8-1984

B792: The Development of the Ability to Select for Increased Milk Production: The Jersey Dairy Cow in Maine, 1900-1984

John R. Paton

Barbara A. Barton

ISSN 0734-9548

THE DEVELOPMENT OF THE ABILITY TO SELECT FOR INCREASED MILK PRODUCTION: The Jersey Dairy Cow in Maine, 1900–1984.

by

John R. Paton and Barbara A. Barton

MAINE AGRICULTURAL EXPERIMENT STATION
University of Maine at Orono

Experiment Station Bulletin 792

August 1984


Maggie Murphy

THE DEVELOPMENT OF THE ABILITY TO SELECT FOR INCREASED MILK PRODUCTION: THE JERSEY DAIRY COW IN MAINE, 1900 - 1984.

By

John R. Paton and Barbara A. Barton

MAINE AGRICULTURAL EXPERIMENT STATION

University of Maine

Orono, Maine

Experiment Station Bulletin 792 August, 1984

We would like to dedicate this Bulletin to the late Clyde Russell of Pine Hill Farms.

TABLE OF CONTENTS

I.	Introduction. David C. Smith	vi
II.	Acknowledgements	ix
III.	Preface. The Development of Modern Commercial Dairying and Its Impact on Breed Development	1
IV.	The Modern Jerseys, 1900 to 1930s	7
V.	The Modern Jerseys, 1930s to the Present	33
VI.	Conclusion	71
VII.	Tables and Maps	81
VIII.	Selected Bibliography	94

PLATES

COVER PLATE

The Maine State Jersey Herd at the Eastern States Exposition, 1936. The photo includes Ross Elliott, Herbert Howes, Edward Rowe, Clyde Luce, Don Elliott. Photo by Hildebrand, provided by the Elliott family, East Corinth.

FRONTISPIECE

Springdale P Abe Pearl 3051743. E-90%. Born September 10, 1976. S: Milkboy Happy Hill Abe 613165. D: Springdale Posy Fin Sweet Pea 2728339.

2-01	302	12223	5.1	629	
3-01	305	16657	4.7	776	
4-02	305	20909	4.5	936	813 protein
5-02	305	20630	4.5	919	867 protein
6-03	305	22379	4.4	986	863 protein

Photo by Maggie Murphy of Agri-Graphics Ltd., Cary, Illinois. Photo provided by Whitcomb family of Springdale Farm, Waldo. Nancy W. Quimby at the halter.

PLATE 1

Foremost Beauty, born December 3, 1936. She was purchased at the Harvey Jersey Club Sale at Harvey Station, N.B., on May 24, 1941, for $85. She is the progenitor of the "B" cows at Pine Hill Farm. Photo provided by the Russell families of Pine Hill Farm, Winslow, and Potter's Brook Farm, Litchfield.

PLATE 2

2-A. Springdale Donna Prof Darcy 3158646. E-90%. Born November 26, 1979. S: Springdale Samson Professor 630851. D: Springdale Deana Mercury Donna 3086870.

2-01	305	18705	2.8	526	718 protein
3-02	301	21304	4.2	887	791 protein
4-01	305	23337	4.0	942	841 protein

Photo by Maggie Murphy of Agri-Graphics Ltd., Cary, Illinois. Photo provided by the Whitcomb family of Springdale Farm, Waldo. Nancy W. Quimby at the halter.

PLATES

2-B. Highland Spirit T. Aletta 3134116. Born February 22, 1979. S: Highland Observer Spirit 628290. D: Highland Trigger O. Aletta 3001813. "Highland Observer Spirit" is one of the 36 proven sons of "Observer Chocolate Soldier." In the January 1982 Summary he ranked tenth among these sons for PD$.

3-06	305	16667	5.3	886	3.6/596 protein
4-11	259	13510	5.4	726	

Photo by Mark Jenson, Walpole, N.H. Photo provided by the Pike and Palmer families of Highland Farms, Cornish.

INTRODUCTION

Many years ago when the idea of a college for farmers was being first discussed, far-seeing people in the discussion thought the idea was good, but that it should go farther. If there were to be colleges, there should also be research into the problems of farmers. Then when questions were answered, farmers could take the knowledge and provide a better life -- to literally grow two blades of grass where one grew before. This was not only because it would make their lives easier, but also in the long run because it would improve the lot of our species.

The colleges were created, and some funds provided. Later in order to foster even more research, experiment stations were authorized. Nearly all of them (and they occur in every state) were located near to or even on the campuses of the agricultural colleges, many of which had grown to become universities by that time. Still later, with the advent of better roads into the country, free mail delivery, and the opportunity to advance farming interests, the transfer of the knowledge obtained by the scientists in their research was hastened by the development of extensions of the universities with demonstration agents in each county.

This meant that each university founded in this way now had a three fold purpose to its work. The first of these was teaching -- to aid the young to improve themselves. The second was research -- to respond to immediate questions, but also to solve the basic problems of modern science as applied to rural life. The third was public service -- to provide to the community the acquired knowledge in such a way that it would enhance their profits, and to make agricultural pursuits more useful for everyone.

This brief history is well-known, but is often honored more by its mention, than by its actual application. This bulletin, however, is an excellent example of how the system is supposed to work. Some years ago I was approached by a potential student who wished to study agricultural history and focus on the state of Maine. It seemed logical that his study would then center on the Jersey cow, as he and his family maintained one of the state's medium sized dairy herds. Eventually that study became a doctoral dissertation which focused on the history of the Jersey breed in Maine. The first large portion of that work is of great interest to historians, especially those who devote their efforts to tracing the ideas of scientific knowledge. The second portion focused on the growth and impact of genetics on this breed, with emphasis on how the herd books could be used to trace these changes, at least among the animals registered there. It was of use to historians, also, and to biologists, animal breeders, and even to experts in genetic science.

The question arose as to how this work might be made useful to all farmers-- in Maine, and perhaps elsewhere. How could this specialized knowledge be made readily available so that Jersey breeders could analyze their own herds, and dairy farmers with other breeds could apply these lessons in their herds? Finally, if one wished, it might be possible to draw some conclusions about history, about agriculture, about Maine, and about the movement of knowledge from the research laboratory to the farmer.

Among the persons who had been of major help in the dissertation work was a young scientist who was interested in animal breeding, and who had been instrumental in the resurgence of the sheep industry in central Maine in recent years. She works in the classroom, in the laboratory, and she has an extension dimension to her mission at the University.

The result of the collaboration between these two researchers is the bulletin before you. It is much changed from the dissertation to a work which takes scientific knowledge, puts it into context, and makes it available for the farmer to read, and use if one wishes. The early days of obtaining knowledge, the development of techniques to control and modify breeding within that knowledge, the impact of practical changes on the work, especially the artificial insemination process, and eventually the establishment of significant Jersey pure-bred herds in Maine are all analyzed here. The story of the famous bull, Chocolate Soldier, is laid out in such a way as to indicate the transitory nature of knowledge and it is a cautionary tale for many who would jump to early judgements.

For my part I hope that this work is just one of many which take history (not by itself a didactic subject) and use the historical knowledge, combined with modern science, to make the three-fold purpose of the university even stronger and more readily available. For here teaching, research, and extension have combined in a significant way.

David C. Smith
Professor of History and
Cooperating Professor of
Quaternary Science
University of Maine at Orono

ACKNOWLEDGEMENTS

The origins of this Bulletin lie in our lifelong interest in dairy cattle, scientific agriculture, and the family farm. We have found others who share our interests and have contributed to this work.

Gretchen Gfeller, Mary Thibodeau, and Eleanor Miller of the University of Maine Library helped to locate numerous materials and made photocopies. The Librarian at the Winthrop Public Library made available seven volumes of the Herd Book of the Maine State Jersey Cattle Association which were unavailable elsewhere.

We would like to thank James Cavanaugh, the Executive Secretary of the American Jersey Cattle Club, and Eugene Barton, the AJCC's Superintendent of Records, and their staff, for making available Club and cattle production records which were unavailable elsewhere, and for providing facilities for research.

Several members of the Agricultural Experiment Station and of the Departments of Animal and Veterinary Sciences and History have read and commented on our work at various stages of its preparation. David Smith of the History Department, Gary Anderson of the Animal and Veterinary Sciences Department, Geddes Simpson of the Experiment Station, and Stanley Musgrave of the Animal and Veterinary Sciences Department read the completed manuscript and made many helpful suggestions.

We would like to thank the Departments of History and of Animal Sciences, the Graduate School, MAES, and Hatch Funds, for the financial support which made it possible to do the research for this work and to prepare it for publication.

Most of all, we wish to express our thanks and appreciation to Maine's Jersey breeders who provided much of the information we needed, opened their barns to us, enthusiastically supported our work, and who, by their excellence in management and breeding, have made the Jersey cow in Maine truly remarkable.

THE DEVELOPMENT OF THE ABILITY TO SELECT FOR INCREASED MILK PRODUCTION: THE JERSEY COW IN MAINE, 1900-1984.

John R. Paton* and Barbara A. Barton**

PREFACE

The Development of Modern Commercial Dairying and its Impact on Breed Development.

Histories of dairying and dairy farming usually pass over one very important topic, the point of origin herself: the dairy cow. In the past 150 years, the period associated with the rise of commercial dairying in the U.S., she has not been a static creature. The story of her development is an important and exciting part of the history of dairying, but this development cannot be explained by such phrases as "feeding and management improved" or "breeding improved". Since the dairy cow of the 1980s is not the same dairy cow of the 1830s, we should understand how this transition occurred and why it is important.

Dairy cows are mammals and, like other mammals, they secrete milk (lactate) for the nourishment of their offspring until the offspring are weaned, or capable of eating adult food. For centuries, people have realized that milk is nourishing for adults as well as infants. Milk contains water, fats, carbohydrates, proteins, and vitamins and minerals, each an important part of the human diet.

The next step was the domestication of species of mammals in order to provide milk for human consumption. Cows, buffalo, sheep, and goats were domesticated at least in part to provide a supply of milk. (They also provided labor, meat for food, and fiber for clothing.) However, there were two factors which until recently imposed limits on people's abilities

* History Instructor, University of Maine at Augusta
** Assistant Professor of Animal and Veterinary Sciences, University of Maine at Orono

to use mammals as a source of milk for human consumption.

Milk is a highly perishable product, and it starts to decompose almost immediately after milking. If its temperature is not quickly lowered to about 38°F and kept there, it can become unpalatable in a day or two, depending on specific circumstances and individual tastes and tolerances. In addition, because milk has a high nutritional value, it is an excellent medium for pathogens, and nature's "most nearly perfect food" can easily become a carrier of disease and death. For these reasons, people often kept only enough fluid milk for domestic and local use and converted excess fluid milk to products such as cheese, which had a smaller volume and need not always be chilled.

The second factor which limited people's ability to consume milk of cows was that cows produced only enough milk to nourish calves until weaning. The cow then dried off and milk production ceased, not to be renewed until after the birth of another calf. People thus faced two related problems. The first was to extend the lactation as long as possible between the birth of successive offspring rather than having the cow dry off right after weaning. The second was to increase the amount of milk beyond the needs of the new-born calf so that this excess could be used for human consumption.

For some time, these problems were not of special concern to people. Livestock of any type, for any purpose, was expensive to acquire and keep. Until there was an economic incentive to produce and sell milk on a large-scale commercial basis, and until there were means of preserving and transporting it over long distances, there seemed to be no reason to be concerned with cows who produced a small amount of milk for a relatively brief period.

In the nineteenth and twentieth centuries the picture changed sharply. In Western Europe and the United States, a rapid growth of the urban population meant many people were finding it increasingly difficult to provide their own milk from a family cow. In addition, the maturing of old agricultural areas and the opening of new ones meant that extensive cereal, sheep, and beef production could move to the frontier (the American West, South America, southern Russia, and Australia) while more intensive dairy production could concentrate in the older, more heavily populated areas.

After 1830, the railroad opened an era of realistic and reliable rapid transportation. The railroads of the U.S. were not designed primarily to serve as milk trains, but as they radiated from the city into the countryside they were able to tie together the farms in the countryside, which was becoming a milk surplus area, and the cities, increasingly milk deficient. In short, a market was developing, and there was a means of tying that market to the source of the milk.

Related to this (all part of what one historian has called the "industrial revolution" in dairying) was the development of refrigeration, the improved technologies of processing and marketing (the "factory system"), the uniform pricing structure of the twentieth century, and the greater attention given to the care and feeding of the dairy cow.

These advances, important as they were, would have had a much smaller impact without a corresponding understanding of the principles of heredity and the manipulation of the genetic pool of the dairy cow. When the nineteenth century opened, most milk cows in the United States were nondescript "natives", descendants of cows brought over by European colonists in the seventeenth century. By the second quarter of the century improved beef breeds had been imported from England, and much thought was given to using them, especially the Shorthorns, for dairy purposes. But by the middle of the nineteenth century the commercial milk market had so developed that dairy breeds (cows bred exclusively for milk production rather than as dairy-beef dual purpose animals) were seen as the best source of milk for a commercial market.

Several distinct breeds of dairy cows, in addition to the native, were available in midcentury: the Holstein-Friesian, Guernsey, Jersey, Ayrshire, and Shorthorn each had her advocates.

Having decided that the dairy cow was the best animal for commercial milk production, dairy farmers became interested in increasing her already relatively large yield of milk. They wanted to feed and manage her for optimum milk yield, and they wanted to select dairy animals so that successive generations would be capable of an increasingly larger milk yield.

This last objective was more difficult to attain than were improved management practices and a factory processing and marketing system. The modern dairy cow is not the dairy cow of the nineteenth century. She is the creation of humans; she was developed to produce milk, and milk production has been the subject of a great deal of genetic research and genetic manipulation. The increased annual production of the average dairy cow during the past 150 years (over 10,000 pounds, from about 3,000 pounds to about 13,000 pounds) was stimulated by a growing retail market, and the increased ability to preserve milk and bring it to that market. Much of this increase is the result of improved management practices, such as improved feeding, care, and health practices. However, over half of this increase in milk yield, that is, about half of the milk produced by dairy cows in this country, is the direct result of an improved understanding of the principles of heredity and the resultant improved genetic pool of dairy cows.

The purpose of this Bulletin is to study the genetic development of the Jersey cow, especially in Maine, to see how this marvelous transformation in productive ability was brought about. Throughout the nineteenth century and until the 1940s the Jersey was the most popular breed of dairy cow in Maine. Jersey breeders have often been leaders in the development of progressive agriculture in general and of dairying in particular in the state, and Maine's Jersey breeders today enjoy an enviable reputation in the state.

This Bulletin is also a study of sources, production records on which selection decisions are made. Since the third quarter of the nineteenth century, when purebred dairy breed associations were formed, breeders often kept records of their individual cows. At first these were simply pedigree records, giving the birth date and the name of the sire and dam of the animal. The American Jersey Cattle Club accepted production records submitted by individual farmers and eventually appointed an official tester of its own. By the last decade of the century, when accurate production records became possible after the development of the Babcock test, an inexpensive, reliable, and accurate means of determining milk fat content, the records were more reliably used in planning matings, because the objective of matings was to obtain offspring who would produce more than their dams.

By the end of the first decade of the twentieth century, two parallel systems of production records were being used: the "advanced registries" of the breed associations and the Dairy Herd Improvement (DHI) programs which became associated with the Department of Agriculture. A production record for a cow is a list of the amount of milk and butterfat she produced in successive lactations, and the length of each lactation. A production record for a bull is a list reporting the amount of milk and butterfat his daughters produced in successive lactations, and the length of each lactation.

It is very important for the reader to be familiar with and understand these production records. Although production records were not kept on all animals, production is the goal of the dairy business. Therefore, it was the animals on whom production records were kept who provided the data on which decisions were made leading to the genetic improvement of the dairy cow. As measurement of production (testing) became accepted in the twentieth century, it became an increasingly valuable tool for those who devised systems to plan matings for increased production. Although dairy farmers in the nineteenth century did try to select for increased production, it was not until the twentieth century that the Babcock test, the advanced registry and the DHI systems, artificial insemination, and an understanding of modern principles of genetics came together for dairy farmers to have the tools and structure they needed to select for production on a scale never before imagined.

The Modern Jerseys, 1900-1930s

In the nineteenth century, and in fact well into the twentieth, livestock breeders understood little of the principles of the selection of animals to be mated to achieve desired production goals. This was particularly true of dairy cows whose production characteristics did not prove to be externally visible and where systems of testing and measurement were not available until the eve of the twentieth century. However, in the first half of the twentieth century there was a revolution in the understanding of the principles of genetics and inheritance which, when combined with improved management and a more comprehensive record-keeping system, led to a quadrupling of the milk production of dairy cows and gave us new sources for the study of the development of the dairy cow.

Most books on genetics, including those of dairy cows, date the beginning of the understanding of modern genetics from the rediscovery in 1900 of Mendel's principles.[1] An additional important development was Wilhelm Ludwig Johannsen's distinction between the "genotype", the genetic constitution of the individual, and the "phenotype" or the external expression of the genetic constitution. He demonstrated there were two kinds of variability: genotypic, due to mutation, and phenotypic, due to the interaction of the genotype with the environment. There had been concerns through the very early 1900s that the heredity factor (genes) might be subject to modification by environmental influences acting on the parent. If this were to happen, the purity of the germ cells would be contaminated, the effects of the environment would be cumulative, and evolutionary changes could thus be directed by such environmental influences.

These doubts were dispelled by the 1909 experiment in which W. E. Castle and John C. Phillips transplanted the ovaries from an immature black guinea pig to an albino guinea pig whose ovaries had been removed. The albino with the ovaries from the black was then mated to an albino male. The albino "foster mother" bore three litters consisting entirely of fully black offspring. No influence of the albino foster mother could be seen. This demonstration convinced many doubting biologists that genes were subject to modification only by mutation rather than by continuous variation and blending inheritance.[2]

This conclusion had been foreseen, although not widely noted, in 1867 in an article by Henry Charles Fleeming Jenkin in the North British Review. Jenkin pointed out that if blending inheritance were the rule, the incorporation of a new and better inheritance could hardly take place because the new variation would be swamped by numbers in the general population and after a few generations its peculiarity would be lost. This argument helped to dispose of the theory of blending. If elements such as genes assumed different forms of mutation and retained their integrity in all combinations, then new variants cannot be "swamped out".[3]

This concept, once it was understood, would have a revolutionary impact on dairy cattle breeding. Since the third quarter of the nineteenth century, when the separate dairy breeds had been identified, breeders had felt that in order to preserve breed purity, and thereby preserve the probability of inheriting desired productive traits, it was necessary to breed like to like and achieve a blending of the features of the sire and dam. In the period from 1900 to 1910 it became evident that the phenotype depended both on the interaction of many genes with each other and on their interaction with the environment.[4] Thus, breeding like to like would not be fruitful because, according to nineteenth-century standards, it was based on external appearance only, with no understanding of the cow's genetic constitution and often without adequate measurement of her productive ability. Despite the intentions of nineteenth-century breeders, there could thus be no predictability of the probability of the inheritance of desired production characters.

The century and a half of cattle breeding from about 1780 to the late 1920s can be characterized as the "breeding-for-type" period. The merits of cattle were judged by external appearance, emphasis was placed on conformity to an accepted physical standard, and attention was given to such unimportant details as the location of markings. This "formalism" flourished in the last quarter of the nineteenth century and the first quarter of the twentieth, when breed associations dominated purebred dairy cattle breeding.[5]

During the first decades of the twentieth century several attempts were made to analyze the inheritance of milk and butterfat on a strictly Mendelian basis, by thinking of milk and butterfat producing ability as being inherited in the same way as shades of color. Three cross-breeding experiments were started in the United States about 1910 to find out how the capacity for milk yield was inherited, but these efforts failed because of the complexity of the trait. While features such as the color markings of cattle are due to the actions of a few genes and are not influenced by the environment, the capacity for milk yield is more complicated; it depends on numerous physiological processes, and most of these processes are probably both controlled by many genes and influenced by a multitude of environmental factors. Thus the classic Mendelian approach did not work and it was necessary to resort to other methods to estimate the relative importance of both genetic and environmental variation.[6]

The actual milk yield of a cow is the culmination of a very complex process, "the manifestation of her genotype under a given set of environmental/i.e., management/conditions".[7] But management, which determines the environment, is practiced with equal effectiveness regardless of the breed of dairy cow. Thus it became more important to identify those animals, both male and female, within each breed who were capable of both producing large quantities of milk and butterfat and of transmitting those qualities to their offspring.

One of the most severe critics of dairy cattle breeding practices in the first half of the twentieth century was E. Parmalee Prentice. He was very interested in means of making agriculture more productive, and he felt that animal agriculture was the most efficient way to convert roughage such as hay and pastureland to nutritious human food such as dairy products, meat, and eggs, in addition to providing fertilizer.[8]

Prentice's main interest was in dairy cattle, and he felt there were four features which made them valuable as dairy producers: a. the ability to give a large yield of good milk through the entire lactation; b. regularity of breeding; c. longevity; and d. persistency of production year after year.[9] He felt that the way to breed cows to improve these qualities was to select the one quality which the breeder sought to attain first, and then to select for mating those animals who through the progeny test best demonstrated the ability to transmit to their offspring the desired characters. When the desired degree of progress was made in that direction, it was then possible among those improved animals to select for a second desired character, and so forth. While this method sounded slow, he felt that by this use of proved sires (sires for whom information on the production of their offspring was available) permanent progress could be made in dairy cattle productivity.[10]

Prentice was very critical of terms such as "purebred" dairy cattle, especially if it was meant to imply that certain groups of dairy cattle had been bred "pure" among themselves for long periods of time. In his books Channel Island Cattle and American Dairy Cattle he said that contrary to popular mythology, Guernsey and Jersey dairy cows were the result of a continuing process of crossbreeding and the introduction of new strains throughout most of the nineteenth century. In addition to showing the influence of their Normandy and Brittany ancestors, both breeds benefitted from crosses with Shorthorn, Dutch (Holstein), and Ayrshire cattle[11].

Channel Island breeders wanted to combine in one breed of cow the Island inheritance of a high butterfat percentage with the Holstein inheritance of a high level of fluid milk. The knowledge in the nineteenth century of the manner in which producing ability is transmitted was not sufficient to achieve this goal. The result was an alternating rise and fall of light and dark colors, of large percentages of butterfat and large quantities of milk. When butterfat percentage was high and cattle were light colored and small, their production of milk was small. But when the breeding process was reversed, the quantity of milk would increase, the butterfat percentage declined, and black and white colors, associated with the Holsteins, would reappear. This was a classic example of mating color and type rather than high transmitting ability, and the result was what one would expect: lots of color and type and no real transmitting ability for desired characters[12].

The popularization of the terms "purebred" and "breed" came in the third quarter of the nineteenth century with the development of herd books and the idea that registered cattle were bred pure and therefore superior to unregistered, non-purebred animals. As a result, the intra-breeding of animals entered in different registry organizations was considered crossing and, for dairy purposes, undesirable[13].

Prentice felt that the establishment of herd books was the result of sincere effort to introduce a superior method of breeding domestic livestock. Charles Darwin's Origin of Species, published in 1859, had presented to contemporaries a picture of a long-continued development to higher and more efficient forms of animals life and held out to them the possibilities of almost indefinite development. Many breeders thus mated best to best, expecting that like would produce like with a blending of inheritance and thereby bringing about a rapid improvement in the economic qualities of domestic livestock.[14]

The chief purpose of the breed associations, which were formed in this period, was to maintain herd books and a system of registration, and thus preserve breed purity. This was important because it separated the cattle whom the breeder sought to improve from the general mass of cattle, and made possible the maintenance of strains characterized by superior producing ability.[15] Although the breed associations did not have a general program in the last third of the nineteenth century for determining the productive ability of the cows entered into their herdbooks, they were the only groups which at this time made any attempt to identify animals who they thought had commercial value.

After the breed associations were formed and their herd books established in the 1860s and 1870s, there were revolutionary advances in the study of inheritance to the extent that Prentice felt that "the methods which/the breed associations/began their work have now been entirely superseded by better methods, and the old methods should be discarded". His criticism of the breed associations was that none of them had ever established production tests for all females, or made production tests a condition for registry. All females, without regard to their production or their ability to transmit those production characters, were registered provided only that their sires and dams had been registered. Such a system, he felt, "is indefensible" because it is impossible to maintain a breed of high-producing dairy cows unless production qualities were given major consideration.[16]

In order to help raise the standard of their dairy cattle, the Holstein-Friesian Association in 1885, the American Guernsey Cattle Club in 1901, and the American Jersey Cattle Club in 1903 each began a system of "advanced registry" testing of the productive ability of selected animals. This system permitted the publication of favorable material while owners were not required to publish the results of their less productive animals. Like pedigree registration, it was thus well adapted to breed promotion and breed advertisement. But as a means of learning the actual milking qualities of the general population of dairy cattle, "there is little to be said in favor of the system". If breeders were to judge accurately the value of dairy cattle, they had to know the weaknesses as well as the strengths of the breed, and a system which did not provide information on the performance of all members of the population of cattle could provide neither the means for determining a general population average nor a basis for intensified selection.

Prentice supported this conclusion by pointing to a 1929 study by the United States Bureau of Dairy Industry comparing the records of 12,830 registered cows and 34,021 unregistered cows in testing association (DHI) herds. The registered cows had an average milk production of 7667 pounds of milk and 296 pounds of butterfat, while the unregistered but tested cows gave 6999 pounds of milk and 281 pounds of butterfat.[17] The advantage which the registered cows had was insignificant and could easily be the result of a difference in management. On the other hand, selection intensity in the tested herds was probably greater, since production information was available on all the cows, so advances in productivity would probably be greater in those herds.

The problem which Prentice saw facing breeders of dairy cattle was not simply that production per cow was low, but that the practice of testing selected daughters, the standard procedure of breed associations, no longer commanded confidence since a new and more comprehensive method using both the herd test with individual lactation records and the progeny test of the offspring of proved sires was available.[18]

Because of their reputation as large producers of butterfat, Jersey cows had long been the subject of some form of testing for the production of butter. A butter test was done for one Jersey cow in 1853; she produced 511 pounds 2 ounces of butter in 350 days. In 1852 Campbell Brown of Tennessee began to compile the first comprehensive lists of butter tests (usually the seven-day fourteen-pound test) on Jersey cows. Since the tests were based on the statements of the cows' owners and were not supported by impartial judges, their impartiality and authenticity were questioned by many. Through the 1880s and 1890s the AJCC experimented with various ways to increase the impartiality of the various tests, and in 1884 it amended the By-Laws to give the Directors authority to conduct "official" butter tests, made under the authority of the Club by Committees appointed by the Directors.

In 1885 the Club appointed a salaried Tester (Henry E. Alvord was the first to hold this position) and in 1887 it took over the publication of private tests from Campbell Brown and his associates. Private tests continued to dominate Jersey testing activity. Official Tests cost money to employ the Official Tester (in 1886 the Club spent $389 for two official tests) and the private tests were more convenient. After 1890, the Club published the results of private tests at no cost. In addition, private tests were accepted for periods ranging from one week to one year, and the owner of the cow could pick any part of the lactation which he wanted tested.

In 1894 the Club's Directors sought a better and less expensive method of testing than the unofficial churn test. The favorable results obtained by using the Babcock test at the Columbian Exposition in 1893 convinced many Directors it should be used by the Club. Valancey Fuller, the superintendent of the Jersey test herd at the Columbian Exposition, proposed at the 1895 annual meeting that the Club accept this method, but the members rejected it as too complex and as only a measure of butterfat, not of butter, the commercially valuable product.[19]

At the 1897 annual meeting the Directors again recommended adopting the Babcock test, asking the members to approve "butter-tests/churning/confirmed by the Babcock test". Since the familiar churning procedure was retained, the recommendation was adopted, and the term "official butter-tests" was replaced by "confirmed butter-tests".[19]

These butter tests, which continued until 1911, were an anachronism in the twentieth century. They may have been useful for breed promotion, but they had little value for breed development. Many of them were submitted by the cows' owners with no confirmation by a disinterested person. Most of them were for periods shorter than a complete lactation, so the owner could select that part of the lactation which gave the best results. Cows were not tested through several lactations if the early tests were unfavorable, so the tests available usually highlighted a brief period, often only a week, in the life of the cow. Finally, there was no policy of testing all the cows in a herd, or all the daughters of a particular sire or dam, in order to begin obtaining breed averages as a basis for breed development.

The Club had been considering a more comprehensive testing program since the late 1890s. In March 1898 Valancey Fuller presented to the Executive Committee a "Synopsis of a Plan for Establishment of a Record of Merit". The plan was discussed by the Committee but no action was taken at that meeting.[20] At meetings of the Board of Directors in 1898 and 1899 the matter was again brought up, but there was no great interest and it remained in the hands of a committee.[21] In April 1901 Henry Alvord moved that the Board recommend to the annual meeting that the Club discontinue the acceptance of private butter tests, an obvious prelude to a more comprehensive testing program, but his motion was defeated.

The issue of a comprehensive advanced registry was also the subject of much discussion in the Jersey Bulletin, the unofficial but authoritative journal of the breed. In a September 1901 article titled "The Fat Test and Advanced Registry", the Bulletin was critical of the advanced registry program of an unidentified breed association. (Only the

Holstein-Friesian and Guernsey clubs had advanced registry programs at this time, and the Bulletin was usually very critical of Holstein claims.) It said an advanced registry was supposed to improve the breed and identify its best producers. It noted that the AJCC was considering some type of advanced registry and asked "...can any reader tell us what good ever came out of advanced registry?". It said the unidentified breed association was using its advanced registry to give "glowing accounts" of the "growing popularity" of its breed among farmers and dairymen. However, it pointed out that Jerseys had progressed further in butter production than had other breeds, without the aid of an advanced registry.[23]

In April 1902 John A. Linsley, a strong advocate of nineteenth-century views of selection for production, came out strongly in support of the seven-day butter tests. This type of testing had done "more than all else" to give the Jerseys their "position of absolute preeminence" among dairy breeds. He referred to the volumes of butter tests issued by the Club and, noting that most of them were private tests, said it would be unwise to abandon a practice "which has in itself been proven to be the foundation element in making the enduring element of Jersey quality. The seven-day test should be continued by every owner of a Jersey cow...".[24]

Linsley's support of the traditional seven-day butter test was supported by S.H. Godman of Wabash, Indiana. He felt that "Butter made in the churn and weighed in the scales...is comprehended by all... Butter fats, though truely and well established by such tests/the Babcock test/ and attested by the chemists, are not so easily comprehended by the cow owner... Theoretical tests mystify and invite argument and discussion...".[25]

The use of the Babcock test as the basis of a comprehensive testing program did have some support, albeit equivocal at times. A.M. Bowman of Salem, Virginia said that if the Club wanted a Babcock-based butterfat test, its results should be kept in a book other than where the results of the butter tests were kept in order to maintain the distinction between a "fat test" based on the Babcock test and a "butter test" based on churning. Like Linsley, he felt Jersey breeders would be dealt a "death blow" if private tests were discontinued. In addition, he objected to the use of the Babcock test because he felt it would give a monopoly in testing to those who lived near experiment stations (where many of the tests were conducted) or to those who could afford to employ the testers.[26]

A.M. Stevens of Ellensburg, Washington felt the Babcock test was of "untold value" to breeders of Channel Island cattle for commercial reasons - it revolutionized the method of paying for milk at the creamery, making possible a more accurate determination of the composition of milk.[27]

Although the Jersey Bulletin was often a conservative journal, it did eventually see value in both the Babcock test and in a more comprehensive, unbiased testing program. After the experience of the Columbian Exposition, it supported the "confirmed test", churning supported by the Babcock test. In March 1903 it urged its readers to report for publication the yields and profits of Jersey herds in order to maintain an unofficial but published record.[28] In June 1902, it specifically gave support to the Babcock test as a more accurate and convenient method than churning to measure butterfat. (Butterfat, the Bulletin pointed out, was what the cow produced; butter was a man-made product.)

Finally, in May 1903 the Bulletin again urged the testing of Jersey cows and reporting the results to both the AJCC and the general agricultural press. It felt that if Jersey breeders wished to continue to dominate the dairy cattle market, that market had to be in possession of all relevant facts concerning the yields of the cows.[30]

The Club, meanwhile, also moved towards establishing an advanced registry testing program. In a March 1902 meeting of the Executive Committee George Sisson proposed a resolution stating that it was "the sense of this Committee" that the Club would "receive, preserve and publish milk and butterfat records" of Jerseys. The results of all tests were to be confirmed by an Experiment Station or agricultural college using the Babcock test, and year-long records had to be verified in a similar method by a monthly test.[31]

In April the Executive Committee voted unanimously to support the adoption of an advanced registry program. Entry into the "Performance Register", as it was tentatively called, would come when at least one of several production requirements, confirmed by the Babcock test, had been met. For a milk record, a cow had to produce a minimum of 6,000 to 10,000 pounds of milk, depending on her age. A yearly butterfat test would be entered if the cow produced a minimum of 260 to 400 pounds of butterfat, depending on her age. The requirement for a seven-day butter record was fourteen pounds of butter regardless of the age of the cow, and a seven-day butterfat record had a minimum of 12 or 15 pounds of butterfat, depending on the cow's age. To encourage breeders to participate in the program, the Club would pay at least half the expenses of the tests of those animals who qualify for entry.[32] In May the full Board of Directors adopted this proposal, noting that this program was to be "in addition to and without interference with" the various private butter tests then being accepted and published by the Club. In May the Club gave final approval for the "Register of Merit of Jersey Cattle".[33]

In the Register of Merit (ROM) the Jersey cow now had what R.M. Gow called "the only compilation of tests of Jersey cows...that can lay any claim both to completeness and authority".[34] It did not meet the requirements laid out by Prentice in the 1930s and make production a requirement for entry into the Herd Register, but production standards were established for entry in the ROM. The seven-day butter test was an anachronism; a one-week test demonstrated nothing of a cow's productive capacity and potential. These seven-day tests were undoubtedly included in the program to satisfy critics such as

Linsley who felt more comfortable with the traditional nineteenth-century programs. What is significant is not that the seven-day tests were included, but that the overwhelming majority of the tests were for over 300 days, i.e., a complete lactation. It is also significant that this authoritative source of the production of Jerseys was based (with the exception of the few seven-day butter tests) on the Babcock test. No longer did the Jersey breeder need to rely on the churn to demonstrate the value of his cow.

The ROM was active from 1903 to 1939 with 51,764 entries. Although volumes were published periodically, about once a year, it is easier to work with the four consolidated volumes. The annual volumes have more detailed information on individual cows, but the consolidated volumes have a separate owners' index (in addition to other indices), making it easier to locate animals within a particular state.

The sire is the parent who most determines inherited milk ability in a breed, since individual sires are more extensively used for breeding purposes than is the dam. The principal part of the ROM is an alphabetic list of sires whose daughters are entered, and each of his entered daughters, with her production information and owner index number, is listed immediately after the sire. Since each sire's daughters are listed with him, it is possible to make some conclusions about his ability to transmit milk and butterfat production qualities. However, the dams of the entered cows are not listed in the ROM so it is not possible to determine their genetic contribution without locating the entered cows' dams in the Herd Register and then checking to see if they have been entered in the ROM.

The first consolidated volume of the ROM included 21,485 entries to May 15, 1924; 58 Maine breeders had 419 entries. Many Maine breeders had very few entries; 31 had only one or two entries. However, several of them had a number of entries, making it possible to draw conclusions on their selection programs. In addition, since the daughters of all listed sires are listed with their sires, regardless of their owner at the time of testing, it is possible to determine some of the impact of individual sires within individual herds and among several herds.

Chandler Cobb and George Blanchard, two breeders active in the nineteenth century, had entries in the first ROM volumes. Cobb, who at this time lived in Lisbon Falls, entered six cows sired by three bulls. Although each cow was entered only once (they could be entered as often as they qualified) they each produced between 6,000 to 9,000 pounds of milk containing 5.5% and 6.9% butterfat when tested. These were not exceptional production records since the milk and butterfat production of most of the tested Jerseys at this time fell within these limits. Cobb was undoubtedly a conservative breeder at this time, trying to maintain breed average without seeking to sharply improve it. He may or may not have been a conservative dairy farmer, which would reflect his general farming practices and which cannot be determined from the ROM.

George Blanchard of Cumberland Center had 20 entries in this volume. His average annual milk production of qualified cows was slightly higher than was Cobb's. None produced less than 6,000 pounds, 16 produced over 8,000 pounds, and 5 of these produced over 10,000 pounds at least once. Aherloe Glenn HR192339 distinguished herself by producing 7159 pounds of 5.35% milk at 16 years 6 months and 9106 pounds of 5.66% milk at 18 years 4 months.

In general, Blanchard's herd can be divided into two groups: the five cows sired by Broadmoor Flying Fox HR101900, and the eight sired by Darling's Interested Owl HR123837. The cows sired by Broadmoor Flying Fox HR101900 had a higher milk production; their average annual production was over 9,000 pounds, and two of them produced over 11,000 pounds. His weakness seemed to be in transmitting butterfat producing ability. Although all these cows easily tested over 4%, only one tested over 5%, a percentage to which Jersey breeders should aim.

In Darling's Interested Owl HR123837 Blanchard had a sire to counter this low butterfat percentage. Seven of his eight daughters in Blanchard's herd tested over 5%; one of them tested over 8%. However, their production of milk was lower, averaging 8,428 pounds compared with 9,890 pounds average of the daughters of Broadmoor Flying Fox HR101900. Both sires had tested daughters in Blanchard's herd at the same time (the early 1920s) and their combined strengths helped to give Blanchard's herd production levels higher than breed average.[35]

The twelve entered tests for Ross Elliott of East Corinth showed no general production pattern. His herd average of 8,268 pounds for tested cows was above breed average but not significantly so; it was below the production average of the daughters of Blanchard's two principal bulls. Nine of Elliott's twelve entered tests were over 5% butterfat, but because the milk production of individual cows was low, only three of them produced over 500 pounds of butterfat; five of them produced less than 425 pounds.

Fifteen Jerseys in the University of Maine's herd had 23 entries, and the production records were in general better than those of Elliott.[36] Only one entry was for 4,000-4,999 pounds, two were for 6,000-6,999 pounds, four were for 7,000-7,999 pounds, four were for 8,000-8,999 pounds, and twelve were for 9,000 pounds. Equally significant was the high butterfat test for the cows. Twelve of the 23 entries tested over 5%, and 13 entries were for over 500 pounds of butterfat. In addition, the University retested cows who showed production potential on the basis of sire selection. A daughter of Lakeland's Poet HR102603 was tested three times from 1921 to 1923. Her milk production went from 9,000 pounds to over 12,000 pounds, and her butterfat production remained over 5.5%. A daughter of Pogis 95th of Hood Farm HR92626 was tested four times between 1916 and 1922, and her milk production went from 4,500 pounds to over 10,500 pounds with her butterfat percentage remaining over 6.5%. Both of these cows were young when first tested, and the University was wise to retain them as they developed this potential.[37]

The fifteen cows with 16 entries from Owen Smith of Portland were also above breed average. His tested cows produced an average of just over 8,600 pounds of milk testing 5.03% butterfat. Only one entry produced less than 5,000 pounds, and only four tested less than 5%. Three of his cows qualified for reentry in this period and their records, while showing improvement, were not as outstanding as the University's reentries.

H.M. Moulton of Cumberland Center had 29 cows with 31 entries. Although his herd's butterfat percentage was generally high, averaging 5.54%, the milk production was about 1,000 pounds less per cow than that of the University's herd. In addition, although he used two sires eight times each, and had enough time for retests in this period, only two cows so qualified. David Moulton of Portland, with 44 cows and 61 entries, had production averages similar to those of H.M. Moulton (they used some of the same sires) but he had more reentries, evidence that some of his sires were better able to transmit production qualities.

The largest Maine herd entered in this period was that of the Ayredale Stock Farm of Bangor with 136 cows and 215 entries. A large variety of sires was used in this herd, among them several "Pogis" bulls from the Hood Farm in Lowell, Massachusetts. Fred Ayer had probably the only "Sophie Tormentor" herd in Maine, based on these (Pogis) bulls, until he dispersed his herd.

Ayer apparently either purchased many of his cows from Hood Farm, or had the use of some of their sires without purchasing them. <u>Pogis 99th of Hood Farm HR94502</u>, who sired nine of his cows between 1917 and 1922, was one of the animals offered for sale at the Hood Farm dispersal sale in 1923. In addition, three of his cows by that sire had previously been owned and entered in the <u>ROM</u> by Hood Farm. Ayer had a number of reentries, in addition to those previously entered by Hood, and over 30 of the reentered cows were sired by Hood Farm bulls. He had 23 cows sired by Pogis 95th of Hood Farm HR92626 and by Pogis 99th of Hood Farm, and 16 qualified for reentry at least once. The production of these cows was unusually high. Of these 23 cows with 43 entries, there were 23 entries for over 10,000 pounds of milk, and only one entry tested less than 5% butterfat. Sophie's Agnes HR296759, sired by Pogis 99th of Hood Farm, produced 16,212 pounds of 6.17% milk, 1,000.07 pounds of butterfat at six years of age, an exceptional record for a Jersey.[38]

The ROM was thus able to identify some outstanding animals; a cow had to meet certain production requirements to qualify for entry. This was a great improvement over the wide variety of butter book tests which were developed in the nineteenth century and continued into the ROM period. The production information on each cow was now both accurate and reliable, and the same procedure was used for each entry. In addition, since the entered animals were listed by sire, it is now possible to easily obtain some information on the impact of the sire in the selection program. But the ROM, although it contained a wealth of valuable information to aid the breeder, still had not devised a method for segregating the genotype of dairy cattle from elements of management, to more easily and accurately determine the genetic contribution made by animals, especially the sire. To understand this, it is necessary to review research done at the University of Maine and the Experiment Station in this period on this problem, culminating in a study of the ROM as an aid to selection for increased production.

The University of Maine and the Agricultural Experiment Station were active in dairy breed development in the first decades of the twentieth century; much of the work was done by Raymond Pearl and John Gowen. Part of the reason for this interest and activity lay in the important role dairying played in Maine's agriculture. Thus the University supported the formation of regional cooperative breeding associations whose purpose was to make available to their members a variety of high-quality registered bulls of their breed. By 1910 there were a number of Holstein associations and a Jersey association in Oxford and Cumberland counties.[39]

Perhaps the principal reason experiment stations were interested in milk production was their central role in measuring and testing the milk for the advanced registry programs. The breed associations wanted this information to be as accurate and reliable as possible, and the experiment stations were the ideal disinterested third party to do this official testing and record keeping.[40]

Two papers read at the 1909 State Dairy Meeting showed in varying degrees the changing emphasis in breeding programs in Maine. In an era of potentially great advances in breeding, that read by J.W. Sanborn of Gilmanton, New Hampshire is of less value. He did, however, point out that too many people had bred and registered livestock on the basis of pedigree and registration alone. Since breeders registered virtually all their eligible animals regardless of their merit (a practice with which Prentice would surely have disagreed), "pedigree" came to mean "registered scrubs" in too many cases as bad animals were registered and then assumed to be good by virtue of that registration.

Sanborn gave too much emphasis to the role of the feed fed to the dairy cow to make this paper a significant one on selection for production. Citing the old saying, "Breed goes in at the mouth", he told of neglected cows who were placed in research herds, fed and kept well, and then made production records which would qualify them for entry into advanced registries. "As viewed by the speaker, feed has been a more potent factor than blood... Good breeders who have made their mark have been good feeders".[41]

This is true as far as it goes. Milk yield, as mentioned above, is the culmination of a very complex process which is the manifestation of the cow's genotype, or genetic constitution, under a given set of environmental or management conditions. But management, which determines environment, is practiced with equal effectiveness regardless of the breed of dairy cow. Every cow has a genotype, and no amount of good feed and care can totally compensate for a bad genotype. So it becomes important to segregate management and environmental factors such as feed from the cow's genotype in order to determine what contribution her genotype makes to her milk production.

Raymond Pearl's paper at the 1909 meeting offered much more radical observations on contemporary breeding policies and their weaknesses. Throughout the eighteenth and nineteenth centuries, and into the twentieth, breeders had invariably bred like to like, feeling that like would produce like. However, two experiments of the 1890s showed this was not necessarily so. There was an experiment in Sweden which attempted to improve grain yields by selecting from each year's crop the best heads to use as seed the following year. The process of selecting seed which seemed to be best "on the basis of performance alone" continued for eight years before it was abandoned. Instead of getting a great deal of improvement after eight years of breeding "best to best", there was "no distinct and fixed improvement whatever". The "indiscriminate propagation of individuals selected simply on the basis of their performance alone led to no definite or permanent improvement..."

The other experiment was much closer to home, an experiment begun in 1898 by the Maine Experiment Station to increase egg production in poultry by selection. In what Pearl described as an "advanced registry" of hens, the only hens used for breeding purposes were those who had laid 200 or more eggs the previous year. This selection from among the highest producers continued for nine years, and when the results were evaluated, they were the same as those of the Swedish grain experiments: there was an actual decrease in egg production per bird as a result of the close selection. The Maine Station also compared the production of the daughters of the 200-egg hens with the daughters of other hens and found that the daughters of the

200-egg hens were not as good layers as the daughters of the other birds.

Thus there were two recent examples available, one for plants and one for animals, to show that mating best to best did not always result in increased production. Performance alone had no role in estimating an animal's value as a breeder. Selection is essential if one wants more than one generation of producers, and an animal had no value as a breeder unless her offspring were also good producers. An individual not only has to have producing abilities, but has to be able to transmit them to offspring.

This then was the "new" method of selection. In examining the various advanced registries of the dairy breeds, Pearl noted that a cow was eligible for entry on the basis of her production, i.e., by the old method. A bull, on the other hand, was entered if a certain number of his daughters had been entered; his entry was based on his ability to transmit high dairy production characters.

The advanced registries as established around the turn of the century were thus a blend of the old and new approaches to selection. In theory, advanced registries were intended to be a guide for breeding superior dairy cows. But this, according to Pearl, was where the principal weakness of the advanced registries lay. Their emphasis was on the cows, but they were entered on the basis of current production rather than on their ability to transmit production characters to their offspring.

To illustrate his point that the sire, who is entered into advanced registries on the basis of his ability to transmit production characters, has a leading role in selection, Pearl noted that of the most recent 160 cows entered into the Jersey ROM (cows numbered 201 to 361 inclusive), the sires of 50% of them were also entered. However, only 15% of their dams had qualified for entry. The entry of females did not seem to be related to their ability to transmit production characters to their offspring.[42]

The University and the Experiment Station did a large amount of research in the next decade on the inheritance of desired qualities in dairy cows. (The construction of a new dairy barn in 1913 aided this work.)[43] In his 1912 report Station Director Charles Wood acknowledged the importance of this work when he wrote:

> The need for investigation which shall lead to the accumulation of knowledge of the principles /of inheritance/ has been keenly felt for sometime past by the dairymen of the State. The dairy industry in Maine is just now in a critical condition. The increased prices of feed without anything like a corresponding increase in the price of milk and other dairy products has materially reduced the profits of the business.

He felt the experience in selecting for increased egg production would be useful to those seeking to select for increased dairy production.[44]

In 1913, 1914, and 1915 there was renewed interest in inbreeding, especially with Jerseys and Holsteins, but no extensive work was carried out.[45] In 1915 John Gowen completed his master's thesis studying the relationship between milk production and age in Jersey cattle based on his study of the Jersey herd of Mrs. George Vanderbilt at Biltmore, North Carolina. Breeders wanted to know if a cow was worth keeping by the time records were completed for her first lactation, and he developed formulae for projecting milk production at an early age.[46]

In 1915 Raymond Pearl also published the Experiment Station's report of the first Aroostook County Jersey sire's futurity test. Pearl reminded his readers that, as the Station had shown over the previous eight years, the only certain test of the breeding value of an animal selected for production was the progeny test, and a sire's futurity test is simply a progeny test. "The only way to tell whether a Jersey bull has the ability to transmit high milking qualities to his daughters is to see by actual test whether a fair sample of those daughters are high producers of milk and butter fat".

Thus, although the animals physically present at the test were four lactating females, born in 1913, it was actually their sires who were being tested. The first prize was given to the owner of the sire of the female who produced the most butterfat, corrected for age and stage of lactation, in a seven-day period. (The use of the seven-day butterfat test was an anachronism, but the principal of testing sires was still correct. Actually, the winning animal based on butterfat production also had the highest milk production in the seven-day period.)

Pearl felt that a sires' futurity test would be of more practical value to the dairyman than would advanced registry work whose participants were often well-to-do breeders who hired herdsmen specially trained to achieve advanced registry entry. The correction of records with respect to age and stage of lactation was also important because:

> This plan of testing heifers all at the same time, regardless of when they freshen and then correcting the results on a scientific basis so as to make them all strictly and justly comparable, eliminates for all practical purposes the element of expert skill in jockeying cows for high records, and puts the animals of the small and inexperienced breeder on a fair basis of comparison with those of the large breeder...[47]

Correction for age is an important part of calculating modern milk records. It is necessary in order to fairly compare the production of cows at various ages. In 1917 Raymond Pearl and S.W. Patterson of the Experiment Station published a short paper on this issue. They noted that each of the dairy breed associations which had advanced registries (Ayrshires, Guernseys, Holsteins, and Jerseys) fixed mature form at five years of age with milk production increasing to that time, but the associations said nothing about milk production decreasing after that age. To determine if milk production did decrease after the cow reached maturity, the authors examined the data presented in Jersey Sires With Their Tested Daughters, published in 1909 by the AJCC.

This book is not an ideal source for studying milk and butterfat production in Jersey cows. It is a compilation of seven-day butter tests extending from that for Bomba HR10330 to those accepted as recently as 31 March 1909. As such it included a large number of cows tested under a wide variety of conditions. About 90% were "private" (unauthenticated) butter tests, while the remaining 10% were authenticated by a representative of the AJCC or of an experiment station. But the book did include the amount of milk the cow produced, the length of the test (virtually all of them were for seven days), and the age of the cow in years and months when the test was conducted. Pearl and Patterson felt that milk production information was probably accurate because butter was the commercially valuable product when these records were made and it was in the measurement of butter where fraudulent conclusions would most likely be entered. They found that milk production increased from 187.95 pounds at 1 year 9 months to 254.35 pounds at 8 years 7 months, and declined to 224.35 pounds at 16 years 9 months of age.[48]

The principal weakness of their method of research was that virtually all the 5,821 records studied were for a single week's production for each cow. No cow was studied for a complete lactation, and no cow was studied over a lifetime of lactations. Thus their conclusions were based on piecing together a series of one-week records, arranged by age, as if each record was representative of the breed at that age.

The conclusion of these efforts in this period to use production records in such a way that the Jersey breeder could use them to develop selection programs came in 1919 when Raymond Pearl, John Gowen, and John Miner published Number 7 of their "Studies in Milk Secretion", "Transmitting Qualities of Jersey Sires for Milk Yield, Butter-Fat Percentage, and Butter-Fat". The authors noted that the sire, who contributes half the genotype of the dairy cow, has a greater impact than the dam because he is much more extensively used for breeding purposes than is the dam. Thus they felt it was "beyond doubt or question" that if the daughters of a bull gave less milk, or milk with less butterfat than their dams, then the bull was "exercising a harmful effect on the breed"; if there was more milk or butterfat, the effect was beneficial. The information resulting from such a study would be "a measure of what inheritance for milk production this bull transmitted to his daughters when given the average inheritance of their dams upon which to work"; in other words, it would be "a measure of the genotype of the bull as distinguished from the phenotype".

The source of the data for this study was the first five volumes of the ROM, from which the authors studied every bull having two or more entered daughters whose dams also had year records. (The inclusion of the dams was necessary in order to compare the production of the daughters with that of their dams under comparable testing procedures.) Records of milk and butterfat production were corrected for age based on procedures learned earlier at the Station.

The principal part of their investigation sought to answer several questions.

a. What were the transmitting qualities of Jersey sires for milk production?

b. What were the transmitting qualities of Jersey sires for butterfat production?

c. What were the transmitting qualities of Jersey sires for net butterfat production?

d. Which sires "materially advanced" the breed?

e. Which sires were "inferior" sires?

Working within the limits described above, with each entered bull having at least two entered daughters whose dams were also entered, the authors came to the following conclusions.

a. Only 105 bulls in a list of 224 raised the milk production of their daughters over that of their dams.

b. 101 bulls in a list of 225 raised the butterfat percentage of their daughters over that of their dams.

c. 99 bulls in a list of 224 raised the net butterfat production of their daughters over that of their dams.

d. 28 bulls had helped the breed by raising their daughters' milk, butterfat percentage, and butterfat production over that of their dams.

e. 47 bulls had decreased the amount of milk and the percentage of butterfat of their daughters compared to that of their dams.

For the Jersey breed as a whole, in each of the three principal categories (section a, b, and c above) the sires selected by the Jersey breeders tended to decrease the level of the production of their offspring more frequently than they increased it. Whatever the reason for selecting these sires, as a group, they had not been chosen for their ability to transmit production qualities to their progeny.

The sires used in Maine were neither the best nor the worst as a whole, but in general they did not transmit production qualities well. (All of Maine's eligible sires from the first Consolidated Volume may not be included in the conclusions of the Station report because this report was published five years before the first Consolidated Volume of the ROM.) In the section for milk production, Maine used no sires from among the top ten.

The highest ranking sires in Maine in terms of milk and butterfat production and butterfat percentage were four sires from Hood Farm in Massachusetts: Pogis 99th of Hood Farm, Pogis 95th of Hood Farm, Hood Farm Torono HR60326, and Hood Farm Pogis 9th HR55552. Native sires did not do so well. Flying Fox's Victor HR64768, used extensively by several breeders in Maine, had a modestly good impact on his daughters' production. But Fontaine's Caiest HR81118 and his sire Mabel's Poet HR65780, used extensively by David and H.M. Moulton, ranked among the lowest bulls: they lowered their daughters' production compared to that of their dams in terms of milk production, butterfat production, and butterfat percentage. Four bulls used in Maine "materially advanced" the Jersey breed, and they came from Massachusetts. Two bulls used in Maine were "inferior" sires, and they came from within the state.

If the Jersey breed was going to advance, a new method would have to be found to determine which sires increased the production of daughters over that of their dams. After the conclusions of Raymond Pearl and his associates, based on their study of the early ROM volumes, were analyzed, additional developments came in the 1920s and 1930s.[49]

The Modern Jerseys, 1930s to the Present

The work which John Gowen was doing in animal breeding at the University of Maine during the second and third decades of the twentieth century, work which included but was not restricted to his study of the Jersey ROM, led him to conclude that "a cow must be bred for milk production or her yield will be small no matter what she is fed". This was particularly important because despite the production records which appeared in the various advanced registries such as the ROM, the national dairy herd, which in the 1920s included 20 million lactating cows, 11 million replacement heifers, and 500,000 bulls for breeding purposes was based on a yearly national production average of just over 3,000 pounds of milk per cow a year.

In order to overcome this low production level, Gowen felt that the practical, successful breeder needed a knowledge of "the milk yield of every cow in the herd and of the average production of the cows in it". Only in this way would it be possible for the breeder-dairy farmer to attain his goal when selecting a sire to head his herd: to have the production of the daughters equal, or preferably exceed, the average production of the previous generation in the herd. As a result of his research, frequently with Holsteins, he concluded that inheritance played a large role in determining the milk yield and butterfat percentage of the cow; it was a much better indicator of her milk yield than was her conformation (phenotype). Thus, in order to be worthy of consideration, a cow's milk or butterfat production record should do two things: it should predict with reasonable accuracy her production in subsequent lactations, and it should indicate to some degree the production of her offspring.[50]

Early in the twentieth century the concept of whole-herd testing, as opposed to the testing of only selected cows, was brought to the United States fron Denmark. The first "cow testing association" was organized in the U.S. in 1906, and the idea spread quickly. There were 40 associations in 1910, 468 in 1920, and 1143 associations testing over 500,000 cows by 1930. The average production of cows entered in the Dairy Herd Improvement Associations (DHIA), as they soon came to be known, was 7,092 pounds of milk and 279 pounds of butterfat in 1924, and 7,464 pounds of milk and 295 pounds of butterfat in 1928. The economic crisis which began in 1929 affected dairying as it did other sectors of the economy, reducing the number of associations, the number of cows on test, and the average number of cows in each association. Thus by January 1933, there were 881 DHIA associations in 44 states testing over 350,000 cows.[51]

The 7,000 pounds of milk produced annually by DHIA-tested cows occurred at the same time John Gowen was lamenting the 3,000-pound-national-average cow. This doubled production of the DHIA cow was made possible in part because, with comprehensive testing, herd owners were able to identify both desirable herd sires, who could be retained, and low-producing cows, who could be culled. During the 1930s, those farmers who remained in the DHIA program practiced more severe culling, while lower-producing cows and herds dropped out of the program. Thus by 1932, the average production of cows who were tested was 7,858 pounds of milk and 310 pounds of butterfat. Prentice noted that since over 95% of the country's dairy cows were unregistered, these figures came primarily from herds of unregistered cows.[52]

Maine entered the age of cow testing associations virtually from the beginning. Leon S. Merrill, the State Dairy Instructor, noted that two associations were formed in December 1907 and began to operate in February 1908. The Waterford and Norway Dairy Testing Associations, and the Kennebec Valley Dairy Testing Association in Winthrop each had about 30 members owning a total of about 300 cows. In June 1908 the Oxford County Dairy Testing Association began operating in Canton.

The comprehensive testing program of these associations enabled the farmer-members to have more accurate and detailed information on the production of all the cows in their herds. The members were thus able to make decisions about which cows to keep or cull based on their profitability. In its first six months of operation, members of the Oxford County Dairy Testing Association sold 39 cows and purchased 13. The total monthly profit of the 39 cows sold was $61.23, while the total monthly profit of the 13 new cows was $66.69. Much of the three-fold increase in profit was due, Merrill believed, to the dairymen's ability to use the testing program to identify and cull low-producing cows.[53]

In a separate report, Merrill talked more generally about the purpose and activities of the cow testing associations. The associations employed trained official testers, at least one of whom was a graduate of the state university. The tester visited each member farm once each month and, staying for the evening and following morning milking, he weighed and sampled the milk from each cow, and weighed the feed fed to each cow. The milk was tested and the percentage of butterfat computed by the Babcock test, and an official record was made of the milk yield, the butterfat yield, and the feed consumed by each cow.

The policy of weighing and sampling each cow's milk one day each month (the method generally followed today) was found to be a "reasonably accurate" means of determining milk production for the entire lactation. Danish studies had shown that the widest variations between daily and monthly testing was 4%, and research in Minnesota showed a variation of 1½%. Weighing and sampling milk one day each month rather than daily was of course less expensive, less cumbersome, and less time consuming, and refinements of the procedure since the associations started early in the century have increased the accuracy of the method.

The cow testing program was designed to be educational and of practical use to the dairy farmer. He had the records of his own cows' production, he could compare these records with those of his neighbors, and he could attend monthly meetings of the association where he could talk with area dairymen and with a representative of the State Department of Agriculture, where copies of the production records were filed. Then as now, the profitable results of this work depended on the individual dairy farmer. It made little difference how much information was known or in what form it was presented if the dairy farmer did not use it, and Merrill urged them to do just that.[54]

Thus by the 1930s there were two well-established systems of cow testing in the U.S., both dating from the turn of the century.[55] The advanced registries of the breed associations, including the Jersey ROM, made a genuine contribution to breed improvement by showing that with a small number of selected cows very high production could indeed be achieved.

The cow testing associations differed from the advanced registries in two very important respects: any cows could be entered, regardless of breed or herd book registry (most were not so registered), and all cows in a member's herd had to be enrolled in the program, and their production recorded, so that there was no selection. In this way it was possible to obtain, among other things, a herd average. In these pre-artificial insemination days, when many dairy farmers kept one bull at any one time to head (breed) their herd, it was thus also possible to get reliable information on his ability to transmit milking qualities to his daughters. The production information was standardized to a 2X 305 or 2X 365 day basis, depending on the length of the lactation, making it easier for farmers to use it.[56]

There was enough material available from both sources by the 1930s to give breeders valuable information. Prentice noted that the average registered bull did not meet DHIA goals of 300 pounds of butterfat a year. More specifically, he noted that in the first volume of Tested Sires, published by the AJCC in 1933, only one of the 773 bulls therein listed had daughters whose average production for a lactation of at least 270 days was as high as 15,000 pounds mature equivalent, and he had been born on January 12, 1917. An additional ten bulls had daughters who averaged between 14,000 and 15,000 pounds mature equivalent, but only three of them were born since January 1, 1922.

In other words, of the 773 bulls listed, only three of them (about .05%) had daughters averaging 13,000 pounds or more (which Prentice felt was competitive) and were still young enough to possibly be sexually active. When it is considered, he concluded, "that we are not here dealing with herd averages, or with a large proportion of the Jersey breed, but are taking into account only a small number of the best bulls of the breed, it is obvious that if this is truely the best the breed can do, the average production of the breed must be low".[57]

Although the AJCC continued its programs of testing and enrolling selected animals in its ROM and Herd improvement Registry (HIR), contributors to the Jersey Bulletin often were interested in comprehensive testing.[58] In 1935 H.R. Horlacher noted that the breed associations' advanced registries were nineteenth-century concepts for breed improvement in the sense that, with the improved understanding of genetics in the twentieth century, it was for the geneticist "just as essential to have information on the low producers as on the high producers. The one tells just as much about genetic constitution as does the other". In order for the dairy breeder to obtain the greatest amount of information from his records for selection purposes, he should have records on all his cows rather than a sample only.

By the 1930s "records are being kept on all the cows of several herds within each breed" (through programs such as the HIR) but

> the genetic viewpoint/based on studying the results of comprehensive testing/ has not yet come to be understood by the rank and file of breeders/ who usually kept unregistered cows and who thus were not eligible for breed association testing programs/, and they do not see the value of taking the trouble to keep such records.

Prentice had written that O.E. Reed, the Chief of the United States Bureau of Dairy Industry, had said in 1929 that past production records of DHIA herds had been the result largely of close culling and improved feeding, and that further increases were unlikely without improved selection methods of sires. Reiterating this view, Horlacher said that the "greatest need" for raising the level of milk and butterfat production was "mass testing". The "modern scientific study of genetics" had shown the importance of the progeny test in breeding for production, much as John Gowen, Raymond Pearl, and others at the Maine Experiment Station had already asserted.[59]

In the 1930s and 1940s Jersey breeders had available a variety of testing and rating programs which they could use as a basis for breed development. Most of the programs were those of the American Jersey Cattle Club, which meant that the information was limited to animals registered with the AJCC. The ROM from its beginning in 1903 tested individual cows and entered them under their sires if certain production standards were met. The HIR, begun in 1928, tested all the registered Jerseys in individual herds to provide both a herd average and separate entry for qualifying individual animals as in the ROM. (Breeders sometimes entered individual cows in their herds concurrently in both ROM and HIR tests.) From 1939 through the end of 1942, the ROM and HIR were combined into one volume with the results of type classification, Production Testing and Type Classification of Jersey Cattle. Beginning in 1943, these records were combined in the Jersey Performance Register (JPR); the first volume, published in 1954, covered the years 1943 to 1950. Separate from these programs, which formed a continuing series, Tested Sires and Dams of the Jersey Breed listed outstanding animals based on their ROM or HIR records.

We have already discussed the ROM and analyzed its strengths (as with other advanced registries, it showed that cows who were entered were capable under certain conditions of producing large quantities of milk) and its principal weaknesses (its selectivity in terms of being restricted to qualifying records of individual cows who were entered in the Herd Registry.)

With the publication of the first consolidated volume of Tested Sires and Dams in 1936, the AJCC pointed out that

> The improvement of the Jersey breed cannot be accomplished by only publishing a portion of the facts. The whole truth about every bull and cow must be known and it is just as essential to know how many poor producing daughters a bull has as it is to know how many daughters have completed high records.

However, the material was still selective rather than comprehensive for the breed in that it was restricted to bulls who had 10 or more daughters who qualified for ROM or HIR entry with lactations of 270 days or longer.[60]

Because this list of sires was selective, the tested daughters' average was high, and some familiar names are present. George Blanchard's Darling's Interested Owl HR123837, born in 1913, had 43 registered daughters at least four years old (the age at which one might expect the first lactation to be completed); 21 of these daughters averaged 10,576 pounds of milk, 626.85 pounds of butterfat, 5.93%. H.M. Moulton's Flying Fox's Victor, born in 1902 and extensively used by several Maine breeders, had 92 registered daughters of whom 21 averaged 8,936M, 487.13F, 5.45%. Fontaine's Caiest, born in 1907 and owned by C.S. Randall of Falmouth, and his sire Mabel's Poet, born in 1899 and owned by C.F. Mabery of Windham, were both cited in the 1919 Maine Experiment Station study as very weak for increasing the production of their daughters over that of the daughters' dams. However, they were both widely used for mating, having 50 and 53 daughters respectively. About a third of their daughters qualified for ROM or HIR entry, producing an average of just under 9,000 pounds of milk and just under 500 pounds of butterfat a year.

The 1919 Experiment Station study had said that among the sires who most increased the production of the daughters over that of the daughters' dams were those who came from C.I. Hood's Hood Farm stock. Two of these were owned by the Ayredale Stock Farm of Bangor. Pogis 95th of Hood Farm, born in 1909, had 49 daughters of whom 25 averaged 11,155M, 649.51F, 5.82%, while Sophie's Gilsland Tormentor HR123534 had 57 registered daughters of whom 14 averaged 10,895M, 578.33F, 5.31%. Duncan Innes of Saco owned Hood Farm Torono 20th HR82854, who was born in 1906. He had 32 registered daughters of whom 21 averaged 10,223M, 559.14F, 5.4%.

There were also at least five sires, four of them from Hood Farm stock, that were not owned by Maine breeders but were extensively used by them for service. The most frequent user of Hood Farm breeding stock was the Ayredale Stock Farm. Although for many years Fred Ayer had the only "Sophie Tormentor" herd in Maine, many of his outstanding animals went to other Maine breeders when his herd was dispersed in the 1920s.[61] Hood Farm Torono, born in 1900 and owned by C.I. Hood, had 109 daughters, 72 of whom averaged 11,802M, 637.34F, 5.36%. The justifiably well-known Pogis 99th of Hood Farm, also owned by Hood, had 176 daughters, 119 of whom averaged 12,373M, 693.88F, 5.61%.

In 1939, 1940, 1941, and 1942 the AJCC combined its two testing programs, ROM and HIR, with its classification program into one volume, Production Testing and Type Classification of Jersey Cattle, published by the Club in New York in 1942. Sixty-five bulls were used by six Maine breeders, including familiar names such as Arthur Blanchard and the estate of George Blanchard of Cumberland Center, and David Moulton of Portland, who entered individual cows in the ROM. Five breeders entered their entire herds in the HIR, and three of them also had separate ROM entries. The two breeders who participated in the HIR throughout the four-year period were George Maylan of Casco and Owen Smith of Sebago Lake.

The HIR index gave herd size and production statistics. Thus we can see that herds on HIR were often small. Three of the five herds averaged between 10 and 20 cows per herd.

E.W. Files of Portland, enrolled for one year, had an average of about 113 cows in his herd, while Erland Records of Livermore, also enrolled for one year, averaged 5 cows. (Files also entered some cows with individual records in the ROM.) Of the two breeders enrolled through the four years, George Meylan averaged 11 cows, while Owen Smith averaged 19.

All the records entered in the Register of Merit, Tested Sires and Dams, Herd Improvement Registry, and Production Testing and Type Classification were very good records of which breeders were justifiably proud. The 45 cows who qualified for entry in the first consolidated volume of TS&D and the 62 cows who qualified for entry in the PTTC volume by having three or more daughters entered in the ROM or HIR also had good records. They were certainly well above the production of the average dairy cow in the U.S., of whatever breed.

One way to determine whether breeders had good cows and were also conscientious about their testing program was to see how many breeders entered their cows through the four-year period covered by the volume. Owen Smith, whose herd was enrolled in the HIR for four years, had nine cows who qualified for entry at least three years. George Meylan, also in the program for four years, had a herd half the size of Smith's, and three of his cows qualified for entry at least three years. Most of the entered animals, however, were tested only once or twice. This meant that the cow did not qualify frequently, the breeder did not stay with the testing program, or the cow was sold to a dairy farmer who did not participate in one of the AJCC's testing programs. Whatever the reason, the record was incomplete in that it was restricted to sires whose daughters had met production requirements; when the production requirements were not met, the production information was excluded from the record.

The "Tested Dams" section of the Production Testing and Type Classification volume, like that of the 1936 Tested Sires and Dams, gave the average annual production of milk and butterfat only of the cows who qualified for ROM or HIR entry. Although the production of these cows was high, usually over 10,000M, 5% butterfat, it was selective rather than comprehensive and, by its arrangement, it emphasized production of the cow rather than the transmitting qualities of the bull, the partner who has the greatest impact in a herd mating program.

The people who devised these testing programs for the American Jersey Cattle Club (the other breed associations had similar programs) were certainly interested in both measuring production and in predicting the transmission of productive qualities to progeny. However, these tests were selective rather than comprehensive (they were usually limited to certain animals selected by their owner) and, despite the increasing awareness of the importance of progeny testing by people such as Pearl, Gowen, and Prentice, these tests usually emphasized simply current production rather than the transmission of productive qualities to progeny.

By the middle of the 1930s a new concept of testing was developed which was designed to increase productive qualities of all breeds. This was not a breed association program but one developed by the Division of Dairy Herd Improvement Investigations of the Bureau of Dairy Industry of the USDA, and it relied for its conclusions on information gained on all dairy breeds in the DHI comprehensive testing program. This "daughter-dam difference" was used by the USDA to evaluate sires from 1935 to 1962. Each cow's yield was judged as a deviation from that of her dam on a standard 305-2X-ME basis. Thus a sire's value was based on the daughter's yield minus the dam's yield. If the daughter produced more than her dam, the sire was judged to have transmitted good milking qualities; if she produced less, the sire transmitted poor milking qualities.

The principal disadvantage of this method was that two or three years passed between the times the dams and their daughters made their first records. During this time, many environmental and management changes were likely to occur even within a single herd which could bias the daughter-dam comparisons. This distortion would be more serious if the daughters and dams made their records in different herds.[62]

This was the testing concept sought so long by Gowen and felt by Prentice to be necessary for the survival and growth of dairying. Its purpose was to "'prove' as fully as possible the breeding value of all sires used in dairy herd-improvement herds, and to make the information available in such a way that it will be of the greatest benefit to the dairy industry".

In DHI work a "proven sire" is not necessarily a good, valuable, or desirable one, but one for whom the production records of at least five of his <u>unselected</u> daughters have been compared with the production records of their dams on a uniform basis.[63]

DHI-tested cows and herds usually had production records comparable to breed association-tested cows and herds, and the DHI program tested more cows than did the breed associations, so these results would be a valuable tool for breed development. In addition, the owners of registered cows were beginning to more frequently use both forms of testing, enabling them to get the advantages of using both and enabling us to compare the results of the two types of testing.

In the 1935-1951 period, there were 6,217 proven Jersey sires; of this number, 147, or about 2.3% were owned by Maine breeders when their daughters' records were made. The name of the owner of the sire was not listed until 1943. However, if he had progeny who qualified for <u>ROM</u> or <u>HIR</u> entry, his owner and the owner of his tested progeny would be listed in the records of the AJCC test for that particular year.

The principal purpose of these volumes was to tell the breeder whether the DHI-tested daughters of the listed sires produced more or less milk than the daughters' dams. Of the 147 Maine-owned sires, 62 were plus for milk and for butterfat, and 64 were plus for butterfat percentage. Eighty-one were

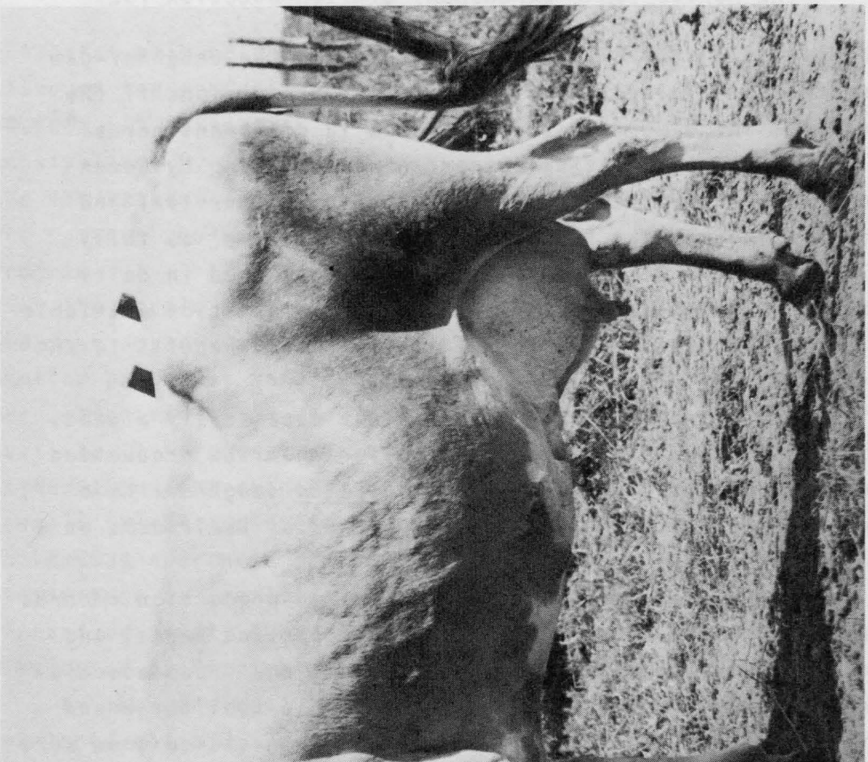


PLATE 1

minus for milk and butterfat, 51 were minus for butterfat percentage, and 32 showed no change for butterfat percentage. All of the sires were not consistent; 34 were plus or no change for milk, butterfat, and butterfat percentage; 39 were minus or no change for milk, butterfat, and butterfat percentage; and 74 showed mixed results.

The information in these volumes was compiled before artificial insemination was widely used, so most of these sires were used in natural service in one or a few herds.

A number of sires had a significant plus performance for both milk and butterfat production in the Proved Sire List; the daughters of several of them had entries in the first volume of the Jersey Performance Register, covering the 1943-1950 period. For example, Rustic's Flying Poet HR263903, born in 1926, was +32M and +3F. The Hilton Stock Farm of Anson had four of his daughters in the JPR with at least two completed lactations each in the HIR program. (All the AJCC records cited here are for the HIR, evidence that the owners were using the comprehensive tests of both the DHI and the AJCC.)

The Russells of Pine Hill Farm of Waterville had two proven sires. In 1943 Double Rustic Poet HR367962, born in 1934, was +443M and +37F. In addition, Pine Hill had 28 of his daughters entered in the JPR. Twenty-three of them had at least two lactations, and their production was quite good, usually about 9,000-10,000M and at least 5%F. (Clyde Russell, a strong admirer of the high testing Sophie Tormentor Jerseys, strongly favored Jerseys who tested at least 5%.) In 1948 Clovercrest Keynoter Rower HR401786, born in 1938, was +367M and -4F. Seven of his Pine Hill daughters were entered in the JPR and their average annual production was about 10,000M.

W.W. and R.S. Pike of Cornish also had two proven sires who had daughters in the JPR. Mary Jean's Hillside Lad HR245887, born in 1924, was +1120M and +9F, and 10 of his daughters qualified for HIR entry. On the other hand, Arcadia V.P. Pink Jeff HR407912, born in 1939, was -576M and -29F.

His eight tested daughters had production averages of about 7,000-8,000 with butterfat averages between 4.3% and 5%.

The Russells of Pine Hill Farm and the Pikes of Highland Farm were and continue to be progressive Jersey breeders. Thus it is not surprising that they would participate in both types of testing programs. It was not important that breeders always get plus-proven sires in the DHI proven sire program, especially in its early years. What was important was that the Russells and the Pikes, and the other Jersey breeders who participated in DHI testing, proved as many sires as possible with the progeny test to find those who could improve the genetic base of their herds in terms of transmitting good milking qualities.

There were weaknesses in the program. For example, a sire who had a plus proof in a low producing herd might have a minus proof when mated with high producing cows. Thus if a breeder wanted to use a proven sire list to plan his mating program, he had to have some information on the herd in which the sire was proved. In the 1930s and 1940s, when most breeding was by natural service, most sires were proven in their owners' herds.

At the same time that the DHI-based progeny test was being introduced, artificial insemination was being introduced in dairy cattle breeding. It eventually became an important part of the progeny test in that, with current technology, a sire could be proven in any herd (preferably in many herds) in the country to get a more accurate estimate of the producing qualities which he transmitted. The progeny test and artificial insemination had a revolutionary impact on dairy cattle breeding.

Artificial insemination is not a new concept; it had apparently been used as early as the fourteenth century by Arab horse breeders, and English dog breeders often used the technique in the eighteenth and nineteenth centuries. However, at this time the significance of the revolutionary impact of artificial insemination was little understood and the technology involved was primitive. It was practiced not to mate a particular male with a large number of females but to use the ejaculate from one male to impregnate (hopefully) one particular female. The technology of artificial insemination until the early years of the twentieth century hardly permitted more. After a natural mating, the semen was recovered from the vagina of the mated female and very soon thereafter inserted into the vagina of the second female. The procedure sounds cumbersome, but it was useful for using a sire for mating purposes in his own neighborhood without moving him or the female with whom he was to be mated from farm to farm.

In the first two decades of the twentieth century there were two developments which increased the significance and showed the potential of artificial insemination. Danish veterinarians found that semen could be "extended" or diluted with a variety of substances. Thus one ejaculate could be used to service a large number of females rather than only one, so the influence of a popular sire would be much more extensive. In addition, several scientists developed artificial vaginas suitable for use with large animals such as cattle. Technicians could now obtain semen without being bothered with the second female, and it was also much easier for them to further process the semen when it was obtained by this method.

These developments, and the discovery in the late 1950s that quick-frozen semen could be stored almost indefinitely, meant that artificial insemination was a realistic breeding method for large numbers of farm livestock. Frozen semen had two advantages. If enough semen is collected from a bull when he is young, he can be slaughtered before he is proven, a process which takes several years. After the bull is proven, his semen can be used or discarded as his owners decide. In addition, until well into the 1950s artificial insemination was restricted to bulls who were located in the farmers' neighborhoods and from whom semen was collected on a regular basis. Freezing semen and storing it in liquid nitrogen tanks meant that farmers had available to them the semen from bulls anywhere in the country.[64]

Although artificial insemination (AI) had been practiced earlier in the twentieth century by individual farmers, an organized program did not start in the U.S. until the late 1930s. In May 1938, the first farmer-owned cooperative AI breeding association began operating in New Jersey with 102 members who owned 1050 cows. In June 1938 a second association began operating in Houghesville, Missouri, aided by the Missouri College of Agriculture and the Farm Security Administration. By 1946 there were 84 such associations (commonly called "bull studs") listed in the Dairy Herd Improvement Letter of the USDA. As of January 1, 1947, there were 140,571 herds containing 1,125,040 cows enrolled in these associations.

The farmer-owned artificial breeding cooperatives were responsible for gradually replacing the "cooperative bull associations" in the U.S. Beginning in 1906 when the first such association was formed in Michigan, this program had grown steadily with over 400 associations active in 1936. The bull association was often a county-wide program in which cooperative member-farmers jointly owned several bulls of the various breeds to be used in natural service. The program was supported by agricultural extension workers and the Bureau of Dairy Industry of the USDA, and its goal of improving the genetic potential of dairy herds was based on using the DHI proved sire lists. The number of cooperative bull associations declined rapidly after 1943 (in that year 318 cows were bred per bull with AI, compared to 33.73 per bull by natural service), but they have to be given credit for promoting for many years improved breeding and progeny testing among dairy breeders.[65]

From our vantage of the 1980s, it is easy for anyone familiar with contemporary dairy farming to see the advantages of AI. Farmers no longer need to keep a bull, who can be expensive and dangerous and, if used alone, can limit the potential for genetic improvement in the herd. The use of outstanding sires can be multiplied a thousand-fold: some outstanding sires in AI service have as many as 100,000 progeny. Semen can be frozen and stored for future use almost anywhere. Related to this, sires can be sampled in many herds in various parts of the country to get a more accurate proof. In addition, with proper management, conception rates can exceed those of natural service at less cost per calf.

There were objections to AI in its early years. Some of them were based on convenience (i.e., a lack of desire to adopt new management techniques): farmers had to detect the cow when she was in heat, call the AI technician, and keep the cow in the barn until the technician arrived. Others felt the whole process offended a law of God, the offspring would be abnormal, the animals mated would no longer have breeding value (the cow would no longer come in heat, and the bull would be sterile), there would be mixups in the semen inventory (again, management had to adapt to new techniques and processes), and the bull market, raising bulls for other dairy breeders to use as herd sires, would be ruined.[66]

None of these fears, with the exception of the end of the bull market, was realized as a result of the development of AI. The comparatively few bulls needed by AI studs can be acquired from a small number of breeders. But we must remember that the purpose of dairy farming is not to produce bulls; it is to produce milk from cows. Thus the loss of the bull market must be measured against the convenience of not keeping live bulls on the farm, and the genetic and financial advantages which come with the use of AI, especially when combined with the progeny test.

Maine quickly adopted these new concepts and techniques. The Maine Extension Service, which since 1929 had been supervising the DHI testing program, sponsored a "better bull" campaign from 1926 through 1931. With the slogan "Better

Bulls Bigger Bank Balance", it emphasized economic milk production through the use of high-yielding cows. As a result of this campaign, about 500 nondescript bulls were replaced by registered bulls, and breeders were looking for herd sires who had production in their pedigrees. Edward W. Towle, a Jersey breeder from Winslow, said "Purchasers of bulls were becoming more critical. Once any animal would sell if it was registered. Buyers now want to see the bull, see his mother, see his sisters, see his pedigree".

The first AI cooperative in Maine was the Central Maine Artificial Breeding Association, organized in Newport on May 2, 1939 with the aid of the Extension Service. By the beginning of 1941 it had 379 members and arranged for the breeding of nearly 2,500 cows. In February 1940 the Androscoggin Valley Artificial Breeders Association was formed in Lewiston, and by the end of the year it had 178 members. By 1946 the two cooperatives were breeding 22,000 cows annually, and in that year they merged to form the Maine Breeding Cooperative. A more centrally located farm was purchased in Vassalboro. The cooperative has since been merged into the Eastern A.I. Breeding Cooperative and no longer uses the Vassalboro farm, but the facilities have been used since 1981 for the Maine Jersey Sale. By 1959 it was estimated the Maine Breeding Cooperative served nearly half the cows in the state.[67]

Maine Jersey breeders not only adopted AI, they frequently used it with proved sires whose daughters qualified for entry into the JPR. From 1948 through 1951, Maine's AI cooperatives used seven proved sires, and they all had offspring in the JPR. In 1948 Cornell Lad Mark HR391835, owned by the Androscoggin Valley Artificial Breeders Association, was proved with +255M and +1F. His two qualified daughters, owned by a New York dairyman, produced 7,845M/4.8%F and 9,230M/5.5%F. In 1949 the Androscoggin Valley Artificial Breeders Association proved two sires: Five-Ply-Sophie-Twi-Interest HR433645 (+26M and -46F) and May-O-Moose Sena-Tid Sophie P HR416239 (-673M and -10F.) The former had three qualified daughters who were tested or qualified by the Pikes in Cornish, while the latter had two daughters in the Pike's herd.

The Central Maine Artificial Breeders Association proved one bull in 1949, Wonderful Moor Sultan HR405148 (-921M, -52F.). He had a number of qualified daughters in the JPR owned outside Maine, and Pine Hill Farm owned one with three completed lactations. Her production averaged 6,884M, 4.9%F.

The remaining eight sires were owned by the Maine Breeding Cooperative. Six of these sires had minus proofs, while two of them had plus proofs. The numbers were sometimes striking. The proof of Prospector HR403258, proved in 1949, was -1437M, -21F. Of the five bulls proved in 1950, Blonde Signal HR407251 was -241M, -19F, Duke of Avaba HR446195 was -488M, -13F, and Volxenia Fairy Noble HR449058 was -800M, -39F; but Jeff Radiolette Owl HR439356 was +1231M, +51F, and Lilac Remus Herald HR414844 was +752M, +29F. In 1951, however, Dreamy Moor Master HR455325 was -861M, -20F, while Gay Lady's Golden Design HR452577 was -1581M, -77F. There were nine daughters of Prospector in the Pikes' herd, and their production averaged just over 6,000M, about 5.4%. They each had only one entry, so we cannot determine if their production markedly changed. The Hilton Stock Farm of Anson had several daughters of Blonde Signal in the JPR, and their production averaged about 6,000M. Jeff Radiolette Owl was used extensively by the Pikes, but his daughters were classified, not tested.

The important point of these developments was not that the proofs of some sires were minus. The results of the testing process which reveals plus and minus proved bulls will inevitably show that some sires have minus proofs. Nor is it necessarily important that progressive breeders such as the Pikes used some of the bulls with minus proofs; they were aware of the proofs, and their decisions to use some of them in their mating programs were based on other conditions. What is important is that AI, which would revolutionize the availability of sires, was being combined with systematic progeny testing, and the joint program, although in its infancy, was being used by progressive Jersey breeders.

Down to the early 1940s, before a large pool of proved sires was available, AI organizations often had difficulty acquiring sires with satisfactory proofs. When the organizations purchased purebred proved bulls, they were usually bulls who had been proved in one herd. Breeders who had proved bulls for sale to AI organizations were usually better than average breeders who provided good management and feed. When a bull who had been proved in herds such as these, under good conditions, was used in AI service on a broad cross section of the dairy cow population, where feed and management might not be as good, his "new" daughters resulting from AI service often did not produce as well as his naturally sired "old" daughters in his original herd. This was a problem which AI organizations recognized and moved to resolve by using more daughters to prove bulls and by relying more on proofs obtained in AI service.[68] With the development of technology for freezing semen for longterm storage in the 1950s, sires could be proved over a wide area when they were young.

In 1947 Raymond Albrectsen, a Cornell University extension dairyman, faced this problem of bulls in AI service with low proofs in a paper presented at the annual meeting of the American Dairy Science Association. DHI workers in New York reported they had found the proof on young sires proved through AI service to be more reliable in predicting future production than were the proofs on sires proved through natural service in a single herd. In a group of 183 AI-sired cows, the offspring showed an increase in butterfat production over that of their dams; 165 cows produced 400 pounds or more in a year, a good production performance.[69] With the passage of time, the issue of "repeatability" (that is, the reliability of the proofs to which Albrectsen referred) was to become as important as the numbers of the proofs themselves.

While this work was being carried out, similar work was being done by the Maine Agricultural Experiment Station.

Writing in 1944, early in the proved sire program, H.C. Dickey and Pedro Labarthe pointed out that while the progeny test was the best way to measure the transmitting ability of older sires, many of them were dead or too old to be used by the time they were proved. If they were proved in natural service in one herd, as many of the early proved sires were, the records of a sufficient number of daughters are accumulated much more slowly than if they had been proved in AI service in a large number of herds. Thus dairy breeders had to accept that for some time many of their most frequently used sires would be young or at least unproved when they were selected.[70]

In 1948 Dickey, H.W. Hall, and A.O. Shaw noted that, based on figures computed from reports of the Bureau of Agricultural Economics of the USDA, the 735,000 dairy cows in New England in the late 1940s each produced an average of about 5,500 pounds of milk a year. If "by new methods" a "race" of dairy cows could be bred who would produce 8,300 pounds of milk a year (the national average production at that time of cows in DHI herds) the same amount of milk could be produced with 490,000 cows, a reduction of 245,000 cows and a savings of $20 million for New England dairymen.[71]

The authors noted that while cattle were registered by their respective breed associations, they were registered without regard to their productive ability. They studied DHI and breed association production figures for the Guernsey, Jersey, Holstein, Ayrshire, and Brown Swiss breeds from 1935 to 1945, including 400 DHI proved Jersey sires who were the sons of proved sires or who had tested dams from 1935 to 1945. Sire selection was based on (a) the dam's record, (b) the proved sire's equal parent index, (c) the combination of the proved sire's equal parent index and the dam's record, and (d) the sire's and maternal grandsire's records with an equal parent index of at least 400 pounds of butterfat, and the dam and maternal grand dam with records of at least 400 pounds of butterfat.[72]

The results of their herd sire selection based on butterfat production of the dam were presented in Appendix Tables 8 through 12 of the report. These tables, according to the authors, showed that a dam's record alone was not a reliable basis on which to predict the transmitting ability of her son, "regardless of the breed". This was because, as the proved sire program of the previous decade had shown, "A cow's record does not prove her offspring, it only helps to prove her sire, and shows her own productive ability".[73] Appendix Tables 13 through 17 showed that a pedigree based solely on the sire's Equal Parent Index, "one of the methods of bull selection often suggested" at this time, was slightly better than a pedigree based only on the dam's record.[74]

The authors concluded that the phenotype of a cow as exhibited by her record of production and the phenotype of a bull as exhibited by his sire index were not reliable bases from which to predict the transmitting ability of their sons. One reason for this was that most dairy cattle are sufficiently heterozygous, or mixed, in their genetic composition and therefore do not transmit according to production records and sire indices.

Another reason is that environmental conditions such as feed, care, and management, a major variable in an era when so many sires were proved in one herd by natural service, varied considerably. They felt it was necessary to adequately control environment if production records were to be used to adequately reflect transmitting ability. If the environment could not be controlled, then the differences in environment should be measured so that the resulting records of production could be used more accurately.[75]

Five methods of developing sire indices from pedigree information were put forward by the authors. The one which they found to be most accurate in terms of the least amount of deviation in the amount of butterfat predicted to be produced by the daughters was an average of the records of the daughters of the three sires; that is, an average of the production of butterfat of the daughters of the sire, the grandsire, and the great grand-sire of the bull for whom the index was being compiled. They concentrated on butterfat production because they noticed that in cases where there was a considerable deviation between the predicted butterfat production and the actual butterfat production, there was also a great deviation between the predicted and actual milk production of the daughters.[76]

This method of proving sires was chosen because, in these early years of the proved sire program, there were few proved sires available for actual use, their price was usually high and, if they were still alive when they were proved, they were often too old to be shipped great distances. Progressive breeders thus often had to rely on promising young sires, and the authors felt that sires of this quality were most likely to be found in herds where owners were fortunate enough to have three good sires in succession.[77]

In a 1954 Bulletin, Dickey and Hall noted that in the past the production record of the dam had been accepted by most breeders above all other criteria for obtaining superior production in inheritance. They believed this approach had gone as far as it could and other methods of selection should be examined. Selection which relied on the dam's production offered only about a 30% to 40% chance of maintaining or increasing production, and breeders who had outstanding herds producing in excess of 435 pounds of butterfat per cow could not afford to breed with a program which had this low rate of success.[78]

They reviewed some of the breed association programs for rating sires and concluded that the most accurate indices were either the one they had described in 1949 (averaging the records of the daughters of the sire, grandsire, and great grandsire of the bull being indexed) or a more complex formula using a combination of production records of the bull's female ancestors on his dam's side and a regression index for male ancestors on his dam's side. In each case it would be necessary to go back three generations. These methods showed the least deviation between predicted and actual production. If the breeder had production information for only one generation, he could use an average of the dam's record and the breed average as an acceptable method.[79]

The purpose of these studies was not simply to provide a more accurate means of identifying and selecting Jersey sires in Maine. The authors were interested in improving the accuracy of sire selection everywhere. The proved sire program had not yet reached maturity in part because AI, which would greatly speed the process of proving bulls, was only beginning to have an impact in the sire-proving process. Since good proved sires were few in number, expensive to obtain, and often not available for mating, the authors sought formulae which would provide an accurate measure of the transmitting ability of sires when they were young.

In 1951 Walter Harvey and Jay Lush studied the genetic correlation between type and production in Jersey cattle. "Type" is in general the phenotype, the overall physical conformation or appearance of the animal which is given so much emphasis in the show ring, at public sales, and in herd classification programs. Because of this importance, the authors felt it was natural to inquire whether type is correlated closely enough with production to serve as an indicator for production.

The data which they used came from the American Jersey Cattle Club. They studied the fat production records and type ratings of 8,464 cows from 245 herds who were in the HIR at least four of the five years from 1943 through 1947. (Since the cows qualified for HIR entry, each of these entries can be located in the first volume of the JPR. Although 39 states were represented, most of the herds were located in the Northeast and Midwest. The average number of production records per cow was 2.01.

After studying 2786 daughter-dam pairs, the authors concluded that selection on the basis of type alone "should" automatically bring some genetic improvement in production.

However, selection on type alone would require about 6 to 10 generations to obtain the improvement that selection on the basis of production would obtain in only one generation.[80] Thus, selection on the basis of type alone would not be of major assistance to breeders seeking outstanding young sires to use in their current breeding programs.

Investigations beginning in the early 1950s, particularly at Cornell University by Charles R. Henderson and his associates, indicated that the accuracy of AI proofs depended on several factors. These included factors which were familiar to breeders at that time: the number of tested progeny available for a given sire, and the number of herds in which the daughters of the sire had been tested. He gave increased emphasis to correcting the production records for the age of the cow, the season of freshening (calving), and so forth. He also introduced a new factor: the use of herdmate or contemporary comparisons (that is, comparing the cow with others in the herd, progeny of different sires, who freshened at about the same time) rather than the daughter-dam comparison which had been used since 1932.[81] The increasing use of artificial insemination made it possible for dairy breeders to use a greater number of potentially good sires in their herds simultaneously, thus making contemporary comparisons possible.

The "herdmate comparison" compared each cow's record with the records of other cows sired by the same bulls and milking in the same herd at the same time. Thus all records to be compared were subjected to many of the same environmental or management influences. This method largely overcame the potential weakness of the daughter-dam comparison in which the milking cows, especially after the introduction of artificial insemination, were subjected to a wide variety of management influences. Several requirements had to be met to reduce the possible biases of the program. For example, the herdmates of all the cows had to be subjected to the same degree of culling, and each cow and her herdmates had to receive the same level of treatment.[82]

The "contemporary comparison" is similar to the herdmate comparison except that only production records of the first lactation are used. Thus the animals are contemporaries; they began their first records at about the same time.

There were two principal advantages of the contemporary comparison compared to the herdmate comparison. First, the use of first records only minimized any possible errors that might arise from the use of age-correction factors. Second, the use of first lactation records only avoids biases that might arise from the use of later records which are made by cows who have been subjected to culling and are thus, in a sense, a selected group. In addition, the comtemporary comparison can be calculated with simpler statistical procedures and is less expensive to derive. The principal disadvantage of the contemporary comparison, one which might counterbalance its advantages, is that the amount of information available for estimating breeding value may be more limited, because in each herd there may be more cows who are herdmates than would qualify as true contempories.[83]

While the USDA-DHIA was using the herdmate comparison, a new concept, Predicted Difference (PD) was developed and introduced in 1963 by American Breeders' Service, an artificial insemination company.[84] Adopted by the USDA in 1965, Predicted Difference is the estimate of a sire's probable breeding value. It is the amount (of whatever is being measured) the sire's daughters would be expected to vary from their herdmates in breed average herds, and it reflects the genetic transmitting ability of a sire more accurately than any measure developed to date. Predicted Difference can be calculated for amount of milk produced (PDM), pounds of butterfat produced (PDF), value of the product produced (PD$), and for type appraisal (PDType.) For example, if we read a sire has a PDM of +900, his daughters, within the limits of the PD concept, would be expected on the average to improve milk production by 900 pounds in breed average herds. Similarly, a PD$ of -120 would mean the value of the milk product of the daughter on the average would decline $120.[85]

Breeders were cautioned not to place too much emphasis on PD as an exact measure of transmitting ability. Its greatest value is as a device for ranking bulls on ability for milk yield. Some feel this is best done without even listing the specific PD for each bull, but this type of list would be more difficult to use. Since PD is an estimate, it is subject to change, depending on the information available when the estimate is made. For example, the addition of more daughters or of more daughters' records might well affect the PD.[86]

The precision or reliability with which PD for milk or fat yields will estimate a bull's transmitting ability relative to other bulls of that breed is called repeatability (Rept.). Repeatability depends on (a) the number of daughters in the sire summary, (b) the number of herds in which the daughters are located, (c) the distribution of daughters among these herds, and (d) the number of lactations per daughter. Repeatability increases as the number of daughters and the number of lactations per daughter go up. An even distribution of daughters among a large number of herds gives a more accurate estimate of transmitting ability than does an uneven distribution of tested daughters.[87]

The higher a sire's repeatability, the more confidence a breeder can place in his sire summaries. However, quite frequently a bull will have a high PD in a desired trait and a low repeatability, or a low PD with a high repeatability. Breeders are thus often faced with reconciling two sets of figures. When the two figures are not uniformly high, it is usually recommended to breed to the high PD rather than the high repeatability.

The herdmate comparison was used by the USDA to estimate the genetic transmitting ability of sires until the Fall of 1974, at which time the "modified contemporary comparison" (MCC) was adopted to determine both cow indices and sire summaries. Improvements were needed in genetic evaluation procedures because of a marked acceleration of genetic progress for milk yield in the 1960s and early 1970s from the use of the herdmate comparison. This increase in genetic merit for milk yield resulted in some of the assumptions of the herdmate comparison becoming outdated. The MCC incorporated the most desirable features of both the herdmate comparison and the contemporary comparison. It also reduced the importance of underlying assumptions regarding animals used in genetic evaluation because adjustments were made for effects that previously had to be accepted as unimportant. This helped to increase the accuracy of the procedure.[88]

The USDA-DHIA Sire Summaries and Cow Indexes are calculated on the same computing system because the basic MCC calculations have already been done on each individual lactation record. The individual data are then pooled to estimate the genetic transmitting ability of both bulls and cows.[89]

There were several changes in the MCC which contributed to its improvement over the previous system. It divided all records into two "contemporary groups" - one of first records only and one of second and later lactations. This permitted the use of all lactation records while also comparing records of cows and their herdmates, thus giving comparisons which would be subject to the fewest biases. The comparison of each cow's record with that of her herdmates is adjusted for the genetic merit of the herdmates' sires, increasing the accuracy of the MCC over previous procedures.

In another step to increase accuracy, bulls are categorized into genetically similar groups based on their transmitting ability as derived from pedigree information. This eliminated the need to assume that all bulls and cows are random samples of one overall population. With the advent of the portable nitrogen tank and frozen semen, sires could be used virtually anywhere in the country, and breeders used the higher-ranking sires. In addition, more accurate age and month of calving factors were introduced; and lactation records in progress (RIPs) were introduced, permitting first genetic evaluations to become widely available sooner.[90]

The MCC was widely publicized and strongly supported in dairy and breed publications, including the Jersey Journal. For example, in May 1975, Dr. Basil R. Eastwood of Iowa State University pointed out that despite the success of the herdmate comparison and predicted difference, dairymen were becoming aware of a major shortcoming in the old sire summaries. As breeders used top sires year after year, the competition facing each new heifer coming into the herd was formidable. Any sire whose daughters are competing in herds of this quality had a difficult time coming up with a high PD. Similarly, a sire whose daughters were entering a low quality herd would look better than he should. Thus the genetic level of herdmates for milk and fat was taken into consideration through the use of a herdmate sire average.[91]

In August, Morris Ewing of the American Breeders Service, noting that the "greatest increase in accuracy" in sire evaluation came with the herdmate comparison, pointed out that the MCC included, for the first time, pedigree information along with progeny information. While this was a difficult concept for many breeders to accept, he felt that two independent estimates of genetic worth contained more information than one alone. The "new" pedigrees could be of use when progeny information is limited, which may well be the case with young sires who have few tested daughters.[92]

Robert Lamb of the USDA and Cleon Kotter of Utah State University pointed out that sire summaries "like any other farm tool... must be kept up to date with changing/genetic/ conditions." In addition, improved statistical procedures help improve the accuracy on each bull used.[93]

Finally, Elmer Clapp of the Eastern AI Cooperative said that "Many studies have shown the positive relationships between 'pedigree indexes' and resulting daughter-contemporary comparisons... Such positive A.I. Proved Sire pedigree results have been difficult to duplicate with other selection methods... Such intense 'pedigree index' selection offers breeders the greatest relative opportunity for genetic progress in 'smaller volume' breeds/i.e., breeds other than the Holsteins./ Greater genetic progress can be made from pedigree selection than from picking the best from the resulting A.I. Proved Sires". The use of a pedigree index helped to compensate for the smaller number of Jerseys available for evaluation compared to the Holsteins.[94]

To illustrate both the accuracy of the new evaluation procedure, and the amount of time it often takes to get a sire proved, we looked at one bull, Observer Chocolate Soldier HR596832, probably the one sire who has done more than any other to raise milk production of Maine Jerseys.[95] He was born April 10, 1962 at High Lawn Farm in Lenox, Massachusetts, the son of Secret Signal Observer HR553236 and Chocolate Tristram May HR2095421. The Eastern A.I. Cooperative was interested in him before he was born, should he be a bull, and, in October, they purchased him for $1500.

His first semen was released for random AI sampling on September 9, 1963. However, he was not very popular and had inadequate use for the desired reliability rating; after six years of service he had only some "preliminary" daughter production information available.

"Chocolate Soldier" was due for reevaluation by the Eastern Jersey Sire Committee, and he did not yet have enough tested daughters to warrant keeping him in service. According to Allaire Pike Palmer of Highland Farms in Cornish, Henry Black of Briarcliff Farm in West Baldwin called her father, R.S. Pike, one day in 1969 and asked him to come over and examine one of his "Chocolate Soldier" daughters. Both Pike and Black had some "Chocolate Soldier" calves and more due shortly, and they were both interested in knowing what contributions he would make to breed development. When they examined Black's two-year-old "Chocolate Soldier" daughter, they were both impressed. She had produced over 11,000 pounds of milk, almost 600 pounds of butterfat, and had a type appraisal score of Very Good-85%.

This was a very good record for a two year old cow at that time. Pike, who was a member of the Eastern Jersey Sire Committee, supported retaining "Chocolate Soldier" in active service. His preliminary data at that time indicated his daughters had "a great will to produce" and were "fast milkers with quiet disposition satisfactory in the traits associated with udder wearability".

"Chocolate Soldier" was thus returned to active service but in late 1972 he began having testicular and scrotal problems, and the quality of his semen declined. He "left the stud" on April 5, 1973, five days short of his eleventh birthday.

The lesson from this experience is that "Chocolate Soldier's" "breed greatness" was achieved and recognized only after his death in 1973. It pointed out the need for dairy breeders to adequately sample the young sires offered by various AI organizations. It is important to have reliable, random AI proofs early to identify the true genetic transmitting ability of individual sires. In "Chocolate Soldier's" case, he was almost missed because of inadequate herd sampling to provide a reliable initial proof.[96]

An examination of "Chocolate Soldier's" summaries, taken from the Jersey Performance Register, shows how his value became known only after his death. It also shows the change which took place in his summary when the MCC was adopted in 1974.

JPR YEAR	USDA SUMMARY	DAUS/HERDS	REPT	PDM	PDF	DAUS AVE
1969	1-70	19/18	54%	688	24	10777/529
1970	1-71	20/19	57%	720	25	10825/531
1971	1-72	20/19	58%	735	21	10929/424
1972	1-73	32/22	62%	704	19	11108/535
1973	1-74	76/41	74%	699	15	10893/524
1974	10-74	207/116	91%	1381	46	10796/511
1975	9-75	558/189	95%	1397	47	11018/520
1976	1-77	1059/301	97%	1453	49	11315/531
1977	1-78	1323/357	98%	1481	49	11465/539
1978	same as 1977					

It is clear that the increase in the number of tested daughters and in the number of herds where they were located, and the adoption of the more precise MCC helped to improve "Chocolate Soldier's" summaries.

As one might expect from the above information, there was considerable interest in proving "Chocolate Soldier's" sons. He had 36 proved sons. Eight of these 36 sons had prefixes indicating they came from Maine farms, and it is not surprising that they all came from the farms of the two breeders who showed so much interest in him in 1969: seven came from Briarcliff Farm of the Blacks, and one came from Highland Farm of the Pikes and Palmers. Henry Black mated his best cows to "Chocolate Soldier" and saved any son born. Every "Chocolate Soldier" son bred at Briarcliff and proved to date has a plus proof.[97]

"Chocolate Soldier", of course, is not the only significant sire used in Maine Jersey herds. The official list for 1980 test year lactations included 88 Maine-owned Jerseys; 24 were sired by "Chocolate Soldier". Four were owned by the Whitcombs of Springdale Farm in Belfast, while 20 were owned by the Pikes and Palmers of Highland Farms. Another important sire on this list is <u>Milestones Generator HR602658,</u> born in 1964. According to the 1977 <u>JPR</u>, his USDA Summary for January 1978 showed 99% repeatability for 8,922 daughters in 1,125 herds; his daughters averaged 11,086 pounds of milk and 499 pounds of butterfat. His PD was +1187M, +17F. The large number of herds in which he had many tested daughters contributed to his high repeatability. The University of Maine and Springdale Farm had one of his entered daughters each, Highland Farms had two, while Joseph and Kay Wood had five of his entered daughters.

The average production of all the cows in this list was over 15,000 pounds. The average by herds was 14,832 for Highland Farms (40 cows), 15,027 for Joseph and Kay Wood of Newport (9 cows), 15,120 for Victor Bissell of Newport (5 cows),

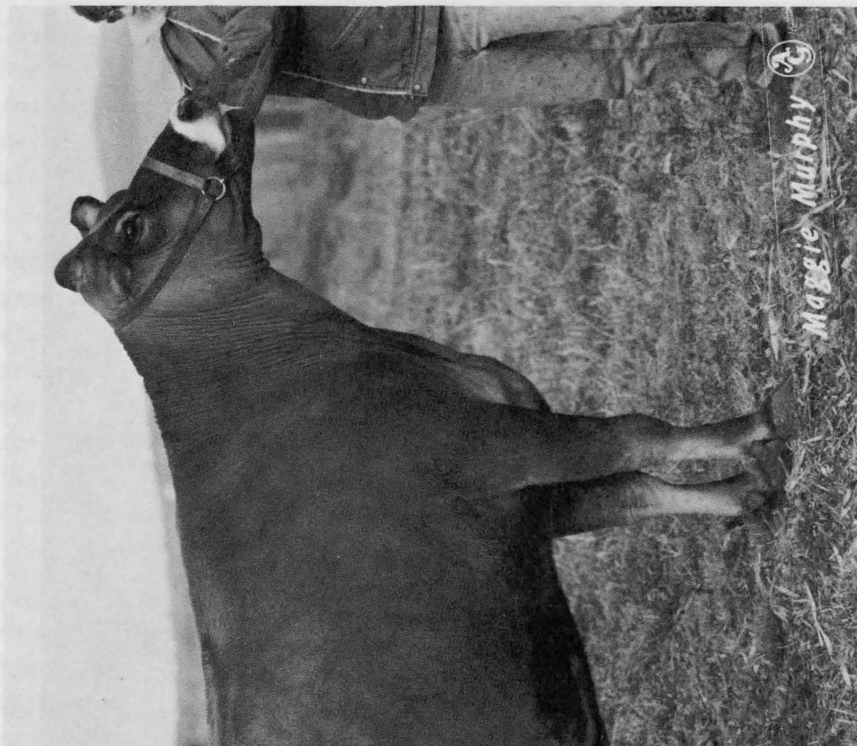


PLATE 2-A

PLATE 2-B

15,520 for the University of Maine (one cow), and 15,567 for Springdale Farm (33 cows). Averages of this type are an indication of both good management practices and of well-developed selection programs based on using the best sires available.[98]

The names of several Maine Jersey breeders recur regularly through the 1970s and 1980s. This reflects not only the excellence of their breeding and management procedures but also, of course, their participation in DHI and AJCC testing programs, the source of official records. Interviews with several of these outstanding Jersey breeders show that they are also good managers.[99] Each of these farmers was among those whose DHIR herd average in 1983 equalled or exceeded 12,234 pounds of milk and/or 584 pounds of fat.[100]

All of these breeders have been with Jerseys since their youth, and two families have links with Jerseys which go back to the nineteenth century. Greg and Kay Fowler live on a family farm which had been owned by the Blanchards, some of whom were among Maine's earliest Jersey breeders, and their family ties with Channel Island cattle go back to 1820. The Pike and Palmer families have similar ties with Jerseys. The Pikes have had registered Jerseys since 1886, and their farm has probably continuously had registered Jerseys longer than any other family in the state.[101]

Other herds date from the twentieth century, but they all show a similar long-term committment to Jerseys. The Black's farm has had Jerseys since 1911. Pine Hill Farm has had Jerseys since the 1930s, under the late Clyde Russell. The farm is now run by Clyde's grandson, Andrew. Potter's Brook Farm, organized in 1980, is only superficially a new farm. Mark and Vicki Russell had earlier been with Mark's family at Pine Hill Farm, and the original cows at Potter's Brook had been selected from among Pine Hill stock. The Bradfords and the Whitcombs have also been associated with Jerseys for over 30 years.

In each of these families, the association with Jerseys goes back more than one generation. For the Fowlers, the Pikes and Palmers, and the Blacks, the link goes to the nineteenth or early twentieth century, when Jerseys were the most numerous and popular breed of dairy cow in Maine. The others chose Jerseys at a time when the market structure, and much informed opinion, favored the Holstein. Their choice of Jerseys, their decision to stay with them, and their success with them, is a tribute to their faith in the breed and their management practices.

The farms are about evenly divided in their choice of physical facilities to house and milk the cows. The Pikes and Palmers, the Blacks, and the Fowlers milk in a milking parlor and have a manure pack or free stall housing facility. (The 30-year-old parlor at Highland Farms is probably the oldest in Maine.) The others have pipeline milking systems with individual tie stalls or stanchions; the Whitcombs also have a freestall facility for loafing.

The choice of housing and milking facilities reflects herd size. The Blacks have 110 milkers, the Fowlers have 115, and the Pikes and Palmers have 140. Many people find it easier to manage herds of this size with a milking parlor. Mark and Vicki Russell have 47 milkers, Andrew Russell has 56, and the Bradfords have 30. Herds of this size can be easily managed in a tie barn. The Whitcombs milk 130 cows in two shifts in their tie barn.

Successful dairy farmers know it is necessary to have a large number of heifers for replacements. The Pikes and Palmers have 80 heifers and 50 calves, the Whitcombs have 42 heifers and 39 calves, the Fowlers have 75 heifers and 25 calves, the Blacks have 60 heifers and 30 calves, Andrew Russell has 50 young stock, Mark and Vicki Russell have 24 heifers and 17 calves, and the Bradfords have about 25 young stock. The Whitcomb's replacement herd numbers 62% of their milking herd, the Pikes' and Palmers' replacement herd is 93%, while those of the other breeders is in the 80% range.

Much of the improved genetic ability of cows to produce milk in recent decades has come from the use of AI and proved sires. Three of these breeders, the Bradfords and Mark and Andrew Russell, use AI exclusively, while the Pikes and Palmers use it 99% of the time. The Whitcombs use semen from AI organizations about 75% of the time, and do the remaining breeding, some of it artificially, with their own bulls. The Blacks do about 90% of their breeding AI, while the Fowlers do about 75%. (Several of these breeders use natural service for heifers or older cows who have difficulty conceiving.) Semen is acquired from a number of AI organizations, especially Eastern, Select, ABS, and Carnation.

The large herds of the Fowlers, Pikes and Palmers, Blacks, and Whitcombs had between 5 and 10 bulls of various ages, some under contract to AI organizations. Albert Bradford had a young bull under contract to Carnation, while Mark and Andrew Russell had no bulls.

All of these breeders sample some young or unproven sires, an essential prerequisite to identifying superior young sires. The Bradfords and the two Russells sample sires from Eastern and Select Sires. The larger farms sample some of their own sires in addition to those of AI organizations. The Whitcombs also have a young bull in the Jersey Young Sire program.

The use of artificial insemination and the sampling of young or unproved sires is essential for breed progress. It takes several years to prove a sire, and reliable proofs are best obtained from a wide variety of herds.

Proving a sire requires the participation of several breeders, and some of those interviewed have bred or helped prove sires. Andrew Russell has helped prove some for Eastern, and he and his brother helped prove <u>Astrid Gen of PHF HR632499</u>, now at Select Sires. The Pikes and Palmers, the Fowlers, the Blacks, and the Whitcombs have helped prove sires with the Highland, Briarcliff, and Springdale prefixes.

The Blacks and the Pikes and Palmers are well known for their contributions to Jersey sire development. They live only a few miles apart, and it was as a result of the close cooperation and interest in Jersey sire development of R. S. Pike and Henry Black that "Observer Chocolate Soldier" was kept in AI service. The number of Jersey sires in current AI service with the "Highland" or "Briarcliff" prefix is a tribute to the continuing efforts of these families.

Most of these breeders have specific breeding goals for the future. The Bradfords, having set national records for milk and fat, are currently interested in improving type. The Whitcombs and the Pikes and Palmers, like most Jersey breeders, are interested in taking advantage of the traditional strengths of the Jersey and breeding for increased fat and protein production. As component pricing becomes widespread, the production of protein in addition to fat will become more important and profitable to Jersey breeders.

Selecting the appropriate sire is only part of the genetic progress in any herd. Profitable dairying is in part the result of careful management to ensure timely conception and a calving interval as close to twelve to thirteen months as possible. The mean calving interval in these herds is thirteen months, with a range of 12 to 14 months. Every dairy farmer has a few cows who contribute to the profitable operation of the farm although they have longer calving intervals. These Jersey breeders have managed to keep their calving intervals close to the ideal.

Careful management also helps to result in fewer services per conception. Each time a cow is inseminated but does not conceive, the calving interval is lengthened, and profitability is correspondingly lowered. The mean number of services per conception among these breeders is 1.74, with a range of

1.5 and 2.5. Many of these cows are bred on the first service.

Successful dairy managers are also concerned with the production and storage of forage. Dairy cows are fed for maintenance, body growth, fetal growth, and lactation. In addition, their feed requirements change through their annual lactation cycle, and as they grow older. The production and storage of feed is particularly important today. The recent advances in selecting for production, means most cows are capable of producing still more milk, and it is the goal of dairy farmers to manage and feed their cows to fully benefit from this genetic potential.

Many dairy farmers today feed haylage or corn silage because this type of feeding lends itself to mechanization and often results in higher nutritional value for the forage. The Blacks, Andrew Russell, the Pikes and Palmers, and the Whitcombs grow some corn for silage. These farmers and the Fowlers also grow some grasses and legumes for haylage. Most of these farmers use horizontal silos, which are less expensive to build and quicker to fill. The Blacks use both upright and horizontal silos, while Andrew Russell has uprights.

Hay is an ideal food for ruminants and one which has traditionally received much attention from Maine's farmers.[102] The Bradfords and Mark and Vicki Russell feed only hay as a forage, and their production records show they do this successfully.

These farmers devote as much attention to detail and to long-range planning in their forage program as they do to sire selection. They all work closely with the Extension Service and the Soil Conservation Service (SCS) to ensure long-term soil productivity and high forage production. They rotate areas regularly and reseed grasses and legumes as needed, and they do soil tests on a regular basis. The Pikes and Palmers, for example, recently completed a ten-year agreement with the SCS.

Several were also interested in developing permanent manure storage systems to preserve nutrients and to eliminate daily trips to the field. Only Mark and Vicki Russell had a permanent manure storage area. The Whitcombs and the Bradfords said they were working with the SCS to develop a system which will reduce labor costs, preserve nutrients, and prevent pollution. The high cost of fertilizer makes this an important concern.

The Whitcombs of Waldo have cleared much land which is used for pastures. Their pastures are divided into eight sections, and the cows are rotated among these sections every few days. These pastures are clipped and fertilized twice a year. They also have used no-till seeding methods and have installed tile drains in wet areas.

The Bradfords are well known among Jersey breeders and other dairy farmers for the attention they give to forage production and to their cows. About half of their 65-acre farm is a fine sandy loam suitable for long-term alfalfa stands. These fields are limed regularly to maintain a high degree of fertility, and the alfalfa is cut four times a year at the bud or early-bloom stage for highest quality.

In order to prevent loss of nutrition from dried, crushed leaves, they bale their alfalfa, still damp, about 28 hours after cutting. It is then stored in the barn where a hay mow drier completes the drying process. The result is a high quality forage which reduces their dependence on feed concentrates.

The Bradfords have also tiled some of their wet fields, and they rotate their cows among several pastures each summer. This attention to detail in their forage program has paid off. In addition to their national production records, the Bradfords always have hay to sell.[103]

Genetic improvement in dairy cows rests on cows for whom production records are kept and used. All of these breeders have registered Jerseys who are classified and on DHIR test. These records and other AJCC programs are regularly used for sire selection and to make culling and other management decisions. They and their families participate in AJCC-sponsored shows and sales, and in 4-H and FFA.

The average production level of all Jerseys on official DHIR test in the country was 12,064/578 pounds in 1982, and 12,234/584 in 1983. Each of these herds exceeded that standard each year. In 1982 Maine Jersey breeders ranked second in the breed for milk production and fourth for fat; in 1983 they ranked first for milk production and third for fat. The Bradfords brought additional honors to Maine by having the highest producing herd for fat and the second-highest herd for milk in 1982; in 1983 they had the highest producing herd in both milk and fat.

These are all family farms, representing the efforts of more than one generation. They feel the future of dairying rests with family farms such as theirs. They recognize that the 1980s is a transitional period for dairying, and none plans to radically change herd size, facilities, or type of forage used. They are Jersey enthusiasts and their plans for the future include capitalizing on proven Jersey strengths - their lower feed consumption, their competitive level of milk production, and their high production of solids, especially protein. In Allaire Palmer's words, "With renewed interest in high total solids, especially for cheese, I see the Jersey cow enjoying a comeback to the forefront". These Jersey breeders are well prepared for the future.

CONCLUSION

Dairy farmers produce a nutritious food product containing fats, proteins, vitamins, minerals, and water. In the U.S. in 1980, in terms of market revenue, dairying was the third most important agricultural activity, behind meat animals and food grains, with revenues of $16,598.4 million. In Maine in 1980, it ranked as the second most important agricultural activity, behind the poultry industry, with $92.7 million in revenue.

This level of production was not possible in the middle of the nineteenth century. Genetically, the dairy cow at that time was unselected; she was bred merely to produce offspring and to maintain lactation.

Two things had to happen before cows could increase their production of milk.

First, a market had to exist. This came in the second half of the nineteenth century with the rapid growth of cities, and the means of getting the milk to the cities. Maine's dairy farmers were fortunate to have a number of farms located close to the south-central portion of the state, between Portland and Bangor, where most of the cities and transportation routes were located. They were also fortunate to have a relatively short haul by truck or rail to Boston, a major urban market which has traditionally taken all milk not needed in Maine. By the end of the nineteenth century this market existed largely as we know it today.

In addition, after dairy farmers had improved production through improved management practices, the pieces of the genetic puzzle had to be identified and put together to provide a basis for improving the genetic ability of the dairy cow to produce milk. Although this work was done throughout the country, with people working with all dairy breeds, much of the pioneering work was done in Maine by scientists such as John Gowen at the Maine Agricultural Experiment Station.

Progressive breeders everywhere participated in DHI and breed association programs, seeking breed improvement; Jersey breeders actively participated in these programs in Maine.

Although dairy farmers in Maine often operate at a disadvantage in the country as a whole in terms of climate and soil, the current position, in Maine and the U.S., of the herds of Maine's Jersey breeders is evidence that these dairy men and women men are both good farmers and outstanding Jersey breeders.

NOTES

[1]L.C. Dunn, A Short History of Genetics. The Development of Some of the Main Lines of Thought: 1864-1939. New York: McGraw-Hill, 1965. 51, 65-66.

[2]Dunn, 88, 94-95.

[3]Dunn, 118.

[4]Dunn, 99.

[5]Ivar Johannson, Genetic Aspects of Dairy Cattle Breeding. Urbana: University of Illinois Press, 1961. x-xi.

[6]Johannson, x-xii, 1, 136-137.

[7]Johannson, 148.

[8]E. Parmalee Prentice, Breeding Profitable Dairy Cattle. A New Source of National Wealth. Boston and New York: Houghton Mifflin Company, 1935. 8.

[9]Prentice, BPDC, 9-10.

[10]Prentice, BPDC, 10.

[11]See E. Parmalee Prentice, American Dairy Cattle. Their past and Future. New York: Harper and Brothers Publishers, 1942; History of Channel Island Cattle. Guernseys and Jerseys. Williamstown, Massachusetts: Mount Hope Farm, 1940.

[12]Prentice, BPDC. In the Frontispiece, Prentice has a picture titled "Guernsey Cattle at Pasture" which he said was copied from a painting in the office of the Secretary of the Royal Guernsey Agricultural and Horticultural Society on the Island of Guernsey. Of the six dairy cows in the picture, three would be identified today as Guernseys while three are obviously Holsteins. On page 70 he said that when Lewis F. Allen published his book in 1875, "black-and'white were again conspicuous among the recognized colors of the Guernsey cattle, along with other dark colors, including the roan color and rounded form to which Mr. Allen objected on the ground that they 'savor of a Shorthorn cross'."

A seventh cow in the picture, only partially visible, resembles a Shorthorn. On page 212 is a picture of "Blossom-A Super-Guernsey". She and two other cows are of Guernsey type and color, but four others are undoubtedly Holsteins.

[13]Prentice, BPDC, 60.

[14]Prentice, BPDC, 76-77.

[15]Prentice, BPDC, 78.

[16]Prentice, BPDC, 77-79.

[17]Prentice, BPDC, 84-85.

[18]Prentice, BPDC, 88-89.

[19]R.M. Gow, The Jersey. An Outline of Her History During Two Centuries - 1734-1935. New York: American Jersey Cattle Club, 1936. The results of the private, official and confirmed butter tests to July 15, 1902 are available at the office of the American Jersey Cattle Club.

[20]Minutes, AJCC Executive Committee, 31 March 1898.

[21]Minutes, Board of Directors, 4 May 1898 and 2 May 1899.

[22]Minutes, Board of Directors, 30 April 1901.

[23]Jersey Bulletin, 4 September 1901.

[24]Jersey Bulletin, 30 April 1902.

[25]Jersey Bulletin, 30 April 1902.

[26]Jersey Bulletin, 30 April 1902.

[27]Jersey Bulletin, 7 May 1902.

[28]Jersey Bulletin, 4 March 1903.

[29]Jersey Bulletin, 11 June 1902.

[30]Jersey Bulletin, 27 May 1903.

[31]Minutes, Executive Committee, 12 March 1902.

[32]Minutes, Executive Committee, 9 April 1902.

[33]Minutes, Board of Directors, 6 May 1902; 5 May 1903; Proceedings, AJCC Annual Meeting (35th), 6 May 1903.

[34]Jersey Bulletin, 15 November 1905.

[35]See John R. Sibley, editor, The Owl-Interest Family of Jerseys. Spencer, Massachusetts, 1929.

[36]We have omitted any tests of fewer than 200 days duration.

[37]See Hood Farm Sale catalogue (1916) and Dispersal Sale of Hood Farm Jerseys catalogue (1923) for further information on C.I. Hood's Jerseys.

[38]Dispersal Sale of Hood Farm Jerseys (1923); Clarence Day and Clyde Russell, "A Century with Jerseys in Maine", Jersey Bulletin, 5 March 1954; Register of Merit of Jersey Cattle, /First/Consolidated Volume. New York: AJCC, 1925.

[39]David C. Smith, The Maine Agricultural Experiment Station. A Bountiful Alliance of Science and Husbandry. Orono: Experiment Station, 1980. Leon S. Merrill, "Cooperative Breeders' Associations", Agriculture of Maine, 1909, 190-200.

[40]Smith, 64.

[41]J.W. Sanborn, "Breeding Problems and How to Raise the Standard in Dairy Herds", Agriculture of Maine, 1909, 201-210.

[42]Raymond Pearl, "Breeding for Production in Dairy Cattle in the Light of Recent Advances in the Study of Inheritance", Agriculture of Maine, 1909, 190-200.

[43]Smith, 66.

[44]Agriculture of Maine, 1912, 285-286.

[45]"Maine Agricultural Experiment Stations", Agriculture of Maine, 1913, 22-24; Agriculture of Maine, 1914, 222-223, 229-230; 1915, 222-229.

[46]John Whittemore Gowen, "An Invesigation of the Relation Between Milk Production and Age in Jersey Cattle", Unpublished Master of Science (biology) thesis. Orono: University of Maine, 1915.

[47]Raymond Pearl, "Report of the First Jersey Sires' Futurity Test of the Aroostook Jersey Breeds Association", Report of the Maine Agricultural Experiment Station, 1916. Bulletin 247. 37-52.

[48]Jersey Sires and their Tested Daughters. New York: AJCC, 1909. Raymond Pearl and S.W. Patterson, "The Change of Jersey Cows". Report of the Maine Agricultural Experiment Station, 1917. Bulletin 262. 145-152.

[49]Raymond Pearl, John W. Gowen, John Rice Miner, "Transmitting Qualities of Jersey Sires for Milk Yield, Butter-Fat Percentage and Butterfat", "Studies in Milk Secretion VII", Report of the Maine Agricultural Experiment Station, 1919. Bulletin 281. 89-204.

[50]John W. Gowen, Milk Secretion. The Study of the Inheritance of Milk Yield and Butter-Fat Percentage in Dairy Cattle. Baltimore: Williams and Wilkens Company, 1924. 7,5,6, 356,344-345,88. Marie Gowen and John Gowen, "Studies in Milk Secretion XIII. Relation between milk yield and butter-fat percentage of the 7-day and 365-day tests of Holstein-Friesian Advanced Registry". Maine Agricultural Experiment Station, Annual Report, 1922. Bulletin 306. 21-60.

[51]Prentice, BPDC, 93.

[52]Prentice, BPDC, 93-94.

[53]Leon S. Merrill, "Report of the State Dairy Inspector", Agriculture of Maine, 1908, 183-185.

[54]Leon S. Merrill, "Report of the Cow Testing Associations", Agriculture of Maine, 1908, 176-179.

[55]Some cows were entered in both programs, but until the 1930s and 1940s this was unusual.

[56]Prentice, BPDC, 147-150.

[57]Prentice, BPDC, 95-96, 98-100.

[58]The Herd Improvement Registry, begun in 1928, was a herd testing program but because the information it offered was not as complete as that offered by DHI tests, and low tests were not published, it was in many ways more similar to the Register of Merit than to DHI testing.

[59]H.R. Horlacher, "Genetic Viewpoint in Breeding of Dairy Cattle", Jersey Bulletin, 20 February 1935. Prentice, BPDC, 95.

[60]Tested Sires and Dams of the Jersey Breed. (Together with Herd Classification Ratings.) 1st Consolidated Volume. New York: AJCC, 1936. 2.

[61]Day and Russell, "A Century with Jerseys in Maine", 25.

[62]Donald L. Bath, et al., Dairy Cattle: Principles, Practices, Problems, Profits. 2nd edition. Philadelphia: Lea & Febiger, 1978. 101-102. John R. Campbell and Robert L. Marshall, The Science of Providing Milk for man. New York: McGraw-Hill, 1975. 113. The first volumes of List of Sires Proved in Dairy Herd Improvement Associations, covering 1935 through 1937, was published in Washington in 1937 by the USDA Division of Dairy Herd Improvement Investigations. Bureau of Dairy Industry. Miscellaneous Publication No. 272. Later volumes were published on an annual basis.

[63]List of Sires Proved..., 1935-1937. 1-3.

[64]Harry A. Herman, Improving Cattle by the Millions. NAAB and the Development and Worldwide Application of Artificial Insemination. Columbia: University of Missouri Press, 1981. 2-5.

[65]Herman, 6-8.

[66]Herman, 9-10.

[67]Clarence A. Day, Farming in Maine 1860-1940. University of Maine Studies, Second Series, No. 78. University of Maine Press, 1963. 65-69. Forty Years with the Extension Service (Manuscript). 10,82,96.

[68]Herman, 16-17.

[69]Herman, 17. Raymond Albrectsen, "Selection and Repeatability of Sires Used in Artificial Insemination", Journal of Dairy Science, 30/8. August 1947. 594-595.

[70]H.C. Dickey and Pedro Labarthe, "Predicting the Transmitting Ability of Young Dairy Sires for Milk Production, Butterfat Test, and Butterfat Production". Journal of Dairy Science, 28/12. December 1945. 893-900.

[71]H.W. Hall, H.C. Dickey, A.O. Shaw, "Selecting a Dairy Bull", Maine Agricultural Experiment Station, Annual Report, 1948-1949. Bulletin 461. 1-42.

[72]H.W. Hall, et al., Bulletin 461, 9-10.

[73]H.W. Hall, et al., Bulletin 461, 9-10.

[74]H.W. Hall, et al., Bulletin 461, 10.

[75]H.W. Hall, et al., Bulletin 461, 10.

[76]H.W. Hall, et al., Bulletin 461, 23-27.

[77]H.W. Hall, et al., Bulletin 461, 18, 28-29.

[78]H.W. Hall and H.C. Dickey, "Predicting the Transmitting Ability of Young Dairy Sires", Maine Agricultural Experiment Station Annual Report, 1954. Bulletin 530. 6.

[79]Hall and Dickey, Bulletin 530, 8-12.

[80]Walter R. Harvey and Jay L. Lush, "Genetic Correlation Between Type and Production in Jersey Cattle", Journal of Dairy Science, 35/3. March 1952. 199-213.

[81] Herman, 21. See also Charles R. Henderson, "Selecting and Sampling Young Sires", Proceedings of the 1954 Annual Convention of the National Association of Animal Breeders, Columbia, Missouri.

[82] Bath, 102-103. Herman, 22-23.

[83] Bath, 102. Herman, 21-22. S.R. Searle, "Review of the Sire-Proving Methods in New Zealand, Great Britain, and New York State". Journal of Dairy Science, 47/4. April 1964. 414-420. Charles R. Henderson, et al., "Use of Contemporary Herd Average in Appraising Progeny Tests of Dairy Bulls", Journal of Animal Science, XIII, 1954. 959.

[84] American Breeders Service was the founder of J. Rockefeller Prentice. (1902-1972), who was intellectually as well as physically the son of E. Parmalee Prentice. Stimulated by his father's research at Mt. Hope Farm to breed more productive dairy cattle, Prentice said he hoped that in his lifetime he could vindicate his father's unorthodox views on cattle improvement. Thus in 1936 he founded the American Dairy Cattle Club. The ADCC took a radical departure from the usual dairy club program of registering any animal whose sire and dam are recorded in that it required continuous records of production on cows and that each sire be measured by the performance of his daughters. Animals whodid not meet production requirements were dropped from registration. This requirement was very controversial among purebred dairy breeders of that time.

In 1943 the USDA Proved Sire List began carrying proved sires registered with the ADCC. Of the five ADCC sires proved that year, three had the "Mt. Hope" prefix.

Prentice realized the advantages which artificial insemination had for dairy cattle improvement, and in 1941 he founded the American Dairy Guernsey Associates of Northern Illinois which in 1950 became American Breeders Service. (Prentice's father had long bred Guernsey's at Mt. Hope Farm.) He also did early research on liquid nitrogen refrigeration and once, when production-record processing of several million dairy cows in USDA files was held up for lack of funds, he contributed $150,000 to keep the program moving. Herman, 327-328.

[85] Herman, 24-25. John F. Lasley, Genetics of Livestock Improvement. 2nd ed., Englewood cliffs: Prentice-Hall, 1972. 396-397. Cole, 224. Bath, 138-140.

[86] Bath, 140.

[87]Bath, 141-142. Campbell, 117. Cole, 224.

[88]Bath, 103-104.

[89]Bath, 106.

[90]Bath, 106-107. See also "The USDA-DHIA Modified Contemporary Comparison Sire Summary and Cow Index Procedures", USDA Production Research Report. No. 165. March 1976.

[91]Basil R. Eastwood, "Interpreting the New USDA-DHIA Sire Summaries", Jersey Journal, 5 May 1975.

[92]Morris Ewing, "Jersey Sire Selection. Young Sire Sampled and Breeder Proven", Jersey Journal, 20 August 1975.

[93]Robert C. Lamb and Cleon Kotter, New Sire Summaries--A Tool for Dairymen", Jersey Journal, 20 August 1975.

[94]Elmer Clapp, Jr., "Why an A.I. Proved Sire Program?" Jersey Journal, 20 August 1975.

[95]This opinion was expressed to me by Eugene Barton, the Superintendent of Records of the American Jersey Cattle club.

[96]Elmer Clapp, Jr., "Almost Missed", Jersey Journal, July 1982. "The Cow that Saved 'Chocolate Soldier's' Neck", Jersey Journal, devoted to New England breeders, has several items devoted to Chocolate Soldier. The cover has a photograph of three embryo transplant daughters born to a cow owned by Greg and Kay Fowler of Spring Brook Farm in Cumberland Center.

[97]"Proven Sons of Observer Chocolate Soldier", "The Sire of Sons", "The Cow that Saved 'Chocolate Soldier's' Neck", Jersey Journal, July 1982. See also Jersey Journal, 5 March 1975, for the list of five Observer Chocolate Soldier sons, four of them proved, then being used in Henry Black's breeding program.

[98]"DHIR Lactations", Jersey Journal, "DHIR 1981" issue. In the Winter 1983 Hoard's Dairyman Bull List, of the 33 Jersey sires listed, 4 have familiar Maine prefixes: 3 "Briarcliffs" and 1 "Highland".

[99] The farms visited in the Spring of 1984 were

1. The Pike and Palmer Families
   Highland Farm
   Cornish

2. Greg and Kay Fowler
   Spring Brook Farm
   Cumberland Center

3. Helen and Henry Black
   Briarcliff Farm
   West Baldwin

4. Albert and Lynette Bradford
   Goodnow Jersey Farm
   Turner

5. Andrew Russell
   Pine Hill Farm
   Winslow

6. Mark and Vicki Russell
   Potter's Brook Farm
   Litchfield

7. Colby and Lois Whitcomb and Family
   Springdale Jersey Farm
   Waldo

[100] Fourteen Maine herds are on this list.

[101] The Libby family of Sebago Lake has had registered Jerseys for a similar length of time.

[102] See W. R. Baron and Anne E. Bridges, "Making Hay in Northern New England: Maine as a Case Study". <u>Agricultural History</u>.

[103] <u>Maine Dairy Newsletter</u>, March 1982; <u>Hoard's Dairyman</u>, October 10, 1982; <u>Jersey Journal</u>, April 1983.

TABLE 1. TOP MAINE JERSEY BREEDERS THAT MET MINIMUM DHIR REQUIREMENTS FOR 1982 and 1983.

FARM	HERD SIZE, HOUSING, AND MILKING FACILITIES					
	Milking Cows	Heifers	Calves	Bulls	Total	Housing Milking
Highland Farm Pike and Palmer Cornish	140	80	50	5	275	Free Stall Parlor
Spring Brook Farm Greg and Kay Fowler Cumberland Center	115	75	25	5	220	Free Stall Parlor
Briarcliff Farm Henry and Helen Black West Baldwin	120	60	30	5	205	Free Stall Manure Pack Parlor
Springdale Farm Whitcomb Family Waldo	130	42	39	10	221	Free Stall Ties Pipeline
Goodnow Jersey Farm Albert and Lynette Bradford Turner	32	28		1	61	Ties/ Pipeline
Pine Hill Farms Andrew Russell Winslow	50	50		0	100	Ties/ Pipeline
Potter's Brook Farm Mark and Vicki Russell Litchfield	47	24	17	0	88	Ties/ Pipeline

TABLE 2. TOP JERSEY BREEDERS IN MAINE

FARM	AMOUNT OF ACREAGE				STORAGE SYSTEMS[1]
	Corn	Grass	Legume	Pasture	
Highland Farm	130	—— 90 ——		30	Haylage, Corn Silage Horizontal Silos, Hay, Standard Bales.
Spring Brook Farm	0	———— 350 ————			Haylage, Horizontal Silos, Hay, Standard Bales.
Briarcliff Farm	100	———— 50 ————			Haylage and Corn Silage, Horizontal Silos. Hay, Small Standard Bales and some Large Round Bales.
Springdale Farm	40	125	35	100	Haylage and Corn Silage, Horizontal Silos. Hay, Small Standard Bales and some Large Round Bales.
Goodnow Jersey Farm	0	—— 55 ——		10	Hay, Standard Bales
Pine Hill Farm	50	45	15	30	Haylage and Corn Silage Upright Silos. Hay Standard Bales.
Potter's Brook Farm	0	—— 80 ——		50	Hay, Standard Bales

[1]All of the breeders interviewed said they do a forage analysis at least once a year.

TABLE 3. 1982 DHIR JERSEY HERD AVERAGES IN MAINE.

All averages are equal to or exceeding breed average of 12,064 pounds of milk and/or 578 pounds of fat.

FARM	TOWN	COW NUMBERS	DHIR AVERAGE MILK (lb)	AVERAGE FAT (lb)	PERCENT FAT
Victor Bissell	Newport	36	14,125	723	5.16
The Blacks	W. Baldwin	88	13,724	578	4.21
George Gates	E. Vassalboro	25	12,341	550	4.46
The Bradfords	Turner	25	17.452	855	4.90
F. & M. Greenwood	Buckfield	20	13,650	633	4.64
Pikes & Palmers	Cornish	131	15,146	709	4.68
Gordon Libby	Sebago Lake	59	12,494	605	4.84
Pine Hill	Winslow	44	14,623	709	4.85
Potter's Brook	Litchfield	31	13,856	625	4.51
Spring Brook	Cumberland Center	84	12,923	640	4.95
Springdale Farm	Waldo	95	14,176	667	4.71
Univ. of Maine	Orono	28	11,818	584	4.94
J. & Kay Wood	Newport	43	14,347	708	4.93
James Young	Buckfield	30	14,600	674	4.61

Source: Jersey Journal, April 1983. p. 21. The list contained a total of 309 herds. Only 5 states exceeded Maine in the number of herds entered.

TABLE 4. 1983 DHIR JERSEY HERD AVERAGES IN MAINE

All averages are equal to or exceeding breed average of 12,234 pounds of milk and/or 578 pounds of fat.

FARM	TOWN	COW NUMBERS	DHIR AVERAGE MILK (lb)	AVERAGE FAT (lb)	PERCENT FAT
Victor Bissell	Newport	41	14,870	727	4.89
The Blacks	W. Baldwin	74	14,739	648	4.39
George Gates	E. Vassalboro	23	12,273	554	4.51
The Bradfords	Turner	25	16,999	838	4.93
F. & M. Greenwood	Buckfield	26	13,464	628	4.67
Pikes & Palmers	Cornish	131	14,739	708	4.80
Gordon Libby	Sebago Lake	58	12,810	612	4.78
Pine Hill	Winslow	47	15,329	740	4.83
Potter's Brook	Litchfield	42	13,731	604	4.4
M. Ross	Thorndike	11	12,099	616	5.09
Spring Brook	Cumberland Center	75	13,505	633	4.69
Springdale	Waldo	91	14,544	681	4.68
J. & K. Wood	Newport	39	14,565	721	4.95
James Young	Buckfield	27	14,609	692	4.74

Source: Jersey Journal, April 1984. p. 41. The list contained a total of 309 herds. Only six states exceeded Maine in the number of herds entered.

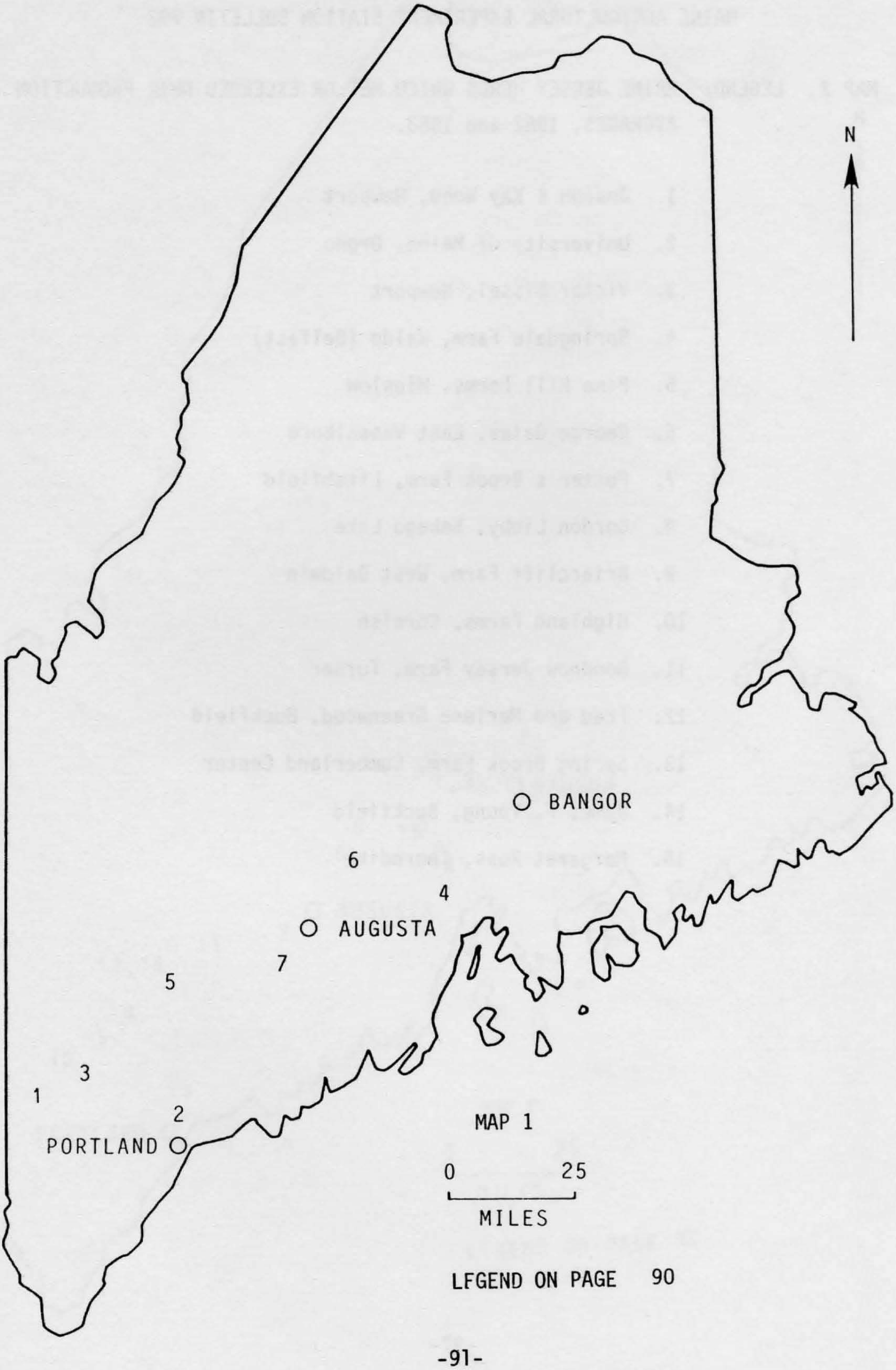
TABLE 5. LEADING ACTIVE SIRES WITH MAINE JERSEY FARM PREFIXES

This list is based on the July 1984 USDA-DHIA Sire Summary, ranked by Predicted Difference for dollars (PD$). Dairy Herd Management, September 1984.

SIRE	NUMBER	PD82$	PD82MILK	PD82%	PD82FAT	TOT HERD	TOT DAU	%RPT
Briarcliffs Soldier Boy	620738	117	946	-.10	33	226	759	96
Briarcliffs Silver Scorpio	632798	110	704	.04	38	11	20	39
Briarcliffs Black Magic	624896	102	917	-.15	25	217	618	94
Highland Observer Spirit	628290	85	710	-.09	23	90	144	89
Briarcliffs SS Early Settler	631158	73	551	-.04	22	10	27	52
Briarcliffs Brave Soldier	621333	69	787	-.21	11	285	850	97
Astrids Gen of Phf	632449	60	428	-.01	19	47	70	75
Springdale Surville Playboy	631715	46	164	.11	21	12	82	64

MAP 1. LEGEND: LOCATION OF CURRENT HERDS PROFILED

1. Highland Farms
   Cornish
2. Spring Brook Farm
   Cumberland Center
3. Briarcliff Farm
   West Baldwin
4. Springdale Farm
   Waldo (Belfast)
5. Goodnow Jersey Farm
   Turner
6. Pine Hill Farms
   Winslow
7. Potter's Brook Farms
   Litchfield

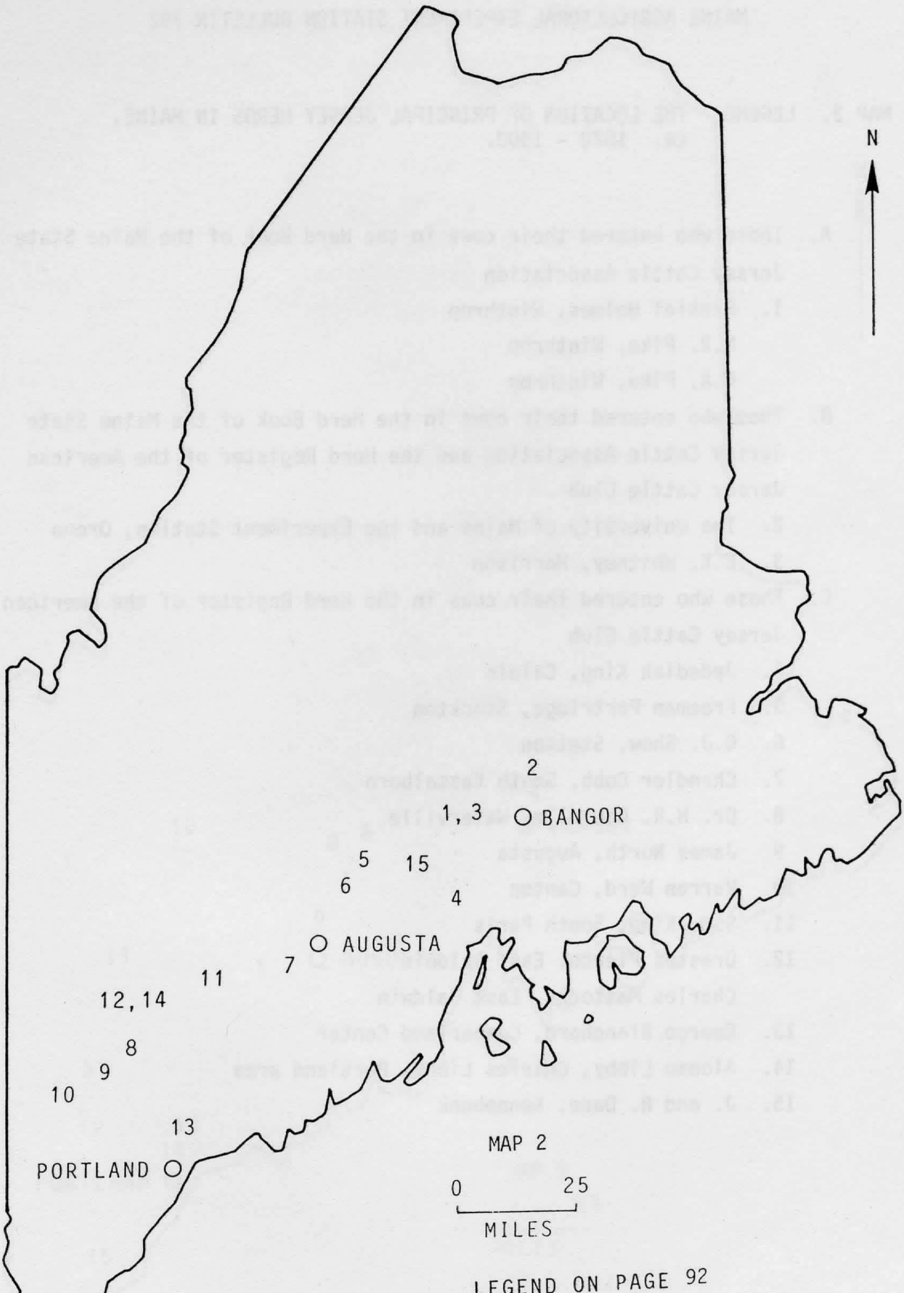


MAP 1

LFGEND ON PAGE 90

MAP 2. LEGEND: MAINE JERSEY HERDS WHICH MET OR EXCEEDED DHIR PRODUCTION AVERAGES, 1982 and 1983.

1. Joseph & Kay Wood, Newport
2. University of Maine, Orono
3. Victor Bissel, Newport
4. Springdale Farm, Waldo (Belfast)
5. Pine Hill Farms, Winslow
6. George Gates, East Vassalboro
7. Potter's Brook Farm, Litchfield
8. Gordon Libby, Sebago Lake
9. Briarcliff Farm, West Baldwin
10. Highland Farms, Cornish
11. Goodnow Jersey Farm, Turner
12. Fred and Merlene Greenwood, Buckfield
13. Spring Brook Farm, Cumberland Center
14. James F. Young, Buckfield
15. Margaret Ross, Thorndike



MAP 2

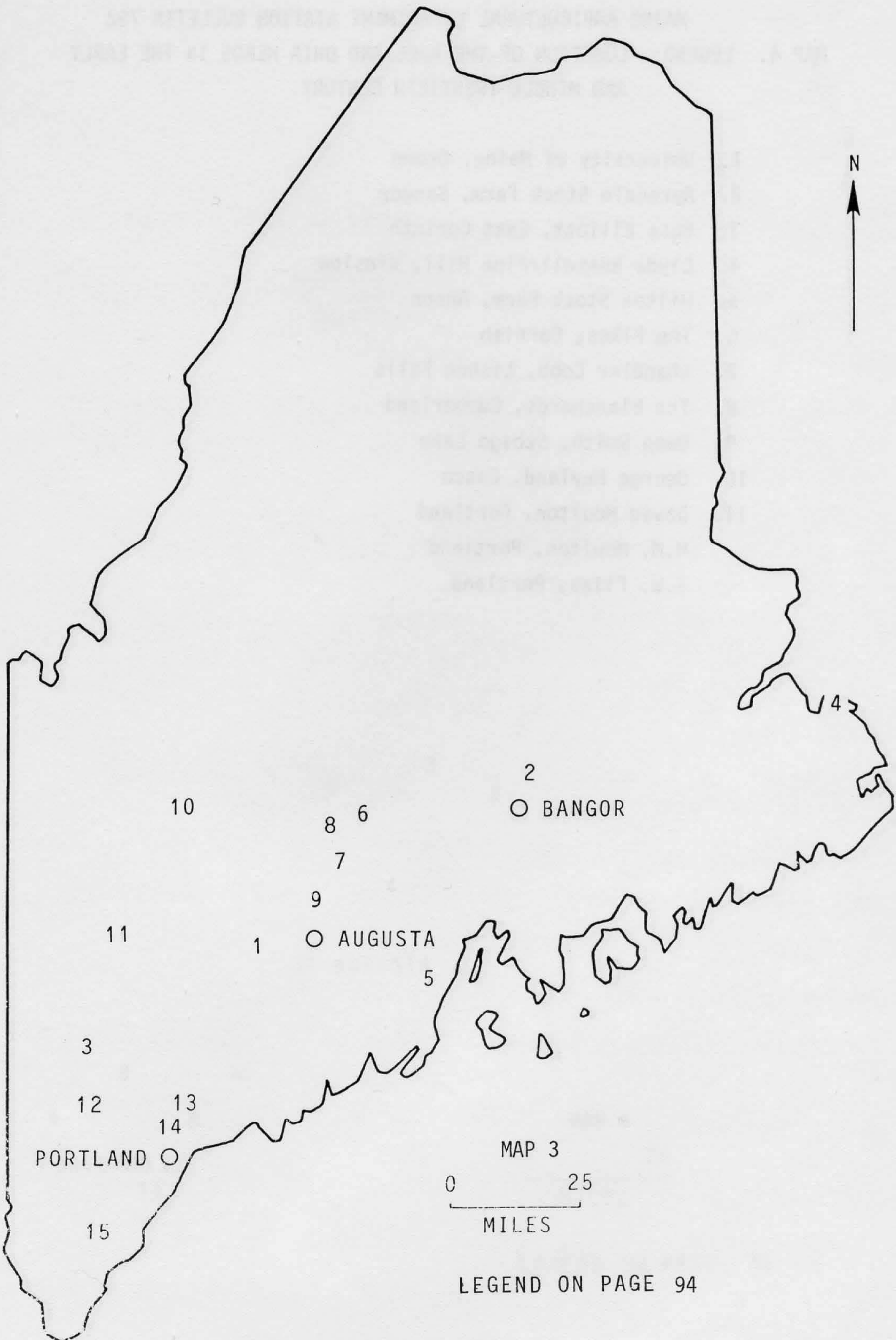
LEGEND ON PAGE 92

MAP 3. LEGEND: THE LOCATION OF PRINCIPAL JERSEY HERDS IN MAINE, ca. 1870 - 1900.

A. Those who entered their cows in the Herd Book of the Maine State Jersey Cattle Association
   1. Ezekiel Holmes, Winthrop
      N.R. Pike, Winthrop
      G.A. Pike, Winthrop

B. Those who entered their cows in the Herd Book of the Maine State Jersey Cattle Association and the Herd Register of the American Jersey Cattle Club
   2. The University of Maine and the Experiment Station, Orono
   3. E.K. Whitney, Harrison

C. Those who entered their cows in the Herd Register of the American Jersey Cattle Club
   4. Jedediah King, Calais
   5. Freeman Partridge, Stockton
   6. G.J. Show, Stetson
   7. Chandler Cobb, South Vassalboro
   8. Dr. N.R. Boutelle, Waterville
   9. James North, Augusta
   10. Warren Ward, Canton
   11. S.M. King, South Paris
   12. Orestes Pierce, East Baldwin
       Charles Mattocks, East Baldwin
   13. George Blanchard, Cumberland Center
   14. Alonzo Libby, Charles Libby, Portland area
   15. J. and N. Dane, Kennebunk

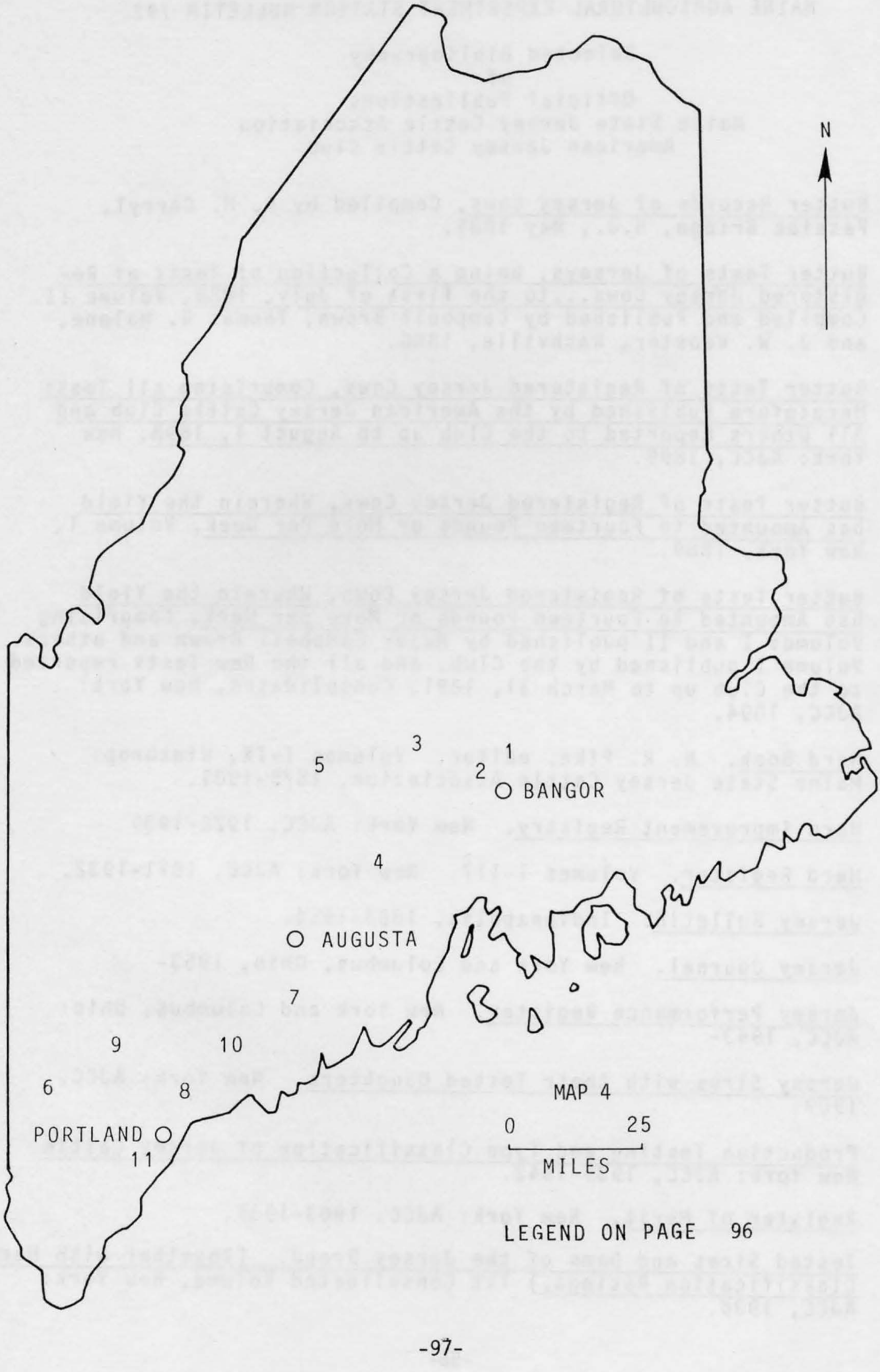


MAP 3

LEGEND ON PAGE 94

MAP 4. LEGEND: LOCATION OF THE AJCC AND DHIA HERDS IN THE EARLY AND MIDDLE TWENTIETH CENTURY.

1. University of Maine, Orono
2. Ayredale Stock Farm, Bangor
3. Ross Elliott, East Corinth
4. Clyde Russell/Pine Hill, Winslow
5. Hilton Stock Farm, Anson
6. The Pikes, Cornish
7. Chandler Cobb, Lisbon Falls
8. The Blanchards, Cumberland
9. Owen Smith, Sebago Lake
10. George Meyland, Casco
11. David Moulton, Portland
    H.M. Moulton, Portland
    E.W. Files, Portland


N
3
1
5
2
BANGOR
4
AUGUSTA
7
9
10
6
8
MAP 4
0
25
PORTLAND
11
MILES
LEGEND ON PAGE 96

Selected Bibliography of Official Publications Maine State Jersey Cattle Association American Jersey Cattle Club

Butter Records of Jersey Cows, Compiled by F. M. Carryl, Passiac Bridge, N.J., May 1885.

Butter Tests of Jerseys, being a Collection of Tests of Registered Jersey Cows...to the first of July, 1886, Volume II. Compiled and Published by Campbell Brown, Thomas H. Malone, and J. W. Webster, Nashville, 1886.

Butter Tests of Registered Jersey Cows, Comprising all Tests Heretofore Published by the American Jersey Cattle Club and All Others Reported to the Club up to August 1, 1898, New York: AJCC, 1899.

Butter Tests of Registered Jersey Cows, Wherein the Yield has Amounted to Fourteen Pounds or More Per Week, Volume 1, New York, 1889.

Butter Tests of Registered Jersey Cows, Wherein the Yield has Amounted to Fourteen Pounds or More per Week, Comprising Volumes I and II published by Major Campbell Brown and others, Volume I published by the Club, and all the New Tests reported to the Club up to March 31, 1891, Consolidated, New York: AJCC, 1894.

Herd Book. N. R. Pike, editor. Volumes I-IX, Winthrop: Maine State Jersey Cattle Association, 1876-1901.

Herd Improvement Registry. New York: AJCC, 1928-1939.

Herd Register. Volumes 1-117. New York: AJCC, 1871-1932.

Jersey Bulletin. Indianapolis, 1883-1954.

Jersey Journal. New York and Columbus, Ohio, 1953-

Jersey Performance Register. New York and Columbus, Ohio: AJCC, 1943-

Jersey Sires with their Tested Daughters. New York: AJCC, 1909.

Production Testing and Type Classification of Jersey Cattle. New York: AJCC, 1939-1942.

Register of Merit. New York: AJCC, 1903-1939.

Tested Sires and Dams of the Jersey Breed. (Together with Herd Classification Ratings.) 1st Consolidated Volume, New York: AJCC, 1936.