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Economics of Dairy Breeding

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from Michigan State University Extension Bulletin E-1148.

Milk yield is highly correlated with feed efficiency, and feed is the largest cost in a dairy operation. Since milk producing ability is reasonably heritable, it should be the primary breeding selection goal for all dairymen. See Figure 1.

From an economic standpoint, the selection of other traits should depend on their heritability, economic importance, and their relationship to other economically important traits.

Female reproductive management practices greatly affect the profitability of the cow being bred. Unlike genetic progress, improvements made in one year from management do not carry forth to the next unless the improved practices are maintained.

Economic benefits from improved management are realized immediately. Economic benefits from genetic improvement are a long time in coming.

Potential Genetic Progress

Genetic gain for a trait per year in a herd (genetic trend) is greater if the herd is in an artificial insemination (AI) program, which uses sires in an organized AI young sire program or sires with AI proofs of many daughters in many herds. Non-AI programs use sires not AI proven and not in an organized AI young sire program.

Practical situations within the industry indicate a genetic progress of 1.74 to 1.87 percent per year. With non-AI bulls in herds of 20 to 200 cows, genetic progress of 0.70 to 1.42 percent per year is possible.

In one study, female selection in the AI program resulted in 15 more pounds milk genetic trend than in a non-AI program. AI sire selection produced a genetic gain of 53 to 130 pounds milk and 1.31 pounds fat per year. Non-AI sire selection resulted in 17 pounds milk and 0.25 pound fat genetic trends.

AI Versus Non-AI

Can 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 in dollars of AI over non-AI for combinations of years 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. Non-AI costs per cow are zero. Results indicate years on a program and the magnitude of genetic trend in the AI population are 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 [(134 x 30) - (32 x 30) = 3,060]. More realistically, the non-AI population would get only a constant 500 pounds behind the AI population. This would be accomplished by using AI sons on non-AI cows. Table 2 contains results of the 32-pound genetic trend in non-AI with a maximum lag of 500 pounds behind AI.

The advantages of AI over non-AI take into consideration the facts that cows can be bred 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; then Table 1 would apply. Almost any AI program results in more net return for the dairyman if there are reasonable costs and genetic progress per cow per year.

The AI genetic gain is approximately 134 pounds of milk per year. This shows an accumulated net economic advantage of $423 to $3,055 (depending on costs) 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.

Choosing the AI Sire

In determining the economic outcome of various choices of sires, keep in mind the following: (1) 80 percent of conceptions will result in live calves; (2) of the calves born, 50 percent will be males; (3) of the heifer calves, 17 per-

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

Years on AI (η)	*breeding cost per cow per year***	*AI annual genetic trend (lbs./yr.)* 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.
**Breeding costs per cow are semen costs plus appropriate hourly wage if breeding your own cows.

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

years on AI (η)	*breeding cost per cow per year*	*AI annual genetic trend (lbs./yr.)*				
		45	*89*	*134*	*178*	*224*
	5	-25	161	254	295	318
10	13	-152	34	127	167	191
	21	-280	-93	0	40	64
	5	25	793	1,034	1,140	1,201
20	13	-433	335	575	682	743
	21	-891	-125	117	223	285
	5	270	2,432	3,055	3,331	3,491
30	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, an interest rate of 10%, and a genetic trend of 32 pounds per year up to a maximum lag of 500 pounds for non-AI.

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
Non-AI Bull	-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
Non-AI Bull ..	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
Non-AI Bull	-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
Non-AI Bull ..	0	0	0	0	-12	-25	-39	-52	-63	-73	-83

cent 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 one, 0.82, 0.68, 0.52, 0.34, 0.25, 0.16, and 0.11 for the first through eighth lactations; and (6) feed costs for each pound of milk are 43 percent of the market value of the milk.

The return on investment in semen will come from following generations. Thus the difference among 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 three years until 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, the dairyman's calf management ability influences the number of a bull's genes which will eventually produce milk. Minimizing calf losses will help maximize return over investment in semen.

Now, consider the bulls in Table 3. The information on the non-AI bull comes from research results. The semen costs of the cow freshener (the non-AI bull) are assumed to be zero because all costs are recouped when the bull is sold for beef. AI costs include the cost of semen. The investment in semen per each resulting milking heifer for each bull is given in Table 4. Costs increase due to the interest rate since the same money in a bank would accumulate principal plus interest. Also, it takes six 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 seven years plus nine months (or gestation time) after the semen investment, Whirlpin is $378 superior to Elevation. Whirlpin exceeds the average non-AI sire by $184 in profitability.

Remember, only production is considered here. Is the type of Elevation daughters worth $378 more than the type of Whirlpin daughters? Assume a dairyman chooses Elevation over Whirlpin to breed his cows to sell their daughters at one year of age. How much more must he get for each Elevation daughter to equal the profit from Whirlpin's daughters? From Table 6, each Elevation must sell for $256 more than each Whirlpin just to repay the extra semen costs. Assume Whirlpin's daughters are selling for $400 per head. Elevation's must get $656 per head just to break even with Whirlpin's. 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 = (predicted difference ÷ 10) - (6 x \$ 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; Non-AI Bull, -\$30.00. The equation ranks bulls the same as Table 6.

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

*PD—predicted difference

Managing Female Reproduction

Female reproduction is usually described by conception rate, days to first service, and efficiency of heat detection. These three factors determine days open and are accepted indicators of a dairyman's management ability.

Records on 31,071 cows showed 46 percent of all heats were not observed. In the top half of all herds, 67 percent of all estruses were caught. In the bottom half, only 41 percent were caught. If cows were observed every 12 hours, less than two percent would be missed due to short heat periods. Heat detection is an area with great opportunity for improvement compared to opportunity for improvement of conception rate.

Missed Heats = days open - voluntary waiting - ½ heat cycle - [(services per conception - 1) x 21 days]. If a dairyman waits 60 days for first service (voluntary waiting), he will have to wait an additional 11 days (½ heat cycle) on the average to breed each cow. That equals 71 days open with all heats detected and 100 percent conception. Dairy Herd Improvement herds average 126 days open and 1.7 services per conception. Plugging into the formula: Missed Heats = 126 - 60 - 11 - [(1.7 - 1) x 21] = 55 - 14 = 41 days. Failure to conceive = 14 days. Therefore, missed heats were much more costly than conception rate. Actually, 53 percent 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. Reducing the 41 missed heat days to below 21 days should be a reasonable goal.

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. Figure 2 shows 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 interval. When all economic factors are considered, improved heat detection has a large beneficial economic impact. Improving heat detection to 80 percent is worth a significant investment in detection procedures.

What about breeding earlier than 60 days after calving? Earlier breeding results in more calves and higher yield per day of life. However, earlier bred cows require more inseminations per conception. Conception rates in Figure 3 start at 25 percent at 10 days after calving and plateaus at 60 percent.

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 earlier 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.

Conclusions

In choosing AI bulls to sire the next generation, keep in mind these thumb rules:

- have confidence AI will sell only semen satisfactory or better in conception rate,
- have serious reservations about buying semen that costs more than \$15 per breeding unit,
- rank acceptable bulls by the simple formula, \$ Net Return = (predicted difference ÷ 10) - (6 x cost/breeding unit), and
- use the bull with the highest value return over investment.

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.

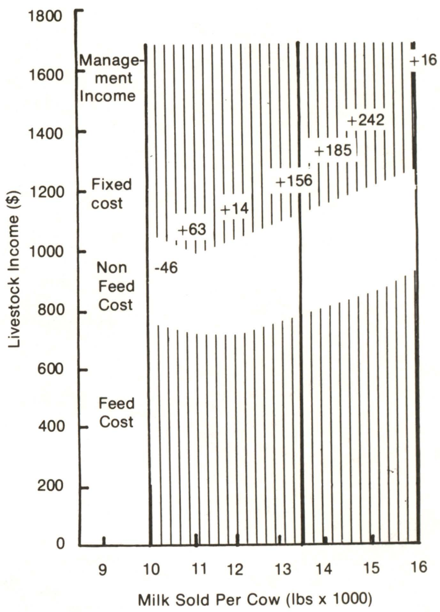

Figure 1. High production provides for management income.

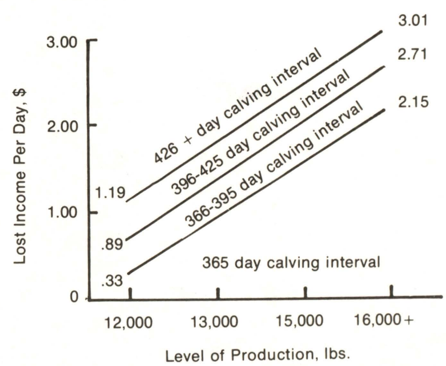

Figure 2. Income lost per day of delayed conception beyond 85 days open.

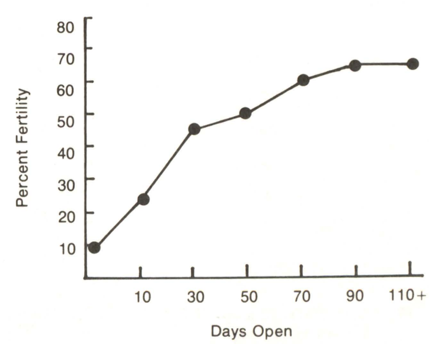

Figure 3. Percent fertility at various days open.

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