

Figure 4.



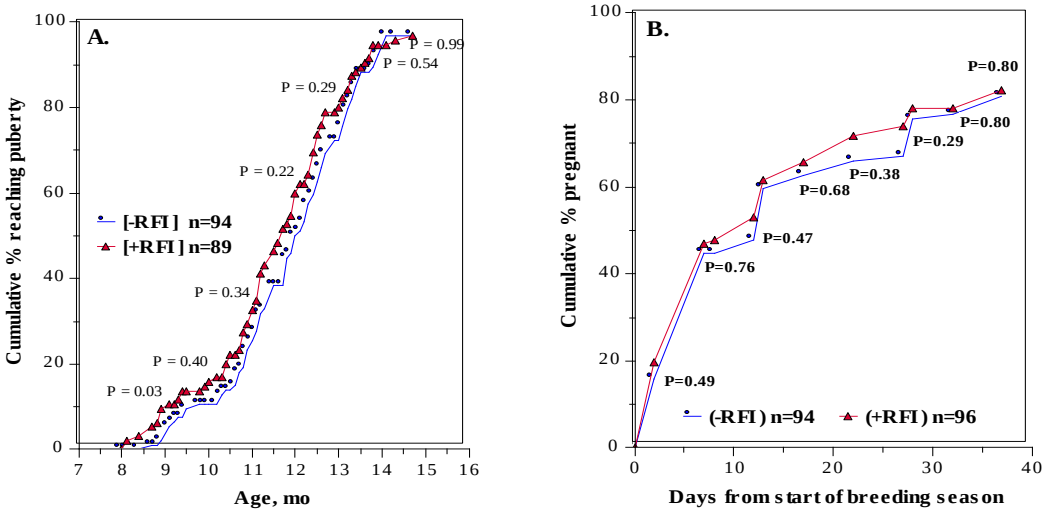
(Basarab and Baron, 2014)

Fertility

The effects of feed efficiency on fertility have been debated. Recent reviews of the relationship of RFI on fertility and productivity show that –RFI and +RFI cows and heifers were similar in culling, pregnancy, calving and weaning rate, calving pattern and kilogram of calf weaned per mating opportunity (in both Canadian and Australian data). However, -RFI (efficient) cows calved 5-6 d later in the year than +RFI (inefficient) cows. Recent research has shown that heifer pregnancy rates in –RFI heifers can be 3 to 5% lower than +RFI heifers but these differences are not detectable in 2nd and older calvers (Basarab et al., 2011). When RFI was adjusted for body fatness (final off-test backfat thickness; RFIfat) no differences were observed in percentage of -RFIfat and +RFIfat heifers reaching puberty by 10, 11, 12, 13, 14 or 15 months of age nor in the percentage of calves born by day 28 of the calving season. Calving difficulty, age at first calving, calf birth weight, calf pre-weaning ADG, calf actual and 200-d weaning weight and heifer productivity, expressed as kg calf weaned per heifer exposed to breeding, were also similar between -RFI and +RFI heifers. The figures below show how –RFI (efficient) heifers appear to reach puberty later and get pregnant later in the breeding season compared to +RFI (inefficient) heifers. However, this small difference is likely a feature of the RFI testing procedure itself. Heifers reaching puberty near the start of the test period may actually have greater energy expenditures (5% greater) because they are cycling throughout the test due to their sexual development and greater activity compared to heifers that reach puberty near the end of an RFI test. So, this explains why they may breed and calve somewhat later. It

may be possible to test older heifers or feed MGA (melengestrol acetate for suppression of estrus) during an RFI test to avoid these issues. What is important is that all the heifers reached puberty by 15 months of age (see Figure 5A below) and all heifers were pregnant before 40 days of a breeding season (see Figure 5B below); both suitable management targets.

Figure 5. Age at puberty and Days to become pregnant for +RFI and –RFI heifers.



A. Levels of significance are given for cumulative percent of heifers reaching puberty by 9, 10, 11, 12, 13, 14 and 15 mo of age. **B.** Levels of significance are given for cumulative percent heifers pregnant by 2, 7, 12, 17, 22, 27, 32 and 37 d of the breeding season. (Basarab et al., 2011).

Fertility of young bulls, as measured by scrotal circumference, breeding soundness evaluation, calves born per sire and semen characteristics, has been largely unrelated to RFI, although several weak associations have been observed with sperm morphology and motility. What this suggests is that perhaps the efficient –RFI bulls are younger and have less developed sperm. These observations may also reflect the need to adjust RFI for off-test ultrasound backfat thickness and feeding behaviors in an effort to prevent the selection for later maturing bulls.

A study at the University of Alberta, Kinsella herd showed there was no difference in the number of calves sired by –RFI bulls compared to +RFI bulls. Conversely, an Ontario study concluded that young bulls with improved feed efficiency (low RFI) have decreased sperm motility, viability, and scrotal circumference (Awda et al., 2013). It is important to not interpret poor sperm morphology with infertility since libido, in addition to other aspects of a breeding soundness evaluation, is important to ensure any bull, regardless of RFI status, is capable of breeding a cow herd.

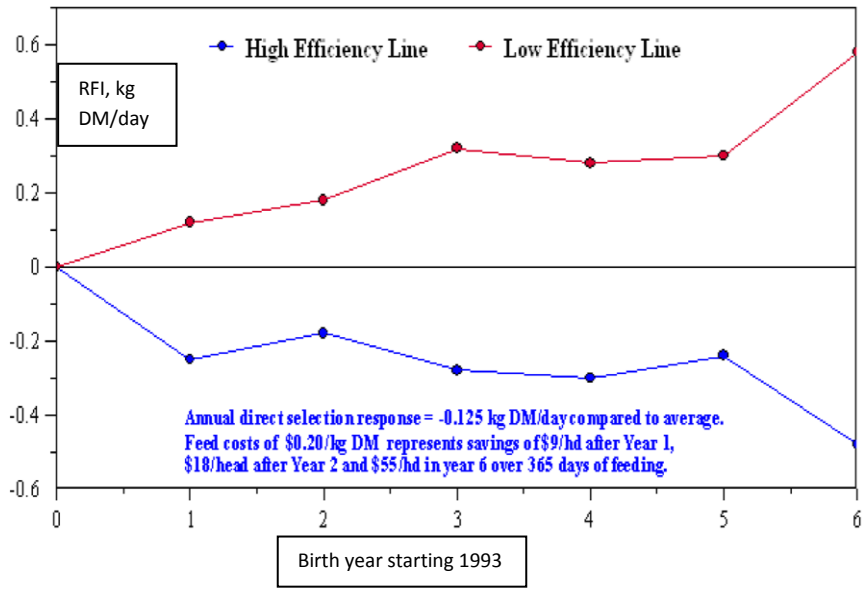
Effects of selecting for feed efficiency on other traits

Research (from J. Basarab, Tiffin Conference 2012) has shown that selection for low RFI (efficient cattle) will have:

- No effect on growth, carcass yield and quality grade
- Reduce feed intake at equal weight and ADG
- Improved feed to gain ratio by 10-15 percent
- Reduced net energy of maintenance and reduced methane and manure production by 10-15 percent (reducing the carbon footprint of cattle)
- Little if any effect on age at puberty
- No negative effect on pregnancy, calving or weaning rate
- Little effect on bull fertility
- Positive effect on body fatness or weight particularly during stressful periods
- Reduced feed costs by: $0.07-0.10/hd/d feeders and $0.11-0.12/hd/d in cows.

The results of an Australian study (Figure 6) have similar findings regarding cow productivity, suggesting that after 5 years (1.5 generations) of divergent selection for RFI, there were no significant effects on measures of maternal productivity in cows differing in RFI EBV by 0.08 kg/day (Arthur et al., 2005). These measures included pregnancy rates, calving %, milk yield, weaning rates and weight of calf weaned per cow exposed to bull.

Figure 6. Trends in estimated breeding values for residual feed intake (RFI), top line=inefficient and bottom line=efficient selection lines from 1993 to 1999.



(Arthur et al., 2005)

Conclusions

Managing your cattle to reach high production through feed, health protocols and humane handling is only part of the equation to reach efficiencies with results varying from year to year due to environmental factors. Selection for low RFI adjusted for fatness, and keeping other traits in balance, should not affect growth, body size, carcass yield and quality, and should improve feed conversion ratio and reduce manure and greenhouse gas production in youthful cattle. In addition, RFI adjusted for fatness should not affect pregnancy, calving and weaning rates and may positively affect early calf-hood survival and adaptability of efficient cows to stressful environments.

Since you can't tell or predict everything about an animal by just looking, and much of the cattle business is based on visual appraisal of animals, a difficult to measure trait like feed efficiency which can't be predicted by animal appearance will need sound scientific and genetic information to improve accuracies of prediction. Selecting for the genetics that represent the superior animals in combination with sound management will lead to the ultimate blend of high production and efficiency – putting you on track for improved profitability.

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