September 1976

Dairy Cattle Breeding: Contributions of Research on Field Data

L. Dale Van Vleck
University of Nebraska-Lincoln, dvan-vleck1@unl.edu

Dairy Cattle Breeding: Contributions of Research on Field Data

L. D. VAN VLECK
Cornell University
Ithaca, NY 14853

ABSTRACT

Papers about dairy cattle breeding published in the Journal of Dairy Science from 1960 through 1975 were categorized according to whether the data came from institutional herds or from field collection and also according to whether the research was done with support of a regional project. Most project papers involved institutional data. The vast majority of nonproject papers made use of field data. Nearly all papers classified as theoretical were also associated with field data or field recommendations. The major impact of breeding research projects with field data has been from improved genetic evaluation for production and from development of optimum selection programs. Institutional projects have had more indirect impact by testing such breeding plans as crossbreeding and inbreeding which if implemented without testing would have reduced dairy income. Additional federal and state funds should be appropriated for collection and analyses of field data with increased emphasis on development of statistical and breeding theory as well as on more efficient computing strategies. Experimental herds should continue to be supported for the collection of management and health data and to illustrate the economic validity of recommended selection and evaluation procedures.

INTRODUCTION

The original assignment for this paper and the one followed was to compare the impact of research with field data with that from institutional herds. The actual title, which came later, turned out to be different. The other speakers, White (2), Mather (1), and Young (3), have done their usual excellent work in reviewing dairy cattle breeding research of the S-49, NE-46, and NC-2 regional products; therefore, this report will not deal with those contributions in any detail except in tabulating published reports. The impact of research with institutional and field data was examined by tabulating the amount and kinds of research accomplished with such data. Although the approach is admittedly not precise, the hope was that some idea of the importance and characteristics of the research could be determined.

The most used, and easiest to obtain, literature in dairy cattle breeding in the United States is published in the Journal of Dairy Science. Thus, papers published in the Journal for the 16 yr, 1960 to 1975, were examined. Although this approach does not give complete coverage of dairy cattle breeding research in the United States, such a summary may be representative of the research. The most important failure of this coverage would be in not giving proper credit to regional research reported in station and regional bulletins which often publish extensive results of joint research effort. The problem with bulletins, however, is that they are not distributed widely, and, in many cases, the research world soon forgets or never knew of their existence. Perhaps a short abstract in the Journal with reference to where they could be obtained would be useful.

Even deciding what papers are concerned with dairy cattle breeding is arbitrary since in a few cases there is obvious overlap with nutrition, reproduction, and economics; therefore, this tabulation may not agree precisely with any other tabulation.

LOCATION AND SOURCE OF DATA

Since part of the assignment was to compare the impact of research in regional projects using institutional data with that from field data, the breeding papers were classified according to location of the authors. Papers that listed NC-2 or S-49 in their acknowledgments were considered project papers. Researchers from the states in those regions also published papers with no reference to NC-2 or S-49. Such papers

Received September 14, 1976.

were classified as nonproject papers. The NE-46 project was mentioned only once in a joint publication with S-49 so NE-46 was not used as a category. Many of the papers from the Northeast came from New York so papers from New York were assigned a separate category as were papers from USDA at Beltsville when the papers obviously were not part of a regional contribution. Canada, mostly Ottawa and Guelph, was a separate category. All other contributions were listed under "other."

The papers further were cross-classified according to the source of data: field collected, including mostly DHIA records but also data from AI studs and many sets of production and type data from the breed associations; and institutional data, including that from university herds, state institutional herds, the Beltsville herd, and also records from single large private herds. Only four papers were concerned with regional data from institutional herds in more than one state. Papers with data from both field collection and institutional herds were assigned arbitrarily to one or the other categories according to the amount of data involved.

Perhaps even more controversial is the assignment of papers to a theory category. A paper was assigned this classification if it contained any advances in methods of analysis, modeling, or simulation. Most such papers did not contain major or revolutionary advances in theoretical knowledge. This category was not mutually exclusive with the categories of field or institutional data since most theory papers also involved analysis of data.

Tabulation of these classifications is in Table 1. As expected, the majority of the project papers involved data from institutional herds which project administrators think they are supporting. Somewhat surprising is the number of NC-2 project papers utilizing field data. Among nonproject papers from the NC-2 and S-49 states, the majority were based on field data, particularly from NC-2 states. Papers from Beltsville were about twice as often based on field data as records from their herd. The output of the two main research groups at Beltsville was nearly as great as the total for the S-49 states. Papers with Beltsville senior authors dealing with S-49 projects were included only under the S-49 category. Canadian and New York reports mostly were based on field data. The relatively few reports from other states

TABLE 1. Classification of dairy cattle breeding papers in the Journal of Dairy Science (1960–1975) according to location of author and source of data.

Data source	Project papers		Nonproject papers		New York	USDA (Beltsville)	Canada	Other
	States in regions		States in regions					
	NC-2	S-49	NC-2	S-49				
Field	21	2	44	26	97	28	16	18
Institution	36	9	9	18	3	15	2	10
Total	57	15[a]	53	44	102[b]	43	18	28
Theory[c]	4	0	5	3	23	4	3	...

[a]Total includes four papers with regional institutional data.
[b]Total includes two theoretical papers with no data analysis.
[c]Papers including advances in methods of data analysis, breeding theory, modeling, or simulation.

followed the general pattern, excluding Canada and New York, in that roughly two of every three papers were based on field data.

Although not shown in Table 1, all except three of the so-called theoretical papers that used data used field data. Although determining the cause and the effect may be speculative, it appears the problems involving field data may stimulate advances in theory.

TYPE OF RESEARCH

The impact of research naturally depends on what research is done. A second phase of the tabulation was to assign each paper to a particular area of research, again determining whether the data were field collected or from institutional herds. As in any such categorization, arbitrary assignments must be made because of a multiplicity of topics within the same paper. Papers were assigned to only one category except that theory papers were classified also to a particular area of research. The results of this tabulation are in Table 2.

Since milk production is the economic reason for dairying, it is not surprising that the most frequently reported research deals with genetic evaluation for production. Approximately 80% of the papers on genetic evaluation concerned sire selection, a proportion not greatly different from the theoretical proportion of the total genetic progress that is possible by male selection.

Accurate estimates of variance components are necessary for efficient genetic evaluation through either herdmate or best linear unbiased prediction methods. Similarly accurate adjustment factors for age, season, and days open are necessary to improve genetic evaluations. Research on part or in-progress milk records also is aimed at improving the accuracy of evaluation, decreasing generation interval, or increasing selection intensity—all of which can contribute to faster genetic progress.

The large number of papers dealing with estimates of genetic trend or differences between different breeding groups, such as AI and non-AI or registered and nonregistered, is surprising. These papers, however, are a valuable check on theoretical expectations and invaluable aids in persuading responsible segments of the industry that animal breeding theories will yield results. A sizeable number of papers also dealt with devising breeding programs to optimize genetic gain or income over investment.

TABLE 2. Classification of dairy cattle breeding papers in the Journal of Dairy Science (1960–1975) by topic of research.

Topic	Number papers	Number also under theory
Genetic evaluation for milk Sires – 42 Pedigree and cows – 10	52	8
Theory, modeling, simulation	42[a]	...
Parameter estimation (milk)	37	8
Part records	29	0
Genetic change and differences Estimates – 19 Projections – 10	29	15
Adjustment factors (milk)	26	3
Milk composition	23	2
Crossbreeding	22	0
Type studies	22	0
Survival and disposal studies	19	1
Abnormalities, twinning, sex ratios	14	1
Body measurements	13	0
Reproductive measures	13	0
Milk recording	10	0
Blood studies	10	0
Genotype by environment interactions	9	0
Inbreeding and relationships	8	1
Milk flow (5), mastitis (3)	8	0
Economic merit – semen, programs, milk and fat pricing	6	3
Feed efficiency	5	0

[a]These are also included under other topics.

The number of theory-type papers associated with each research category is also interesting. More than one-third were concerned with estimating genetic change or in devising optimum genetic breeding programs. Papers on estimation of parameters necessary for genetic evaluation and directly on genetic evaluation accounted for nearly 40% of the theoretically inclined papers. As shown in the next paragraphs, these areas of research have dealt mainly with field-collected data.

The data sources for various areas of research are shown in Table 3. Some idea of the relative importance of field and institutional data during the period, 1960 to 1975, can be

TABLE 3. Data sources for various areas of research reported in dairy cattle breeding papers published in the Journal of Dairy Science (1960–1975).

Topic	Data source	
	Field	Institution
Sire evaluation (milk)	42	0
Pedigree and cow evaluation (milk)	10	0
Parameter estimation (milk)	31	6
Part records	26	3
Adjustment factors (milk)	21	5
Milk composition	14	9
Crossbreeding	0	22
Type studies	19	3
Survival and disposal studies	16	3
Reproductive measures	7	6
Genotype by environment interactions	7	2
Inbreeding and relationships	2	6
Economic merit	6	0
Feed efficiency	0	5

seen. Certainly the most important single kind of research for theoretical and practical reasons is in the area of sire evaluation because of the implications for genetic progress. All the papers dealing with sire evaluation were derived from field data as were the papers on evaluating cows and pedigrees.

Estimates of parameters used in genetic evaluation also came mainly from field data and for good reason since such estimates should be more applicable to evaluations based on field data than estimates from institutional herds which often have unique management. A similar proportion of papers on adjustment factors also derived from field data. Research on in-progress records largely has come from DHIA files.

Type studies have been accomplished mainly from field collected data from breed associations or from special projects to collect such data from the field. Similarly, longevity and other studies dealing with reasons for culling were mostly from field data, usually DHIA or special projects.

Papers dealing with economics of breeding decisions have been developed either from field data or for field applications. Papers on milk composition and reproduction are evenly divided between field and institution data. Milk composition data are likely to be available from university herds, but a considerable number of special DHIA projects have gathered field data. About one-half of the research reports on reproductive measures such as services per conception, calving interval, and days open were based on field data even though such data are not easy to obtain.

On the other hand, the areas of research in which institution data are used primarily are those where field data are not available or where the necessary experimental control is not likely. All crossbreeding reports came out of the regional projects with institutional herds. Both the S-49 and Illinois projects have been reported extensively and illustrate the type of research which must be done institutionally. Similarly, feed efficiency data can be obtained only from experimental herds since the cost is prohibitive for collection on field herds. Most dairymen could not afford the disruption in their usual routines which would be created by recording individual cow feeding information and weighbacks.

Studies of inbreeding have been primarily in experimental herds. The only field studies have been to monitor inbreeding in the population. The inbreeding levels necessary for studying the effects of inbreeding usually are not attained in regular dairy herds; thus, the necessity is created for the use of institutional herds to study the effects of inbreeding.

The foregoing paragraphs give an impression of the value and impact of field data and of institutional data for dairy cattle breeding research.

COSTS

In general, field data cost little for research, especially when collected for other purposes. Records of DHI are a good example. Research using DHI records probably has yielded economic benefits from the associated genetic improvement which is far in excess of the testing costs. The testing costs were to pay for the original purposes of providing management information. Even when data must be collected by special surveys and projects, the cost per unit of data may be small. The additional benefit of field data is that inferences to field conditions are much easier to justify than when institutional data are collected under special

TABLE 4. Federal and state[a] funding of NC-2 and S-49 regional projects[b].

Period	NC-2		S-49	
	Federal	State	Federal	State
1951–55	$ 356,929	$ 838,236		
1956–60	786,100	1,372,420		
1961–65	910,567	1,876,197	$ 839,592	$ 896,961
1966–70	1,065,375	1,884,965	1,176,031	1,534,330
1971–75	1,257,000	3,166,443	1,034,410	2,101,819
Total	$4,375,971	$9,138,261	$3,050,033	$4,533,110

[a]Most state funds are probably derived from the project herds and thus should not necessarily be construed as coming from state tax dollars.

[b]Adapted from CSRS, personal communication, 1976.

conditions. The major cost of field data is in the data analysis—the trained personnel necessary for the often complex analyses and the computer costs. Many of these same costs also occur with analysis of institutional data.

Institutional data appear costly. Although funds for regional projects are used for more than experimental herds, some idea of the costs involved may be obtained from summarizing the federal and state contributions to the NC-2 and S-49 projects (CSRS, personal communication, 1976). Table 4 shows the contributions from federal funds. The state part of the budget undoubtedly includes revolving funds so may not be a realistic measure of actual cash supplied by state governments. As a reviewer has stated strongly, most state funds come from income from the project herds. This income also may sometimes be used to support other dairy cattle research as well as for various educational programs. Thus, little state money would be saved if dairy breeding project herds were eliminated. What fraction of either the federal or state funds is used for salary items which involve duties outside the scope of the regional projects is not clear. How much of that cost goes to support field studies and how much for studies involving institutional herds is also not apparent. A valuable byproduct of the regional funding may be in providing support to many graduate students in animal breeding. Quite possibly the value of such training may justify completely the federal input even though that was not the original intent.

CONCLUSIONS

Cost-effectiveness studies have not been made with regard to the contribution of breeding research on field data for dairy cattle improvement. If done, they would certainly show that the impact is positive by increasing dairy income through higher production or producing milk for consumers at reasonable prices. The main research projects leading to these results have concerned increasing genetic gain for yield through improved genetic evaluation which includes estimation of the necessary variances and adjustment factors. Advances in theory stimulated by dealing with field data and field problems also have contributed to more efficient genetic evaluation and to development of more optimum selection programs.

The impact of regional, institutional projects has been more indirect. These projects have tested several ideas which, if implemented without testing, would have resulted in reduced dairy income. Thus, the gain from regional projects has been more in the nature of saving money rather than in increasing income. Of course, the argument can be made that dairymen would not have practiced crossbreeding, excessive inbreeding, or have been concerned with feed efficiency. However, there was a chance that crossbreeding and inbreeding could have been profitable and that feed efficiency could have been much superior to milk yield for selection purposes.

RECOMMENDATIONS

More federal and state funding should be put into collection and analysis of field data. Emphasis also should be placed on development of necessary statistical and breeding theory and on development of efficient computing strategies to utilize field data most efficiently.

On the other hand, funding should be continued for experimental herds to do research which is extremely difficult with field data such as on management and health costs and also to do demonstration research to emphasize the economic validity of using recommended selection and evaluation practices.

REFERENCES

1 Mather, R. E. 1977. Review of regional project NE 62: Relationships between genetic markers and performance in dairy cattle. J. Dairy Sci. 60:483.
2 White, J. M., R. H. Miller, and C. J. Wilcox. 1977. Review of regional project S-49: Genetic methods of improving dairy cattle for the south. J. Dairy Sci. 60:474.
3 Young, C. W. 1977. Review of regional project NC-2. J. Dairy Sci. 60:494.