CALF COLLEGE™ COURSE NOTES

— FULL POTENTIAL FEEDING YIELDS LIFELONG REWARDS —

TAKE HOME MESSAGES

- A growing body of research shows that calves provided more nutrients from milk/milk replacer early in life are more likely to be productive as adult cows.
- Direct correlations have been made between preweaning average daily gain (ADG) and milk production in the first lactation and beyond.
- An economic model comparing the cost of raising replacement heifers in a conventional versus full potential feeding program shows a significant advantage for full potential feeding.

Over the past decade, "intensified feeding," "accelerated growth," or "full potential feeding" of dairy calves has become an area of significant research interest. The "old standard" of feeding two quarts of 20:20 milk replacer twice a day once was thought to provide adequate nutrition to calves. Recent research proves otherwise.[1]

Researchers now conclude that nutrient intake from milk or milk replacer during the preweaning phase alters the phenotypic genetic expression for milk production later in life. The implication for increasing nutrients early in life shows greater yields in milk output and profit potential when animals reach the milking string.

Lifetime Milk Production Improvement

A collective analysis of 12 studies (Figure 1) evaluated early life nutrition of replacement heifers, and its impact on milk production later in life. That evaluation showed that **calves that received more milk or milk replacer prior to weaning were estimated to produce 429 + 106 pounds more milk in their first lactation.**[2]

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1 Soberon F. et al. 2012. Preweaning milk replacer intake and effects on long-term productivity of dairy calves. *J. Dairy Sci.* 95:783-793

2 Soberon F and M.E. Van Amburgh 2013. The effect of nutrient intake from milk or milk replacer in preweaned dairy calves on lactation milk yield as adults: a meta-analysis of current data. *J. Anim. Sci.* 91:706-712.

Figure 1. Milk production differences as adults among treatments where calves were allowed to consume approximately 50 percent more nutrients than the standard feeding rate prior to weaning from either milk or milk replacer.

STUDY	MILK YIELD (LB)
Foldager and Krohn, 1991	3,092[s]
Bar-Peled et al., 1998	998[t]
Foldager et al., 1997	1,143[t]
Ballard et al., 2005 (@ 200 DIM)	1,543[s]
Shamay et al., 2005	2,162[s]
Rincker et al., 2006 (proj. 305@ 150 DIM)	1,100[ns]
Drackley et al., 2007	1,841[s]
Raith-Knight et al., 2009	1,582[ns]
Terre et al., 2009	1,375[ns]
Morrison et al., 2009	0[ns]
Moallem et al., 2010	1,600[s]
Soberon et al., 2011	1,216[s]

Milk response is the difference between treatment milk yield minus control
[s] $P < 0.05$, [t] $P < 0.1$, [ns] $P > 0.1$

Further analysis of this data set by Cornell University indicates that a calf that receives more nutrients during the preweaning period was two times more likely to produce more milk than a calf that is restricted during that same period.[3]

Milk Production and Pre-Weaning Average Daily Gain

Analyzing the collective 12 studies from the perspective of ADG, accommodating for the influence of other management factors including starter grain in the diet, in addition to milk and/or milk replacer, there is a significant jump in milk production potential. The analysis by Cornell University showed that **for every 1 pound of preweaning ADG, calves produced 1,551 pounds more milk during their first lactation.**[4]

Management and nutrition appear to have a greater impact on future milk production potential than genetic selection. Consider that genetic selection for milk production will increase milk production in the range of 150 to 300 pounds per lactation. Research shows that early life nutrition increased milk three to five times that of genetic selection.[5] This demonstrates that as cattle are bred for greater genetic capacity for milk yield, we need to feed and manage them accordingly, especially as neonates.

Benefits Continue Beyond 1st Lactation

From the data collected at the Cornell herd, researchers also were able to evaluate milk production through three lactations from 1,244 cows that had been raised on a full potential feeding program. By the third lactation, 450 of those animals were still available in the herd for analyses. The cumulative results over three years showed that **the average additional per-cow milk production for each pound of preweaning ADG was 2,279 pounds of milk (Figure 2).**[6]

Economic Advantages of Full Potential Feeding

One perceived drawback of full potential feeding of preweaned calves is that it amounts to a significantly higher initial financial outlay compared to traditional milk or milk replacer feeding programs. But given the long-term rewards in milk production, health benefits and potentially early entry into the milking herd, is it worth it?

3 Early life nutrition and management and the impact on lifetime productivity of calves, 2013 Four State Nutrition Conference, M.E. Van Amburgh and F. Soberon, Department of Animal Science, Cornell University, Ithaca, NY

4 Soberon F., and M.E. Van Amburgh. 2013. The effect of nutrient intake from milk or milk replacer on preweaned dairy calves on lactation milk yield as adults: a meta-analysis of current data. *J. Anim. Sci.* 91;706-712

5 Early life nutrition and management and the impact on lifetime productivity of calves, 2013 Four State Nutrition Conference, M.E. Van Amburgh and F. Soberon, Department of Animal Science, Cornell University, Ithaca, NY

6 Overton M.W. et al. An economic comparison of conventional vs. intensive heifer rearing. *Proceedings of 2014 Mid-South Ruminant Nutrition Conference*

Figure 2. Predicted differences by Test Day Model residual milk (lb.) for 1st, 2nd and 3rd lactation as well as cumulative milk from 1st through 3rd lactation as a function of preweaning average daily gain and energy intake over predicted maintenance for the Cornell herd.

LACTATION	n	Predicted difference in milk per lb. of preweaning ADG (LB)	P VALUE	Predicted difference in milk for each additional Mcal intake energy above maintenance (LB)	P VALUE
1st	1244	850	< 0.01	235	< 0.01
2nd	826	888	< 0.01	108	0.26
3rd	450	48	0.91	351	< 0.01
1st - 3rd	450	2,279	0.01	902	< 0.01

The Cornell researchers concluded that to achieve additional milk yield in lactation as a result of early life nutrition, calves must grow at a rate that will allow them to at least double their birth weight by weaning at 56 days of age. They also suggested that **milk or milk replacer intake must be greater than traditional programs for the first three to four weeks of life to achieve this response.**

A team of veterinarians compared the long-term economic outcomes of a conventional versus full potential feeding program.[6] They developed an economic model that compared the cost of raising heifers on a conventional diet versus a full potential diet. Nutritional costs were divided by six life stages:

1. Birth to 2 months of age;
2. 2 to 4 months of age;
3. 4 to 10 months of age;
4. 10 months of age through breeding;
5. Gestation; and
6. The last 2 months prior to calving.

The preweaning rations formulated for the two groups consisted of:

Conventional group – 20 percent protein:20 percent fat (DM basis) milk replacer containing 1 pound of powder per gallon, fed at 4 quarts per day for 7 weeks. Starter grain containing 18 percent crude protein (as-fed basis) was offered free choice and reached a consumption level of 4.4 pounds per day by the time of removal from the hutch at 63 days of age.

Full potential group – 28 percent protein:18 percent fat (DM basis) milk replacer containing 1.25 pounds per gallon, fed at varying volumes over time. Weeks 1-2: 1.25 gallons per day; weeks 2-6: 1.75 gallons per day; week 7: 0.88 gallons per day. Starter grain containing 22 percent crude protein (as-fed basis) was fed free-choice and was not consumed aggressively until the weeks 8 and 9, at which consumption reached 3.8 pounds per day.

Based on historical data comparing the two feeding methods, the conventional group was predicted to weigh 155 pounds per head at the time of removal from the hutches, versus a projection of 192 pounds per heat for the full-potential group.

Throughout all but the final stage, heifers on the full potential diet received rations higher in metabolizable protein but with similar energy density.

In addition to feed costs, the model included factors for labor; health care; interest; reproductive culling; death loss; and housing. Figure 3 shows that from birth to freshening, feeding heifers a full potential diet produced a savings of $4 per heifer, not counting the value of additional milk production. Including a value of $195 for predicted additional first lactation milk production resulted in a total economic advantage of $199 per head for full potential feeding.[7]

Additional gains would be expected to be realized as full potential-reared cows continue to produce more milk in subsequent lactations.

Figure 3. Summary of Results
Based on the current assumptions used in this model:

		ADVANTAGE
Feed Costs	($94)	Conventional
Labor Costs	$30	Intensive
Health/Vet Med	$11	Intensive
Interest Cost (Not incl. calf)	$4	Intensive
Reproductive Culls	$7	Intensive
Other Costs	$34	Intensive
Calf Investment Cost	$2	Intensive
Savings	$4	Intensive
Value of the additional 1st lactation milk	$195	**Intensive**
Net results	$199	**Intensive**

Based on this economic model investing in full potential feeding can result in a 2:1 return on investment.[8]

7, 8 Overton M.W. et al. An economic comparison of conventional vs. intensive heifer rearing. *Proceedings of 2014 Mid-South Ruminant Nutrition Conference*

Full potential feeding is a worthwhile investment that can pay dividends in more efficient animals that have been proven to have greater lifetime productivity potential.