Breeding Costs and Strategies of Illinois Dairy Farms

Briley Lenkaitis, Phil Cardoso, Derek Nolan, and Jared Hutchins

Abstract

Breeding preferences on dairy herds have adapted and changed as milk cow productivity has increased and breeding techniques have evolved. In this study, we examined the breeding costs and preferences of dairy farmers in in Illinois. In our survey of 62 dairy farms, respondents were asked about which genetic traits they ranked as most important, which genetic trait indices they used, and how much they paid on average for different breeding services (e.g. sexed semen, beef semen, genomic testing). Farms in our sample were also asked if they had production, health, or type-oriented breeding goals to create a typology of farmers. The average herd size in our sample was 175 cows and 44.07% ($n = 26$) were production oriented, 35.59% ($n = 21$) health oriented, and 20.34% ($n = 12$) were type oriented. While all types of farmers preferred milk and fat yield, type-oriented farmers tended to prefer the Total Performance Index (TPI) and the Udder Composite index over Net Merit, an index the other types of farmers rated highest. About 57% of the entire sample indicated that they consider Net Merit when selecting bulls, whereas the use of the udder and feet indices had higher consideration (76-79%). Average prices for non-sexed semen, beef semen, and sexed semen were $24, $12, and $39, respectively, with little difference between breeding orientations. About 66% ($n = 42$) of our sample used sexed semen or beef semen, with 52% ($n = 32$) of the sample using both on their operation. When asked about their sources of information for new bulls, most farms said genetics companies themselves, though some type-oriented farmers were more likely than the rest of the sample to say breed association. This research provides some important descriptive evidence on the breeding strategies of dairy farms in the Midwest and what costs these farmers currently face.

Over the past two decades, there has been significant technological advancements in breeding technology for dairy farmers. Genomic testing has assisted farmers in understanding the current role of genetics and the genetic potential of their herd and allowed for quicker rates of genetic improvement (citation). Better measurement of cattle traits has also led to a growth in the number of traits and indices In addition to genomic testing, the growing use of sexed semen has allowed dairy farmers to choose genetics more precisely. Thanks to sexed semen, the use of beef semen on dairy farms has also grown in popularity.

Yet, little work has been done understanding how dairy farmers are adapting to these changes. Given the precipitous technological changes in breeding and genetics, it is important to understand which technologies dairy farms are adoption, which traits they are using to choose bulls, and how much the technology is costing them. To determine how farmers are making their breeding decisions and the costs associated with breeding decisions on their herd, we sent a survey to all Illinois dairy farmers requesting information about breeding decisions and costs. In the survey, we asked dairy farmers to characterize their breeding goals as either production-oriented, health-oriented, or type-oriented. We then asked them to select and rank genetic traits and indices that they used in their breeding decisions and whether they used a number of genetic technologies: sexed semen, beef semen, genomic testing, and embryo transfer. We finished the survey by asking which information sources they used to discover new bulls. While Illinois is a small dairy state, the farms in the state are broadly reflective of the smaller scale production systems found in the Midwestern United States.

Previous studies have explored breeding strategies among dairy farms, but seldom in the United States. An early study done in Illinois, Shanks et al. (1983), surveyed Holstein farms to determine adoption of artificial insemination and which traits farmers used to select bulls and cows. Since then, more recent studies have used discrete choice experiments and typologies to study farmer breeding strategies and technology adoption in Australia (Martin-Collado et al., 2015), Sweden (Clasen et al., 2021), and Denmark (Slagboom et al., 2016). Very little work has been to understand recent adoption trends in the United States. These previously mentioned studies can be difficult to use in comparison to US dairy herds due to differences in production system, climate, and milk payment system.

Moreover, even fewer studies have determined how costly these technologies are to use. While sexed semen may deliver high-quality genetics, it is important to understand its costs in order to know whether using sexed semen is cost-effective or not. In this study, we both characterize the breeding strategies of Illinois dairy farms and obtain a measure of average

cost for non-sexed semen, sexed semen, and beef semen, The results of this survey are an important first step to exploring the costs of different breeding strategies in future work in greater detail.

We distributed our survey to all (435) Illinois dairy farmers on April 18, 2022, via mail and QR code, and collected responses on September 25, 2022. A total of 61 surveys were returned (a 14% response rate). The survey consists of four sections: farm characteristics, breeding goals, breeding expenses, and breeding practices. Questions on the survey were developed to understand farmers' stated preferences in their breeding decisions. Questions consisted of multiple choice, select all, ranking, and short response.

In addition to the survey sections, we connected farmer responses with corresponding breeding data from the Dairy Herd Improvement Associations (DHIAs), specifically the Dairy Records Management System (DRMS) 202 Herd Summary Sheet. The DRMS 202 Herd Summary Sheet gives an overview of farm characteristics including milk production, reproduction, genetics, udder health, and feed cost information, and shows the actual net merit of their breeding decisions. Records from September 2021 to September 2022 were analyzed.

Dairy producers were asked to rank their breeding goals from first to third as either production, health, or type. In our analysis, farmers were then broken into orientations based on this question. Percentage breakdowns are shown in Table 1. Production was ranked first by 44% of respondents and health was ranked first by 36% of respondents. With production and health ranked closely, farmers can be shown to trade off production and health goals within their herds, valuing them closely. Type was ranked third in importance by 50.85% of the sample of Illinois dairy farmers. In the survey responses, 26 farms are production-oriented, 21 are health-oriented, and 12 are type-oriented. In twenty-two DRMS 202 reports, 7 producers are production-oriented, 5 are health-oriented, and 10 are type-oriented.

Farmers were also asked to indicate their age and education, shown in Figure 1 Approximately 33% of respondents were over 60 years old in any orientation while health-oriented

Table 1: The percentage of respondents that ranked production, health, and type first, second, or third.

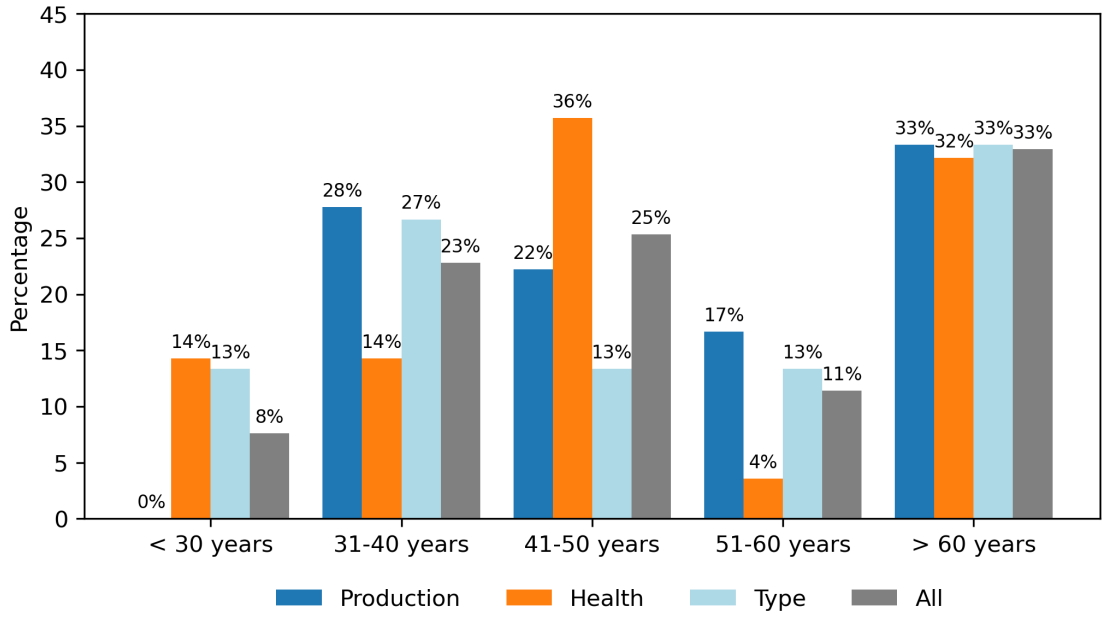
	Production	Health	Type
1st Rank	44.07% (26)	35.59% (21)	20.34% (12)
2nd Rank	33.33%	38.33%	28.33%
3rd Rank	23.73%	25.42%	50.85%

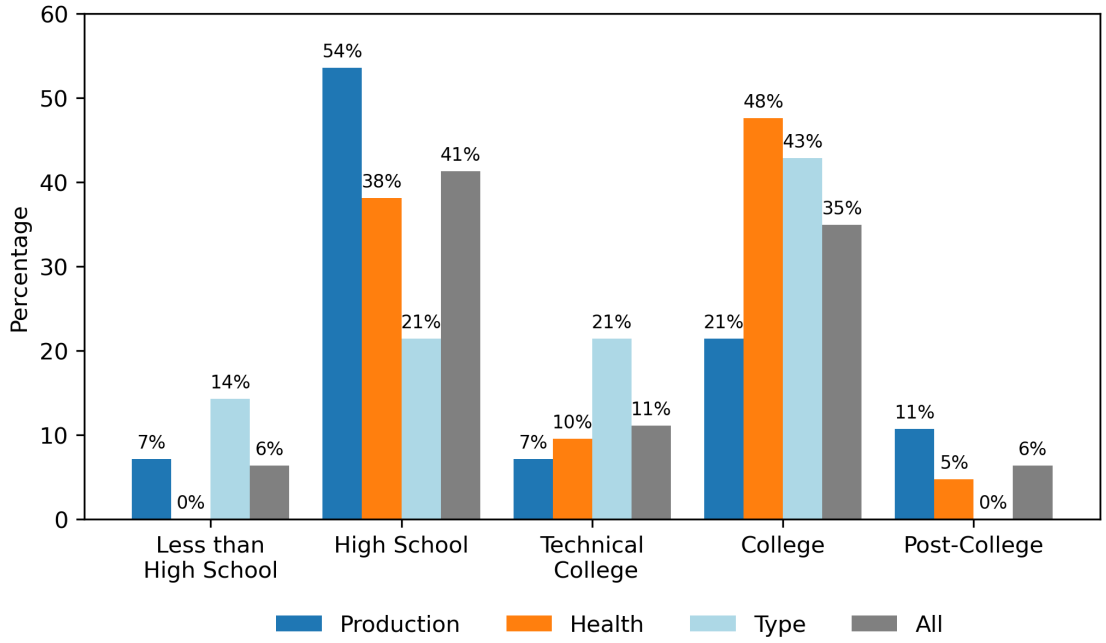
farms had more owners in the 41-50 years old category. In terms of education, 40% of respondents' highest education was a high school diploma. Production-oriented herd owners have the most variety in education levels with 54% having a high school diploma, but the most master's degrees in the sample (11%). Health and type-oriented herds have similar education breakdowns, with the main difference being that type and health herds have higher percentages of post-high school education (technical college and college).

The average milking herd size for the entire survey sample was 175 cows with an average of 68.8 pounds per cow daily. Production, health, and type-oriented farms had average herd sizes of 144, 284, and 136 respectively, and average milk productions of 68.4 lbs/cow/day, 88.9 lbs/cow/day, and 72.1 lbs/cow/day. However, health-orientated farms have the two largest herd sizes in their sample. By removing these outliers, the average herd size for health-oriented dairy farms was 140 and the average milk production per cow was 79.2 pounds per cow per day. The average herd size in Illinois is 166 cows with an average of 62 pounds per day (**?**). Our survey is highly representative of the Illinois dairy industry due to similarities with state-reported averages.

Using the breeding and production data from the DHIA reports, we compared the average NM$ of dams and maternal sires for the three different orientations. Production, health, and type farms showed an actual average milk production of 78, 85, and 68 pounds per cow per day using production data within the DRMS 202 reports. One important note is that milk production differs from the entire survey sample because of the smaller sample size or inaccurate farmer reporting. In addition, the average Dam NM$ and average maternal sire NM$ were +229 and +387 (production), +159 and +339 (health), and +57 and

Figure 1: Survey results showing the distribution for farm owner age and education





+153.5 (type). Health-oriented farms have the highest actual milk production per cow and production-oriented farms have the highest average NM$ for animals used and calved in their herd.

Next, survey participants indicated which trait indices are most considered when making breeding decisions: Net Merit (NM$), Total Performance Index (TPI), Grazing Merit/Fluid

Table 2: DHIA 202 reports for farms broken into orientation and their average milk production, net merit per animal, and net merit per sire.

	Production-Oriented (7)	Health-Oriented (5)	Type-Oriented (10)
Actual Milk Production/Cow	78 lbs/cow/day	85 lbs/cow/day	68 lbs/cow/day
Avg NM$- Dam	+229	+159	+57
Avg NM$- Dam's Sire	+387	+338	+153.5

Merit/Cheese Merit (GM$/FM$/CM$), Udder Composite (UDC), and Feet and Legs Composite (FLC). Dairy producers were asked to select all the indices they consider and then rank which one is the most important. Udder composite was selected a majority of the time (79%) with feet & legs composite (76%) following closely behind. Net Merit was considered by 57% of the herds in the sample and TPI by 46%.

However, when asked to rank, Net Merit was ranked in first importance by 34% of farms, followed by the feet and udder composites. Producers seem to find Net Merit and feet and legs composite very important when selecting bulls, but they may consider udder composite to be an extra consideration when breeding if they have the extra resources or time. TPI and the other merit indices (e.g. Grazing Merit) were ranked first by less than 15% of the respondents.

Table 3: Trait index considered or ranked first when selecting bulls.

% Considered	Index	% Ranked First	Index
79%	UDC	34%	NM$
76%	FLC	24%	UDC
57%	NM$	17%	FLC
46%	TPI	14%	TPI
13%	GM$/FM$/CM$	7%	Other
		3%	GM$/FM$/CM$

When analyzed by orientations, results show that production and health-driven herds value NM$ higher than TPI—which is valued higher by type-driven herds. Type-oriented herds do not rank NM$ in their top 3. The absence of NM$ in type herds could be an explanation as to why their average NM$ in Table 2 was lower than the other two orienta-

tions of herds. Net merit is driven more by health and production traits; in contrast, total performance index weights type higher in its calculation, which follows our results closely.

Table 4: Trait indices ranked on average by orientation.

Production-Oriented	Health-Oriented	Type-Oriented
1st Rank NM$	1st Rank NM$	1st Rank UDC
2nd Rank TPI	2nd Rank UDC & FLC	2nd Rank TPI
3rd Rank UDC	3rd Rank TPI	3rd Rank FLC

Respondents also ranked individual predicting transmitting abilities (PTAs) which make up the indices. Respondents were asked to consider 11 PTAs: milk yield, fat yield/percentage, protein yield/percentage, somatic cell score (SCC), daughter pregnancy rate (DPR), conception rate (CR), calving ease (CE), type, feed efficiency/feed saved, productive life (PL) and cow livability. The first selected all that are considered when making mating decisions and the ranked their top five PTAs. Milk yield was highly considered followed by fat and protein yield. Cow livability and feed efficiency/feed saved were chosen the least amount of times, being some of the newest PTAs on the list. These results may suggest that some dairy farmers may not have known about new traits, are unable to obtain new sources of information, or want to stick to breeding with older, more well-known PTAs. Interestingly, milk yield was the most common trait to rank as first among the PTAs (44% of respondents), followed by fat yield (18%) and type (12%).

When broken down by orientation, production-oriented herds ranked milk, fat & protein yield first the most, which is expected from a production standpoint. Health-oriented herds consider the milk components and yield highly but also have higher considerations for productive life, conception rate, and cow livability than other orientations. Type-oriented herds are milk yield driven but also breed high for type in their herds. Production, health, and type-oriented farms all have a common goal to produce high milk yields, but additional goals may differ when considering other PTAs.

The next section of the survey asks farmers how much they pay on average for a number of

Table 5: PTAs that are considered when making mating decisions.

% Considered	PTA	% Ranked First	PTA
85%	Milk Yield	44%	Milk Yield
74%	Fat Yield %	18%	Fat Yield %
71%	Protein Yield %	12%	Type
71%	Calving Ease	7%	Protein Yield %
65%	Conception Rate	7%	Productive Life
61%	Type	4%	Calving Ease
61%	Productive Life	4%	Conception Rate
60%	Somatic Cell Score	4%	Cow Livability
50%	Daughter Pregnancy Rate	4%	Daughter Pregnancy Rate
23%	Cow Livability		
18%	Feed Efficiency/Feed Saved		

Table 6: Orientation results for percentage first rank of PTAs.

Production-Oriented		Health-Oriented		Type-Oriented	
50%	Milk Yield	35%	Milk Yield	46%	Milk Yield
21%	Fat Yield %	15%	Fat Yield %	31%	Type
8%	Type	15%	Productive Life	15%	Fat Yield %
8%	Protein Yield %	10%	Conception Rate	8%	Protein Yield %
8%	Calving Ease	10%	Cow Livability		
4%	Productive Life	5%	Type		
		5%	Protein Yield %		
		5%	Daughter Pregnancy Rate		

breeding services. On average, non-sexed semen costed $24 per straw; this question was a free response assuming that a majority of herds use this breeding method. The other questions asked if respondents used the method and, if so, how much it cost per straw/service. Sexed semen is used by 69% of herds with an average cost of $39/straw. Beef semen is used on 66% of herds, costing an average of $12/straw. Genomic testing and ET are used on 26% and 16% of herds, respectively, with costs of $59 and $282 per animal, respectively. High variance is reported in the results for genomic testing and embryo transfer since these methods are only reported on a small percentage of Illinois farms. When looking at the cross-tabulation in Table 8, 52% of farms use both sexed and beef semen. The percentage of farms that use one or the other is almost identical with 15% using only beef semen and 16% using only sexed semen. There are no significant differences between the orientations in terms of what they are paying for. Figure 2 shows the adoption rates and average costs across breeding

orientations. Overall, there are no significant differences across orientations.

Table 7: Costs and uses of different breeding methods.

	Non-Sexed Semen	Sexed Semen	Beef Semen	Genomic Testing	Embryo Transfer
Percent Using		67.74%	66.13%	25.81%	16.13%
Average Cost	24.47	38.55	11.79	58.83	282.5
	(11.07)	(10.38)	(6.16)	(53.39)	(341.39)

Table 8: Cross-tabulation table showing the adoption rate for sexed semen and beef semen.

		Sexed Semen	
		Yes	No
Beef Semen	Yes	51.61%	16.13%
	No	14.52%	17.74%

The survey also asked respondents to report what percentage of their herd they bred with non-sexed semen, sexed semen, embryo transfer, and natural service. For the average herd in our sample, the distribution of breeding methods can be shown as follows—non-sexed, artificial insemination is used on 73% of animals. Sexed, artificial insemination is used on 17% of the herd, and natural services and embryo transfer are performed on the remaining percentage of the herd. Table 9 shows the breeding methods broken out into breeding orientations. While almost all orientations use the same proportion of non-sexed semen, type-oriented herds use sexed semen more than any other orientation.

Finally, the survey asked respondents where they got information for new bulls. Figure 3 shows the percentage of respondents that checked the option as a source of information in

Table 9: Percentage breakdowns of breeding methods across orientations

	Non-Sexed	Sexed	Embryo Transfer	Natural Service
Production	73.0	16.08	3.58	7.35
Health	73.95	15.5	1.37	9.25
Type	76.08	24.7	2.5	1.5
All	71.97	16.53	2.48	10.02

the whole sample and across orientations. More than 80% of respondents in any category indicated that the genetics company is the main source of information for new bulls. However, production-oriented farms are more likely than other groups to use other farmers and type-oriented farms are more likely to use the breed association.

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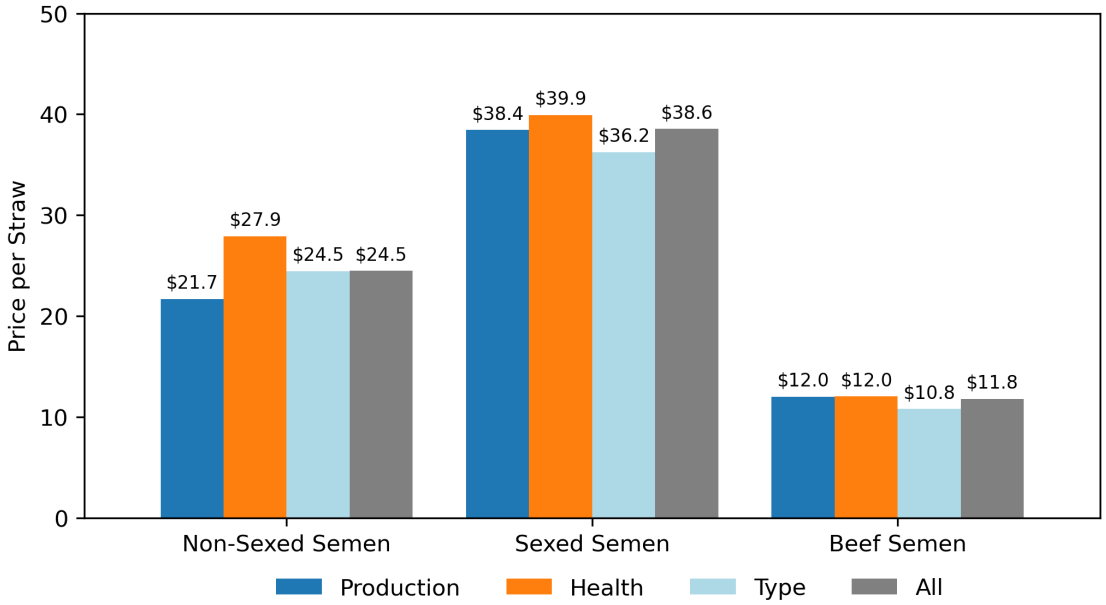
Figure 2: Cost of different semen options and adoption rates across orientations



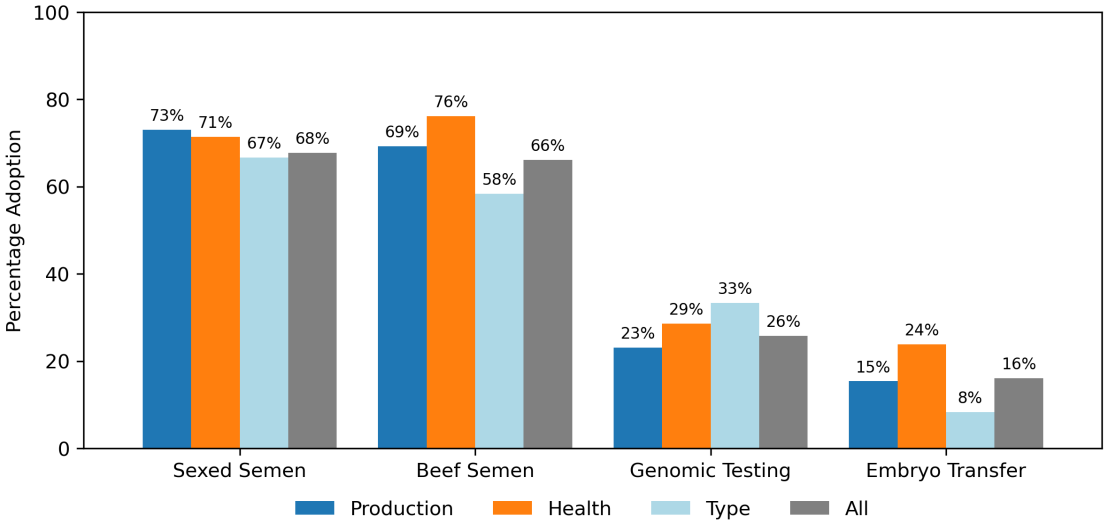


Figure 3: Sources of information for new bulls