Economics of Dairy Cattle Breeding
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"Choose Parents Wisely"

Economics of Dairy Cattle Breeding

DAIRY CATTLE BREEDING EXTENSION BULLETIN E-1148 JANUARY 1978

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Milk production is the major source of income in dairy cattle, accounting for 80 to 90% of the gross income. Milk yield is highly correlated (0.7) with gross feed efficiency, and feed is the largest cost. Milk is reasonably heritable. Thus, milk production should be the primary selection goal for all dairymen. From an economic standpoint, the selection of other traits should be dependent upon their heritability, economic importance, and phenotypic and genetic relationship to other economically important traits. Profitability is the goal.

The rate of progress achieved is dependent upon progress in the population from which the sires and dams are selected by individual dairymen. Genetic and economic aspects of these two sets of alternatives will be discussed later.

Female reproductive management practices have major effect on the profitability of the cow being bred. Unlike genetic progress, improvements made in one year do not carry forth to the next unless the improved practices are maintained. Economic benefits from improved management are realized immediately. Economic benefits of genetic improvement are a long time in coming.

Potential Genetic Progress

Progeny in AI populations of 10,000 tested cows should yield an annual genetic progress of 1.7 to 2.3%. Practical situations within the AI industry indicate achievement of 1.74 to 1.87%. Genetic progress of 0.70 to 1.42% per year with non-AI bulls in herd sizes of 25 to 200 cows is theoretically possible.

Selection during the first through fourth lactations was found to be 40, 32, 27, and 24% as effective as selection solely for milk yield. Selected animals were 267 pounds superior in milk yield to unselected cows. Cows with daughters were 309 pounds superior to unselected cows. This resulted in 15 pounds genetic trend due to female selection. Non-AI sire selection resulted in 17 pounds of milk and 0.25 pound of fat genetic trend per year. AI sire selection produced a genetic trend of 53 to 130 pounds of milk and 1.31 pounds of fat per year. Regardless of the precise amount of genetic trend, estimates of achievement range from 0.5 to 9% and 0.2 to 0.3% of the mean for AI and non-AI. Actual results are very poor compared to theoretical results.

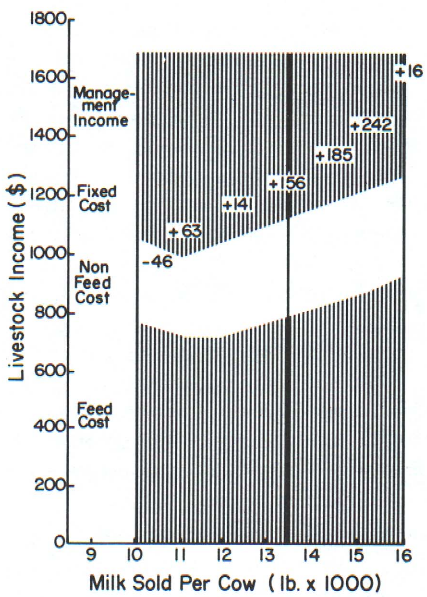

Figure 1 — High production provides for management income which is the goal of all dairymen.

Studies to maximize genetic gain in AI estimated an optimum 1.89% gain per year. Most programs of AI studs should produce 1.49% genetic trend. Results are very optimistic compared to actual.

Causes of a less than optimum genetic trend are: (1) young sires are produced from the top 14% of the sires, 6% of the cows, and 43% of the maternal grandsires; (2) overemphasis on type results in a 16 to 43% reduction in efficiency of selection; (3) too many sires produced AI sons; (4) there is a constant decrease in genetic trend as the number of sires of young sires increase; (5) sires average only 2 to 5 tested sons each; (6) widely used sires had less than 40 sons in AI; and (7) half of the bull sires had only one tested son, and these sires were only slightly above average.

AI Versus Non-AI

"Would a dairyman make more money starting on an AI program than continuing with his non-AI program for the next 30 years?" Assume the dairyman has a 100-cow herd.

Table 1 contains the superiority of AI over non-AI for combinations of year on the program, AI genetic trends, and breeding costs per cow per year. The non-AI genetic trend is assumed to be 32 pounds per year. Costs per cow are zero. Results indicate years on a program and the magnitude of genetic trend in the AI population are very important in the economy of a program. An AI program for 30 years, a genetic trend of 134 pounds per year and a breeding cost of $13 per cow would produce $6,645 per cow more accumulated net income and interest than a non-AI program. This amounts to $664,500 for a 100-cow herd.

Assuming an AI genetic trend of 134 pounds per year, in 30 years the AI population would be 3,060 pounds ahead of the non-AI population. More realistically, the non-AI population would only get 500 pounds behind the AI population, and stay a constant 500 pounds behind. This is accomplished by getting AI sons to use in non-AI. Table 2 contains results when the genetic trend in non-AI is 32 pounds per year until non-AI is 500 pounds behind the AI.

The advantages of AI over non-AI assume one can breed cows free in the non-AI program, and non-AI does not lag by more than 500 pounds genetically. The non-AI lag behind AI is approximately correct except in completely closed herds, and then Table 1 would apply. Almost any AI program results in more net return for the dairyman if there is reasonable genetic trend and costs per cow per year. The AI genetic trend is approximately 134 pounds of milk per year. This shows an accumulated net economic advantage of $423 to $3,055 per cow over the non-AI program for a 30-year period. If average costs of AI are $13 per cow per year, a dairyman with 100 cows would have $173,900 more net income and interest 30 years from today than if he had stayed on non-AI.

Table 1 — Superiority of AI over non-AI in net income and interest (per cow) accumulated for η year.*

Years on AI (η)	Cost per cow per year	AI annual genetic trend (ΔG)				
		45	89	134	178	224
10	5	–25	166	358	550	742
	13	–152	39	231	422	614
	21	–280	–89	103	295	487
20	5	25	1,120	2,216	3,311	4,407
	13	–433	662	1,758	2,853	3,949
	21	–891	204	1,299	2,395	3,491
30	5	270	4,116	7,961	11,807	15,653
	13	–1,045	2,800	6,645	10,491	14,337
	21	–2,361	1,484	5,329	9,175	13,021

**Assuming $5.70 income over feed costs per cwt, an interest rate of 10%, and a non-AI genetic gain of 32 pounds per year at no cost per cow.*

Table 2 — Superiority of AI over non-AI in net income and interest (per cow) accumulated for η year.*

Years on AI (η)	Cost per cow per year	AI annual genetic trend (ΔG)				
		45	89	134	178	224
10	5	–25	161	254	295	318
	13	–152	34	127	167	191
	21	–280	–93	0	40	64
20	5	25	793	1,034	1,140	1,201
	13	–433	335	575	682	743
	21	–891	–125	117	223	285
30	5	270	2,432	3,055	3,331	3,491
	13	–1,045	1,116	1,739	2,016	2,174
	21	–2,361	–119	423	700	858

**Assuming $5.70 income over feed cost per cwt and interest rate of 10%. A genetic trend of 32 pounds per year up to a maximum lag of 500 pounds for non-AI.*

Choosing the AI Sire

Concerning the choice of an AI sire to produce the next generation, dairymen must realize that return on investment in semen will come from the next generation. To determine the economic outcome of various choices, the following must be considered: (1) 80% of conceptions will result in live calves; (2) of the calves born, 50% will be males; (3) of the heifer calves, 17% will die or leave the herd before freshening; (4) bull calves have equal salvage value as veal calves; (5) the probabilities that a daughter will survive, given that she freshens, are 1.00, 0.82, 0.68, 0.52, 0.34, 0.25, 0.16 and 0.11 for the 1st through 8th lactations; and (6) feed costs for each pound of milk are 43% of the market value of the milk. The economic benefit from improving on several of these undesirable conditions will be discussed later.

The difference between sires in return over investment must be recouped entirely by the sire's progeny or grandprogeny. The semen investment today will show no returns for 3 years when the daughters start milking. The return over investment in semen will continue for many years in the production of the daughters, granddaughters, etc. Since future generations of cattle are considered, it is obvious the calf management ability of the dairyman influences the number of genes of a bull which will eventually produce milk. Minimizing calf losses will help maximize return over investment in semen.

Now, let's talk about bulls. Consider the bulls in Table 3 which have proofs and semen costs. The information on the non-AI bull comes from research results. The semen costs of the cow freshener are assumed to be zero. When the bull is sold for beef, all costs are recouped. AI costs include the cost of semen. The investment in semen for each milking heifer of each bull is given in Table 4. Costs increase due to the interest rate, or the same money in a bank would accumulate principal plus interest as shown in Table 5. Also, it takes 6 units of semen to get a milking heifer. The accumulated return over feed cost plus interest for the daughters is given in Table 5. Table 6 has income over investment. Differences between bulls are important. For example, at 7 years and 9 months after the semen investment, Whirlpin is $378 superior to Elevation. Whirlpin exceeds the average non-AI sire by $184 in profitability.

True, only production is considered here. Is the type of Elevation daughters worth $378 more than Whirlpin daughters? Assume a dairyman chooses Elevation over Whirlpin to breed his cows to sell their daughters at 1 year of age. How much more must he get for each Elevation daughter to break even? From Table 6, each

Elevation must sell for $256 more than each Whirlpin just to repay the extra semen costs. Assume Whirlpin's are selling for $400 per head. Elevation's must get $656 per head just to break even. Will Elevation yearlings sell for $256 per head more than Whirlpin's?

A return over investment system, taking into account all future generations, reduces to a simple and easy formula. The formula for ranking sires on return over investment: $ Net Return = (PD/10) — (6 × $ Cost per Breeding Unit). Applying this to our bulls: Elevation, —$121.50; Whirlpin, $57.20; Top Spot, $30.00; Pride, $53.20; Pat, $59.20; Cow Freshener — $30.00. The equation ranks bulls the same as Table 6. It is easy to use by hand or with a pocket calculator.

Managing Female Reproduction

Female reproduction is usually described by 3 parameters: (1) conception rate, (2) days to first service, and (3) efficiency of heat detection. These determine days open and are accepted indicators of the dairyman's management ability.

Records on 31,071 cows showed 46% of all heats were not observed. The top half of all herds caught 67% of all estruses. The bottom half caught only 41%. If cows were observed every 12 hours, less than 2% would be missed due to short heat periods. This is an area with a greater opportunity for improvement compared to trying to improve conception rate.

"Missed Heats = Days Open — Voluntary Waiting — ½ Heat Cycle — [(Services per Conception — 1) × 21 Days]." Waiting 60 days for first service (voluntary waiting), it will take an additional (½ heat cycle) 11 days on average to breed each cow. That equals 71 days open with all heats detected and 100% conception. DHI herds average 126 days open and 1.7 services per conception. Plugging into the formula: Missed Heats = 126 — 60 — 11 — [(1.7 — 1) × 21] = 55 — 14 = 41 days. Failure to conceive = 14 days. Therefore, missed heats were much more costly than conception rate. Actually, 53% of the heats were undetected. Herd conception rates were not extremely variable. Dairymen lose twice as many days to missed heats compared to failure to conceive. It appears reasonable to be able to reduce the 41 missed heat days to below 21 days.

Female reproductive management has its major economic impact on the profitability of the cow being bred. The impact is expressed through changes in milk per day in the herd and ampules of semen per cow.

An acceptable days open has been defined as 85 days. In Figure 2 are the losses in income per cow for each day open beyond 85 days, assuming $10 milk. Example, calving interval on a 50-cow, 15,000-pound herd is 430 days. Income per year is $8,495 less than with a 365-day calving in-

Table 3 — Bulls considered for mating.

Bull	PD milk	PD fat	PD fat corrected milk	$ value	$ per service
Elevation	1,143	41	1,187	119	40.00
Whirlpin	605	41	812	81	4.00
Top Spot	1,254	35	1,200	120	15.00
Pride	1,002	19	862	36	5.50
Pat	1,474	32	1,312	131	12.00
Cow Freshener	–300	–11	–300	–30	Free

Table 4 — Dollar investment in semen per milking heifer.

	Age of daughter										
Bull	0	Birth	1	2	3	4	5	6	7	8	9
Elevation	240	258	284	312	343	378	416	457	503	553	603
Whirlpin	24	26	28	31	34	38	42	46	50	55	61
Top Spot	90	97	106	117	129	142	156	171	189	207	228
Pride	33	35	39	43	47	52	57	63	69	76	84
Pat	72	77	85	94	103	113	125	137	151	166	183
Cow Freshener	0	0	0	0	0	0	0	0	0	0	0

Table 5 — Accumulated income over feed costs and interest.

	Age of daughter						
Bull	3	4	5	6	7	8	9
Elevation	$ 49	$101	$154	$203	$246	$288	$328
Whirlpin	34	69	106	141	171	200	227
Top Spot	50	103	157	208	251	294	334
Pride	36	74	113	149	181	211	240
Pat	55	113	172	226	275	321	365
Cow Freshener	–12	–25	–39	–52	–63	–73	–83

Table 6 — Dollar return over investment in semen.

	Age of daughter										
Bull	0	Birth	1	2	3	4	5	6	7	8	9
Elevation	–240	–258	–284	–312	–294	–277	–262	–254	–257	–265	–280
Whirlpin	–24	–26	–28	–31	0	31	64	95	121	145	166
Top Spot	–90	–97	–106	–117	–56	–14	1	37	62	87	106
Pride	–33	–35	–39	–43	–11	22	56	86	112	135	156
Pat	–72	–77	–85	–94	–48	0	47	89	124	155	182
Cow Freshener	0	0	0	0	–12	–25	–39	–52	–63	–73	–83

Table 7 — Milk production during 3 lactations for cows bred at first estrus and first estrus after 74 days calving.

	Early Bred	Late Bred
First lactation	14,896	15,610
Second lactation	14,209	15,994
Third lactation	15,988	16,466
Total	45,093	48,070
Milk per day	44.1	42.1
Number of days	1,023	1,142

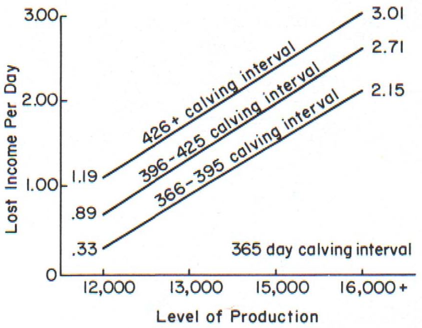

Figure 2 — Income lost per day of delayed conception beyond 85 days open.

terval. When all economic factors are considered, improved heat detection has a large beneficial economic impact. Improving heat detection to 80% is worth a significant investment in detection procedures.

What about breeding earlier than 60 days after calving? Early breeding results in more calves and higher yield per day of life. Early bred cows require more inseminations per conception. Conception rates in Figure 3 go from 25% at 10 days after calving and plateaus at 60%.

Breeding should begin 40 days after calving. First insemination would average 50 to 60 days. A 12-month calving interval can be achieved. Is this economical? Assuming dairymen want maximum production per unit, Table 7 indicates early bred cows have a higher production per day, and more calves each year. Lower complete lactations are due to the depressing effect of earlier gestation.

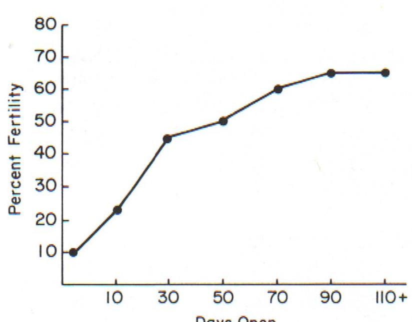

Figure 3 — Percent fertility of various days open.

Conclusions

Properly managing the breeding program will help maximize net profits. Dairymen must be dedicated to a well-organized, scientifically sound AI program. The additional net income will provide an economic advantage over non-AI neighbors.

In choosing AI bulls to sire the next generation, keep in mind the thumb rules: (1) have confidence AI will only sell semen satisfactory or better in conception rate, (2) have serious reservations about buying semen that costs more than $15 per breeding unit, (3) rank acceptable bulls by the simple formula, $\$ = (PD/10) - (6 \times \text{Cost/Breeding Unit})$, and (4) use the bull with the highest value.

Female reproductive management provides two areas for improved net return to the dairyman. Start breeding cows earlier, say at 40 days after calving. Investigate ways of increasing heat detection capabilities. More efficient heat detection has the greatest room for improvement and can produce the greatest dollar return for the dairyman.

Glossary of Terms

AI program — use of sires in an organized AI young sire program or sires with AI proofs of many daughters in many herds.

Accumulated net income — net income plus interest summed over time. Compounding of interest with principal.

Breeding costs per cow — same as semen costs plus appropriate hourly wage if breeding your own cows.

Calving interval — number of days from one calving to the next calving.

Conception rate — total number of services used divided by the number of conceptions obtained.

Cow freshener — a non-AI bull used to breed cows. Slang term for a non-AI bull.

Genetic trend — genetic gain per year in the population for a trait.

Gross income — income earned exclusive of deductions of expenses.

Net income — total income minus total expenses.

Non-AI program — use of sires not AI proven and not in an organized AI young sire program.

Progeny test — measurement of genetic merit of an individual offspring, usually the individual can not express the trait itself.

Return over investment — gross dollars received minus the dollar costs.

Semen costs — total cost of an average breeding during one heat period. Costs include service, semen, AI supplies, liquid nitrogen and depreciation of equipment.

Variable — opposite of constant, or steady. A measure of fluctuations or changes.

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