EVALUATION OF RESEARCH ON JERSEYS

by

R. E. McDowell

Final Report
Under Memorandum of Agreement
between
North Carolina Agricultural Research Service
College of Agriculture and Life Sciences
North Carolina State University
Raleigh, North Carolina
and
The American Jersey Cattle Club
Columbus, Ohio

Titled
Evaluation of Research on Jerseys

1988

PREFACE

Most reviews on topics in dairying are limited in scope with statements and conclusions supported by precise documentation. To follow this procedure to include nearly 1000 references would make an unwielding document. After considerable deliberation, coupled with consultation from scientists and breeders in the U.S. and abroad on the most practical approach, it was decided to concentrate on an "interpretative summary" because data from various locations did not lend themselves to pooling. Emphasis is placed on comparisons among breeds or breed groups to reflect supportable comparative advantages of Jerseys and possible limitations which can be tackled in future efforts. Occasionally, points or conclusions from technical data are supported by observations of the author and colleagues.

Terms of reference from The American Jersey Cattle Club (AJCC) were broad. Initial consideration was given to use largely observations from the U.S. but it was found that in most studies Jerseys were used to increase number of animals for treatment groups instead of full focus on any uniqueness of Jersey. The search was expanded to a worldwide scope on the premise that the utility of the breed could be better appreciated by examining in the wide range of environments to which Jersey and its crosses have been or are being subjected to.

No literature search of the proposed scope can be complete particularly when numerous data sets never get to press since they lie buried in non-Ph.D. theses, abstracts for meetings, field day reports, etc.; however, I have never taken an assignment in which cooperation and free sharing was as great. Scientists from around the world were very responsive in taking time to provide copies of reports and in writing letters in response to inquiries.

The initial search turned up approximately 4,000 citations but there was no usable computer program to edit for duplication or value of content. Hand sorting was required. Near 2,000 were dropped as duplicates or near so, plus about 1,000 as not containing significant data. What is considered a useful bibliography consists of about 1000 references published from 1970-1987. These have been indexed under 162 major topics and approximately an equal number of subheadings for those seeking supportive details.

Expectations for this report are: 1) those concerned with policy for breeders or serve as reviewers of research proposals will accept the comments in the spirit offered, that of some closer examination of average performance of the breed; and 2) scientists will have increased interest in research with Jerseys and concentrate more on "researching the breed" to enhance its capabilities, especially in those traits showing limitations.

Although many contributed, the author assumes full responsibility for oversights and errors in interpretation.

Thanks are expressed to the AJCC for the opportunity and for their support of the study. Special gratitude is expressed to those who patiently responded to inquiries and provided documentation. I am grateful to Mr. Karl Schneider, Reference Librarian, National Agricultural Library, Beltsville, Maryland for his diligence in the search of the DIALOG database files; to Ms. Nancy Hill for the editing, evolving the bibliography and development of guidelines for use of computers in searching the bibliography; and Dr. John Wilk of NCSU for advice on evaluations of research.

Table of Contents

Introduction 1
Framework of the Review 2
Breed Characteristics 3
Growth Rate 3
1. Birth Weight 3
2. Growth of Heifers 3
3. Postpartum Changes 4
Milk Yield 5
Milking Rate 6
Milk Composition 7
1. Colostrum 7
2. Fat Characteristics 7
3. Fatty Acids 7
4. Protein Components 7
5. Milk Energy 8
6. Minerals 8
7. Characteristics of Cheese 8
Health 8
1. Mastitis 9
2. Milk Fever 9
3. Udder Edema 10
4. Displaced Abomasum 10
5. Laminitis 10
Stayability 10
Mortality 11
Age at Puberty 12
Age at First Calving 12
Gestation Length 12
Calving Interval 13
Calving Ease and Dystocia 14
Lactation Length 14
Breeding Efficiency 15
Udder Characteristics 16
1. Teat Size 16
2. Udder Volume 17
3. Udder Strength 17
Blood Constituents 17
Nutrition 18
Body Composition 20
Temperature Stress 21
Biochemical Polymorphisms 22
Semen Characteristics 22
Economics 23
Beef Production 23
1. Pure Jersey 23
2. Jersey Sired Crosses 24
3. Crosses from Jersey Cows 25
4. The Crossbred Cow 25
Crossing For Milk Production 26
1. Jersey Dam 27
2. Jersey as Sire 27
Other Traits 29
1. Coat and Hair Characteristics 29
2. Other Physiological Characteristics 29
3. Poll vs. Horns 30
4. Type Score 30
5. Temperament 30
6. Draft Power 30
Selection 30
1. Heritability 30
2. Results from Selection 31
Some Indications 34
Appendix I. Sources For Literature Search
Appendix II General Guidelines for Use: Computerized Bibliography and Indexes on Jerseys
Appendix III. INDEX.ASK, General Index by Subject Matter
Appendix IV. BREEDIND.ASK, Index by Breed
Appendix V. COUNTRYI.ASK, Index by Country
Appendix VI. Listing of Bibliography Alphabetically by Author
Appendix VII. Computer Disks

INTRODUCTION

The value of purebred Jersey cattle for dairying and their high combining ability with other breeds or types to produce crossbreds is globally renowned. There are large populations of purebreds in more than 12 countries, grades in approximately 30 countries and the breed has been used in crossbreeding or grading-up programs for either meat or dairy production in at least 46 countries (Table 1). The Jersey is just slightly behind Holstein (U.S. and Canada) and Friesian (Holstein type in Europe, Australia, New Zealand and other countries) in extent of sampling for dairy programs. Jerseys have been evaluated against other recognized breeds and local native type cattle, used for crossing programs and its genes incorporated into new strains or breeds of cattle developed from a crossbred foundation. These programs involved 77 breeds or types of cattle in the period of study (Table 2). Among the notable new breeds encompassing Jersey breeding are the Jamaica Hope (about 80% Jersey), developed in Jamaica, the Australian Milking Zebus (75% Jersey) of Australia, Improved Rhodope, Bulgaria (50% Jersey) and Improved Russian Black Pied, USSR (75% Jersey).

TABLE 1. COUNTRIES REPORTING RESEARCH ON JERSEYS

Asam	Kenya
Australia	Libya
Bangladesh	Malaysia
Brazil	Mali
Bulgaria	Mexico
Canada	Netherlands
Colombia	New Zealand
Costa Rica	Norway
Cuba	Pakistan
Czechoslovakia	Poland
Denmark	Rumania
Egypt	Saudi Arabia
Ethiopia	South Africa
France	Sri Lanka
Ghana	Sudan
German Democratic Republic	Sweden
Germany, Federal Republic	Turkey
Haiti	Uganda
Hungary	Venezuela
India	United Kingdom
Iran	United States
Ireland	USSR
Jamaica	Yugoslavia
Japan	

Even though Holsteins and Jerseys originated from small populations in Germany and the Channel Islands, there appears greater similarity among pure Jersey types around the world than Holstein. Perhaps this is due to more common objectives of selection programs; Jerseys principally for milk production, versus meat, milk and in a few areas draft power in Holsteins. For Jerseys, differences in mature size, age at puberty, mortality rate and breeding efficiency among countries appears small. There are, however, differences in milk fat content, e.g., 6.0% in Denmark vs. 4.5 - 5.0% in the U.S., New Zealand and Australia. Milk yield tends to be higher in the U.S. and Denmark but more modest in Australia, New Zealand and South Africa.

Development of the breed in the U.S. is quite well described by Becker (1973).

This is an appropriate time to re-examine the strategy of selective breeding in Jersey cattle. It is established that consumption of fluid milk on per capita basis in the U.S., Canada and Western Europe is declining with rising income. New markets and consumer attractive products are needed to maintain national herds in countries with surplus dairy products. Evidence from Third World countries clearly shows that as national income increases, elasticity of demand for milk products becomes greater than 1.0. For instance, over the past decade in Taiwan consumption of the traditional food, rice, declined near 40% and is replaced by milk products, meat, fruits and vegetables. Domestic milk production trebled over the past 42 months. Imports of milk products into countries of West Africa has expanded to over $200 million per year and is rising by 10% per annum, thereby offering tremendous new markets if economic conditions in these countries can be improved. Good dairy breeds producing efficiently are needed to establish and maintain viable relations between producers and consumers in all countries.

TABLE 2. CATTLE BREEDS OR NEW STRAINS JERSEYS COMPARED TO OR USED IN DEVELOPMENT OF NEW GROUP

Aberdeen-Angus (Europe)	Limousin
Angus (U.S.)	Maine-Anjou
Aquitaire Blond (New Zealand)	Meuse-Rhine-Yssel (Netherlands)
Ayrshire	Montafon (Czechoslovakia)
Baladi (Egypt)	N'Dama (Mali)
Barca (Ethiopia)	North European (Australia)
Black-eared White (Colombia)	Norwegian Red (Norway)
Blanco-Oreiinegro (Colombia)	Pied Lowland (USSR)
Boran (Kenya)	Pinzgau (Czechoslovakia)
Brahma (U.S.)	Polish Black and White (Poland)
Brown Swiss	Polish Red (Poland)
Bulgarian Brown (Bulgaria)	Polish Red and White (Poland)
Canchin (Brazil)	Polled Hereford (U.S.)
Caucasian Brown (USSR)	Pie Rouge (USSR)
Charolais	Rathi (India)
Chiania	Red Sindhi (India)
Damietta (Egypt)	Red Steppe (USSR)
Danish Jersey (Denmark)	Rhodope (Bulgaria)
Danish Red (Denmark)	Rumanian Brown (Rumania)
Dexter (UK)	Russian Black Pied (USSR)
East German Black Pied	Sahiwal (India, Pakistan)
European Red Brachyceras (USSR)	Shorthorn
Friesian (Europe, Australia)	Simmental
Georgian Mountain (USSR)	Sinhala (Sri Lanka)
German Black Pied (West Germany)	Slovakian Pied (Czechoslovakia)
Gir (India)	Slovakian Pinzgarr (Czechoslovakia)
Guernsey	Slovak Spotted (Czechoslovakia)
Hariana or Harayna (India)	Sofia Brown (Bulgaria)
Hereford	South Devon (U.K.)
Holstein-Friesian	Swedish Friesian (Sweden)
Holstein (U.S.)	Swedish Jersey (Sweden)
Horro (Ethiopia)	Swedish Poll (Sweden)
Hungarian Pied (Hungary)	Swedish Red and White (Sweden)
Hungarofriz (Hungary)	Tharpakar (India)
Jamaica Hope (Jamaica)	West Flemish Red (Poland)
Kankrej (India)	West African Shorthorn (Poland)
Kedah-Kelantan (Malaysia)	Zebu (Bos indicus, no specific breed)
Kortroma (USSR)	Zwartbont (Netherlands)
Latvian Brown (USSR)	

FRAMEWORK OF THE REVIEW

The Memorandum of Agreement with The American Jersey Cattle Club (AJCC) for this review listed as outputs: 1) preparation of a computerized bibliography of pertinent reports on the performance of Jerseys; 2) provide an interpretative summary on where the breed stands in relation to competitive breeds; and 3) provide suggestions on some points for possible focus in research to enhance the value of the breed.

Appended to this report is a computerized bibliography indexed by relevant topics along with guidelines for use on small computers. Due to time and costs, there were the options of screening research reports from the U.S. over the past 40 to 50 years or using a lesser time frame but more extended scope. Because of the low number of reports on Jerseys in the U.S. during the past two decades, and the need to identify, insofar as possible, comparative advantages or limitations of the breed for domestic and world markets, it was deemed most useful to conduct a broad search.

Appendix 1 describes the main resources used and identifies some of the problems encountered. The printed bibliography lists about 1000 references selected from DATALOG databases or furnished following inquiries to researchers. Where available, abstracts are included. Abstracts for a number of titles, particularly from Eastern European countries were not available in English but the titles and authors are included to illustrate the scope of activities on Jerseys. The bibliography also includes numerous citations on crossbreeding for meat or milk production. Some may be reluctant to support the value of including crossbreeding but the counter is that reports on crossbreeding serve to broaden conclusions on performance, especially the utility of a breed, in combining its characteristics with other breeds. Results from experiences in crossbreeding can also be indicative of which traits will most rapidly respond to selection.

The discussion to follow is sorted by topics, accompanied on occasion by tables to illustrate observations. Major emphasis is given to reports with more than Jerseys involved. There are numerous reports with one or more experimental treatments between groups of Jerseys or where Jerseys were used to fill numbers in experimental groups. These types of studies prevail widely in nutritional research. Such tests have some value but the position is taken that breed comparisons serve as the best base to appreciate possible comparative advantages or shortfalls of any breed. Although of significance to U.S. breeders, type scoring was not made a focal point as breed comparisons would not have a common base.

BREED CHARACTERISTICS

Topic headings are for convenience of readers and not arranged by priority.

GROWTH RATE

1. Birth Weight

Jersey cows in the U.S. produce female calves at birth equivalent to 5.5-6.5% of their non-pregnant body weight. Males are slightly higher, 6.2 - 6.8%. Yield of calf in relation to dam varies some among countries, Denmark 6.0-6.4%, Australia 5.2-5.4% and New Zealand 5.1-5.6%. Environmental effects influence calf birth weight, especially low nutrition and heat stress. In Jamaica and India, Jersey females average up to 6.5% of dam weight but in years when feed supplies are low, calf weight may drop to <5% of cow weight. When calves are 10 to 20% below normal in weight at birth, they may eventually reach normal size if given an opportunity by high feeding. If birth weight is 25% or more below average, seldom will the animal reach accepted size (McDowell, 1987). The latter situation may occur in harsh climates and on occasion even in the U.S. when dry cows are poorly fed.

Holsteins produce female calves equivalent to 5.8-6.5% of dam weight. However, calves from Holsteins and Brown Swiss are more affected in ratio to dam weight by environmental factors influencing birth weight than Jerseys. The conclusion is that under most conditions, Jersey cows are good allocators of nutrients to fetuses in most all environments.

2. Growth of Heifers

The recommended rate of growth for Jersey females given in Table 3 are satisfactory. The "standard" corresponds closely to that of the herd at the Dairy Experiment Station located at Lewisburg, Tennessee (Table 3, Tennessee), which is recognized as an excellent performing herd. Many of the experiments reviewed conveyed the impres-

TABLE 3. RECOMMENDED GROWTH RATE FOR JERSEYS UP TO 24 MONTHS

	Recommended			
Age (mo)	Body wt (kg)	Heart girth (cm)	Height at withers (cm)	Tennessee body weight (kg)[a]
0	25		65	--
1	32		68	33
2	50	78	75	51
4	82	95	85	85
6	127	110	95	115
8	163	120	100	151
10	200	130	105	187
12	232	139	108	220
14	259	145	110	252
16	281	149	113	275
18	304	153	115	300
20	327	158	118	--
22	350	160	120	--
24	368	165	123	--

[a]From Dairy Experiment Station, Lewisburg, TN.
Source: Purina Mills Management Recommendations (1987).

sion of disappointment that Jerseys did not gain as rapidly as larger breeds. This is a poor interpretation as clearly, the growth rate of Jerseys based on ratio of changes in weight from one time to another make the breed among the fastest growing (Table 4). Jerseys grow 16% faster than Holsteins from birth to 6 months, 6.8% faster from 6-12 months and have the same rate of development from 12 to 36 months which indicates early maturity of Jerseys. There is general agreement that Jerseys reach mature body size sooner than larger breeds (Oldenbroek, 1987; Matthews et al., 1975).

TABLE 4. GROWTH RATE OF JERSEYS AND HOLSTEIN FEMALES FROM BIRTH TO 36 MONTHS IN WEIGHT AND PERCENT CHANGE BY INTERVAL

	Jersey		Holstein	
Age	Wt (kg) period end	% change	Wt (kg) period end	% change
Birth to one year				
0-30	33	28.6	54	22.9
31-60	46	41.7	73	35.6
61-90	63	35.2	96	32.5
91-120	82	31.1	123	27.3
121-150	104	26.0	151	23.3
151-180	126	21.4	179	18.3
181-210	148	17.3	205	14.7
211-240	168	13.5	230	11.9
241-270	185	10.6	252	9.9
271-300	202	9.1	275	9.0
301-330	218	8.1	297	8.1
331-365	236	7.9	323	6.2
1-3 years				
12-15	265	12.3	368	14.0
15-18	300	13.2	418	13.7
18-21	337	12.4	472	12.8
21-24	372	10.5	515	9.2
24-27	382	2.7	528	2.4
27-30	397	4.0	543	2.8
30-33	415	4.4	565	4.2
33-36	431	3.8	593	4.5

Source: Values compiled from > 20 references.

Jerseys also tend to excel Holsteins in rate of change with age in skeletal dimensions as illustrated in Table 5. For three body circumferences (forechest, rear chest and paunch), Jerseys were 1.3% slower than Holsteins at 3 months but

TABLE 5. RATE OF MATURITY OF JERSEYS VS. HOLSTEINS FOR BODY DIMENSIONS IN RELATION TO MATURE SIZE (%) DEVIATION FROM HOLSTEIN, (+) FASTER THAN HOLSTEIN, (-) SLOWER

	Age (mo)				
	3	6	12	18	1st lactation
Circumferences (3)	-1.3	.4	1.7	1.3	.7
Body widths (7)	-2.3	-.5	.4	.5	.8
Body depths (3)	.6	2.3	2.6	2.6	1.7
Heights (4)	1.5	2.8	3.2	2.5	1.7
Body lengths (6)	.2	1.5	1.9	1.8	1.3

at 6, 12 and 18 months and at first lactation Jerseys exceeded Holsteins in rate of change. Based on the mean for seven measures of body width, Jerseys were most mature at first lactation. In body depths, heights and lengths, Jerseys exceeded Holsteins in rate of development. Further evidence for rapid skeletal development comes from Sweden. Using radiographic cartilages (growth plates), Jerseys closed their growth plates faster and earlier in life than for heavier breeds (Holmberg et al., 1984).

The conclusion is that although small at birth, Jerseys have a high capability for rapid acceleration in growth commencing immediately after birth. This is not characteristic of most large dairy and beef breeds. Jerseys show excellent response to feeding which is well demonstrated by tests on various levels of feeding in Poland (Gozczynski and Jasiorowski, 1981).

3. Postpartum Changes

Effects of early development on reproduction rate are characterized in other sections but for body weight, evidence from the U.S. (Ruvuna et al., 1986) and New Zealand (Bryant and MacMillan, 1985) show that following parturition Jerseys lose less in proportional body weight than other breeds. The lower loss leads to Jerseys returning to positive energy balance sooner and usually sooner commencing estrus.

Ratios of change in external and internal body dimensions and organs from first to second lactation (1:2) and from first to mature lactation (1:M) are in Table 6. Jerseys showed the least change in body weight which further indicates early maturity.

TABLE 6. RATIOS FOR JERSEY VS. HOLSTEIN IN BODY CHARACTERISTICS FIRST TO SECOND LACTATION (1:2) AND FIRST TO MATURITY (1:M)

	Jersey		Holstein	
Trait	1:2	1:M	1:2	1:M
Body weight	6.6	7.7	7.9	20.3
Circumference				
forechest	4.7	5.3	4.3	7.5
Height at withers	1.6	2.4	1.5	2.9
Abdominal fat	8.3	8.3	10.0	10.0
Thoracic fat	18.2	22.7	11.7	11.7
Weight				
Blood	12.5	25.0	12.5	25.0
Lungs	12.0	28.0	12.0	28.0
Heart	6.7	13.3	10.0	15.0
Liver	9.0	9.0	7.5	13.4
Small intestine				
Weight	5.6	14.8	4.2	6.2
Length	4.4	8.9	2.3	6.9
Inside diameter	.0	6.7	.0	6.2
Inside surface	.0	14.3	16.7	16.7
Large intestine				
Weight	5.3	21.0	3.2	9.7
Length	.0	10.0	.0	8.3
Inside diameter	.0	8.3	4.8	9.5
Inside surface	.0	.0	1.5	.0
Stomach size				
Rumen	8.9	18.9	3.5	10.5
Reticulum	8.3	25.0	10.0	12.0
Omasum	8.7	15.2	.0	7.9
Abomasum	11.1	27.8	6.7	20.0

Source: Matthews et al. (1975).

Changes in circumference of forechest, height at withers and abdominal fat are similar in both breeds, but Jerseys show a higher level of thoracic fat storage. Weight changes with maturity in blood, lungs, heart and liver show similarity in both breeds. Jerseys show about the same change in size (weight and length) of small and large intestines as Holsteins but Jerseys have greater changes in size of rumen, reticulum, omasum and abomasum. Marked changes in digestive capacity suggests Jerseys can use higher proportions of forages in their diet.

MILK YIELD

In milk yield, Jerseys usually average slightly below Guernseys and 35-58% less than Holsteins as illustrated in Table 7 for herds at the University of Florida. On an FCM basis, the deviation from Holsteins is reduced to around 20%. For Europe, New Zealand, Australia and South Africa, where there is more emphasis on fat yield, deviation from Friesians average less, e.g., 25-28% in Denmark (Table 8). In these countries, differences in FCM yield are small (< 10%). In the USSR, Jerseys were 18-30% below seven other breeds in milk yield but ranked second in FCM yield (Pankratos and Sorokin, 1985).

A significant positive correlation has been reported between body size and milk yield, e.g., Wood et al. (1980) from Britain and the Univ. of Tennessee, while others hypothesize the relationship may be near zero, e.g., at N.C. State University milk yield increased 900 kg per lactation with very small change in body weight (< 50 kg).

Several researchers suggest that Jerseys are capable of deriving 10-15% more of their energy output in milk from mobilization of body reserves (Wood et al., 1980). In Britain, Jerseys are similar to Friesians in persistency but are better than most other breeds (Wood, 1980). Breed differences in persistency need interpretation with respect to parity number as peak milk yield is lowest in first lactation but persistency is greatest.

In Libya, imported Jerseys and Friesians were compared in first lactation for milk yield in relation to body size. Jerseys averaged 7.2 kg of milk per 100 kg body weight vs. 7.0 for Friesians (Alim, 1985). Similar differences come from New Zealand and India. In the U.S., milk output per 100 kg of weight is higher for Holsteins but when feeds are limited in quantity or quality, Jerseys may have an advantage. The Jersey appears to require slightly more feed per unit of output of milk but on a milk energy basis they show comparative advantage (Davis et al., 1985).

The correlation of milk yield in lactation 1 and 2 is about .95 for Jerseys vs. .80 for Holsteins which lends further support to earlier maturity of Jerseys. A high correlation indicates sire proofs based on first lactation records can be more accurate for estimating transmitting ability of bulls and cows.

TABLE 7. BREED MEANS AND STANDARD DEVIATIONS FOR YIELDS AND MILK COMPOSITION FOR JERSEYS, GUERNSEYS AND HOLSTEINS IN UNIVERSITY OF FLORIDA DAIRY RESEARCH UNIT

	Jersey		Guernsey		Holstein	
Trait	Mean	SD	Mean	SD	Mean	SD
Days in milk	264	73	258	80	266	74
Milk yield (kg)	2764	1000	2872	1178	4434	1614
Fat yield (kg)	139	50	139	60	151	57
Solids not fat (kg)	265	88	268	110	413	124
Total solids (kg)	405	134	406	169	573	171
Protein yield (kg)	103	35	103	43	144	49
Lactose yield (kg)	161	55	166	69	263	82
% fat	5.00	.69	4.74	.67	3.42	.44
% protein	3.69	.30	3.58	.31	3.19	.23
Ratio % prot.:% fat	.75	.12	.77	.13	.95	.13
% SNF	9.36	.30	9.29	.42	8.74	.27
Ration SNF%:% fat	1.90	.25	2.00	.27	2.60	.30
% lactose	5.68	.36	5.72	.44	5.55	.32
% total solids	14.37	.90	14.03	1.00	12.14	5.77
% chloride	.137	.017	.136	.04	.141	.018
% acidity	.169	.030	.166	.022	.169	.032

Source: Simerl (1982).

TABLE 8. BREED AVERAGES FOR DAIRY BREEDS IN DENMARK

Trait	Jersey	Black & White	Red Dane	Red & White
Milk (kg)	4396	6106	5792	5587
% fat	6.17	4.05	4.18	3.88
Fat (kg)	271	247	242	180
FCM (kg)	5823	6147	5547	4935
No. cows	115,773	420,619	108,727	7,055
Age 1st calving (mo)	25	29	29	30
Calving interval (d)				
1-2	382	383	400	375
Other	368	367	380	362
Ave. age cows (yr)	4.5	4.3	4.3	4.7
% entering herd/yr	37	46	44	45
% culled/yr	34	43	43	42

Source: Nat'l Comm. on Danish Cattle Husb. (1984)

Final conclusions are not yet made on the use of recombinant bovine growth hormone (BST) as a stimulant for milk yield. Preliminary results show the response in milk yield is linear with level of dosage reaching about 20% in rise with high dosage. Thus far, response to BST among dairy breeds is similar but differences may emerge in other traits, e.g., some evidence shows treated Jerseys may maintain higher breeding efficiency, are less subject to abortion and show less stress during the summer months.

MILKING RATE

It is recognized that Jerseys can be milked out rather rapidly, e.g., A.M. and P.M. 9.21 minutes vs. 9.96 for Friesians and 9.77 for Jersey x Friesian crosses (Arre et al., 1986). But when milking time is adjusted for total yield, Jerseys tend to be slightly slower milkers, e.g., in Germany, Jerseys yielded only 10.3% of their milk during the first three minutes vs. 14.6% for Jersey crosses and 25.6% for Friesians (Fiedler and Puir, 1974).

Phillips (1986) concludes Jerseys need good stimulation - perhaps above average - for adequate let-down. Phillips found that following "good stimulation" (details not given), lactation length increased 32 days with 17% more milk and 18% more fat. It was suggested that as numbers of Friesians increases in New Zealand herds, Jerseys may be penalized in total yield for slower let-down rate resulting from inadequate stimulation. MacMillan et al. (1987) did show that as milk yield increased following selection milking time was not extended.

MILK COMPOSITION

For areas where Bos taurus breeds (European origin) predominate, Jersey milk is highest in most components associated with energy or protein (Table 7). Advantages of Jerseys hold in spite of known effects of age of cow, stage of lactation, feeding level, season of calving and environmental temperature on milk constituents as no breed interaction effects are revealed in the literature. Additional comments are offered on other components which can be of value in uses of milk.

1. Colostrum

Jersey milk immediately after calving is higher in total solids, protein and specific gravity than Holstein colostrum. Acidity and ash are relatively high in colostrum, then gradually declines with advancing lactation. Breed differences in these traits are undetectable. Lactose content is low in colostrum but increases as lactation progresses. Jerseys exceed Holsteins in lactose at all stages of lactation (Kohayashi et al., 1986).

Total immunoglobulin content of colostrum in milk from Ayrshire, Brown Swiss, Guernsey, Holstein and Jersey immediately after calving was 7.8, 6.7, 3.5, 5.6 and 9.0%. Jersey colostrum is highest in IgG (6.65%), IgA (1.86%), and IgM (0.53%). High calf mortality and early health problems may be related to low IgA and IgM in colostrum. Colostral total Ig is lower for all breeds at first calving than in subsequent lactations (Muller and Ellington, 1981).

There is general agreement that the solids content, coupled with immunological properties of Jersey colostrum, makes it good in several respects for feeding neonatal young, however, the protein to fat ratio may be lower than desired as will be discussed later.

2. Fat Characteristics

The color of fat in cream is affected by season, usually richest in fall and winter. Jersey cream contains 11.1 - 16.3 mu of carotene per gram vs. 3.2 - 5.1 for Friesians (Keen and Uddy, 1980). Where comparisons have been made with Holsteins or Friesians, Jersey milk fat globules are larger. This too adds to milk color. Bida (1981) and Ioannisyam (1985) have recommended that new breeds be developed in the USSR using Jerseys in order to attract consumers to better color in butter. Campbell (1977), in New Zealand, recommended crossbreds be 75% Jersey breeding in order to maintain the fat, solids-not-fat, protein and lactose contents most profitable in the export market.

Jersey crosses are preferred over Brown Swiss, Ayrshire and Holstein in rural areas of India, Pakistan, Ethiopia and other countries because the larger fat globules provide greater ease and higher efficiency in hand lifting or skimming of the cream from pans. To these farmers this is important as fat and its products becomes the marketable product when farms are distant from town. Likewise, the fat globule and fat content aids flavor and in sale value of fermented milks as well as in home food preparation.

Jersey milk produced on winter feeding has a higher fat retention in the curd which is desirable in cheese processing (Banks et al., 1986).

3. Fatty Acids

Triglyceride distribution is largely governed by diet, therefore it is concluded that nutrition is more important than genetic differences among breeds (Clapperton et al., 1985).

A number of studies have been made for testing the effects of feeding supplementary fat on milk fatty acids. Most results are similar, e.g., Palmquist (1987) concluded that mammary de nova synthesis of fatty acids is less sensitive to supplemental fat in Jerseys than Holsteins.

4. Protein Components

In Denmark, kappa-casein content of skim milk as percent of total protein was highest for Jerseys, 23.9 vs. 21.5 and 21.3 for Black and White Danish and Red Danish. Kappa-casein was found highly correlated with protein in Jersey milk (r = .71) vs. .58 - .62 for the other two breeds (Thymann, 1972).

Among commercial dairy herds in Pennsylvania, Jerseys ranked highest for true protein percentage (4.07 ± .49) followed by Brown Swiss 3.84 ± .52, Guernsey 3.56 ± .53, Ayrshire 3.07 ± .52, Milking Shorthorn 3.17 ± .47 and Holstein 3.07 ± .43. In all breeds, whey protein and beta-lactoglobulin content was influenced by genotype with beta-lactoglobulin A AB B. The differences in genotype indicate breed selection could be effective for change if beta-lactoglobulin fractions become of economic importance (Cerfulis and Farrell, 1975).

A Japanese study (Komatsu et al., 1981), using Jerseys and Holsteins imported from the U.S., concluded breed differences were small and nonsignificant for .kappa-C_n, .beta-lg, .alpha S1-C_n and .beta-C_n.

Clearly, Jersey is a high breed in protein content of milk and bits of research indicate its quality for product production and human use is also highest. Protein quality is assuredly an area needing further investigation.

5. Milk Energy

Due to identified differences among breeds in ratio of protein to fat and solids-not-fat, New Zealand workers (Grainger et al., 1983) prepared separate equations for determining the energy value of Jersey and Friesian milks: Jersey, E = .0291 fat + .0337 protein + 1.059 (constant); Holstein, E = .0381 fat + .084 protein + .482.

Gibson (1986), in a study with British Friesians and Jerseys, concluded Friesians were more efficient at producing milk but no more efficient at producing milk energy.

6. Minerals

Numerous nutrition trials have been conducted on the effects of dietary levels of chloride, sodium, zinc, magnesium, calcium, phosphorus, sulfur, copper and selenium levels in milk. Breed differences are not noted because of use of a single breed or breed observations were unsorted when the tests involved two or more breeds. Only a single test in New Zealand showed a significant breed difference for zinc in milk; Jerseys 4.55 mg/l vs. 4.06 for Friesian with crosses of the two breeds intermediate (Joerin, 1978). It seems reasonable to assume that if breed differences were large in mineral content of milk, the literature would reflect same.

7. Characteristics of Cheese

Four cheeses made from Jersey milk containing total solids of 12.77%, protein 3.4% and fat 3.99% had moisture, protein, fat, ash and salt content and maturity indexes of 51.9, 18.3, 26.7, 2.4, 1.3 and 87.0% fresh and 47.9, 20.5, 29.0, 2.6, 1.3 and 82.3% after ripening for five weeks (Nukada et al., 1985). Compared with cheeses from Holstein milk of similar composition, the Jersey cheeses were harder with less moisture, had a slightly higher maturity index, higher amino acids and trimethylene N content but were similar in contents of ammonia N and VBN.

An experiment in Britain (Banks et al., 1986) showed an influence of diet on the efficiency of conversion of milk solids to cheese. Jerseys showed better response than Friesians. Feeding was associated with improvement in the level of fat retention in curd.

The bibliography contains other citations on the value of Jersey milk for cheese making in several countries. It is widely recognized that Jerseys have comparative advantages in producing milk to yield high quality cheeses.

General conclusions for milk composition are that Jerseys produce quality milk and definitely have advantages with genetic linkages. Further testing on means to best exploit these qualities in view of current and projected market trends warrants more investigation. e.g., work in New Zealand (Richardson, 1983) showed plasmin was low in Jersey milk but was high in plasminogen which can be important in both the processing and storage stability of milk products.

HEALTH

Herd conditions strongly influence health problems, therefore, it is difficult to declare one dairy breed has greatest resistance. Estimates made thus far on general resistance to diseases show Jerseys and Holsteins about equal (Erb and Martin, 1978; Erb and Grohn, 1988), however, a number of investigations indicate Jerseys have lower frequency of mastitis, less cases of metabolic disorders, fewer problems at parturition and show some advantage in length of herd life. Where available, comparative estimates are discussed.

1. Mastitis

Results from several investigations lead to the conclusion that Jerseys are less susceptible to mastitis, e.g., in dairy herds of Florida, mastitis and udder disorders were more frequent among Holsteins (51% of cows treated) vs. 22% for Jerseys. Holsteins averaged 1.28 clinical cases per lactation vs. .63 for Jerseys. Losses due to problems at parturition favored Jerseys (2.6 vs. 4.8%). After first parturition, Jerseys had the longest predicted life span, 61.1 mo. vs. 56.2 for Holsteins. Similar observations on mastitis come from New Zealand (MacMillan, 1981).

Miller et al. (1976) found, in a study of a Jersey herd in Tennessee, that a mastitis index based on stage of lactation at which infection occurred had less variation, greater variation among sires, and a continuous distribution in contrast to the traits, proportion infected and number of cases. Mastitis increases with advancing lactation number subsequent to second lactation. Fall calvers may have less mastitis since they would be dry or in late lactation during the summer.

Possible breed advantages for mastitis must be accepted with some caution as many investigations have confounding effects, such as the breeds not being contemporary herdmates, imbalances in observations due to age effects and differences in milk yield. Short (1986) showed, for example, that Jersey cows produced by intensive selection for milk yield had significantly higher health costs than the control line, mainly from mammary costs.

Conclusions at this point are that on average Jerseys have less problems with mastitis, but this may not have a genetic association. Also "bragging rights" cannot be issued because economic cost is a problem in all breeds.

2. Milk Fever

Lactational incidence rate of milk fever in Holstein cows is 1 to 11% with most estimates 7% and Finnish Ayrshires 4-10% (Erb and Grohm, 1988). A higher risk and likely occurrence at earlier ages is generally accepted for Jerseys and Guernseys. In a large Jersey herd in South Africa, the incidence of milk fever averaged 17.4% of the cows for all lactations (Belonje and Vander, 1971). Frequency was related to lactation age, increasing to 24.8% in third and later lactations. Season effects proved important, highest August-November.

Hibbs and Conrad (1976) showed that feeding 20-30 million units of Vitamin D for 3-8 days prepartum prevented about 80% of expected milk fever in mature cows with histories but found Vitamin D supplement did not reduce incidence in cows without history of milk fever; 28.3% in treated cows and 23.7% in controls.

Examination of literature prior to the early 1970s versus post 1980 shows a marked reduction of reports on milk fever among Jerseys. This leads to several implications: 1) intentional selection or low contributions by affected cows due to involuntary culling since retained placenta, metritis and clinical ketosis increases the risk of milk fever; 2) the problem is now dealt with as a routine herd management procedure; or 3) methods of feeding have reduced risks. Occurrence in Holsteins may be increasing with higher milk because of more clinical ketosis and hypocalcemia in first lactation, both of which increase risks of milk fever (Erb and Grohm, 1988). This implies problems for all breeds with intensity of selection for higher milk yield. A study in California showed differences in incidence within herd over several years could be 200% and between herds variation was nearly 100% (Phatak and Touchberry, 1988). The extent of variation attributed to herd management shows the condition of data collection can be important in assessing risks among breeds.

Downer Cow Syndrome has no universal definition but is generally used to identify cows which have not risen either 10 minutes and sometimes within 24 hours of treatment with intravenous calcium. There remains little documentation on the incidence rate, but if milk fever is related to the syndrome, Jerseys may have medium risks. A survey made in New York state identified possible lower risk in Brown Swiss than in Holsteins (15.7/1000 cow-years vs. 22.2/1000) while rate for Jerseys in 83 herds was 17.9 cases/1000 cow-years and 21.8 for Guernseys. Breed differences were nonsignificant (Erb and Grohm, 1988).

3. Udder Edema

Edema becomes evident 2-5 d prepartum, peaks in severity at parturition, then declines normally within 1-2 wk. The condition is most common and severe in first lactation but the condition can occur or repeat in second and later lactations. Incidence of severe edema is 1-18%. Its relation to milk production remains unestablished. Some reports indicate no strong ties while others claim 11% greater risk in heifers of high genetic potential. There is no clear evidence of breed risk or cow's previous lactation milk yield. Rectovaginal constriction (RVC) does appear associated in Jerseys (Al-Ami et al., 1983, 1985). Jerseys with RVC seem to develop serious edema somewhat earlier (14 days before parturition) and tend to persist longer -- 3-10 d after parturition -- than non-affected cows.

Nutritional factors are the most predisposing causes. High dietary sodium or potassium, level of intake of energy and protein and proportion of grain in prepartum diet have all been associated with occurrence of severe udder edema. There seems to be a significant interaction between parity and grain feeding for edema.

4. Displaced Abomasum

Displacement to the left occurs most frequently. Reports of the 1960s indicated high risk in Jerseys and Guernseys but within the period under review (>1970) no proof is made that breed differences are important either in the U.S. or abroad. Risk and high milk yield have been determined as associated but conclusions on the point are inconsistent with the number of reports saying the relationship is unlikely or low occurrence is predominant. Similar findings and conclusions are drawn for clinical ketosis.

5. Laminitis

Laminitis (podoermatitis aspectia diffusa) may have both genetic and environmental relationships. Chronic laminitis of Jerseys was reported in California and Pennsylvania in 1968 but implication of an autosomal recessive gene was not determined. In South Africa, pedigree information was sufficient to trace a mutant gene to a Jersey bull 16 generations back (Edwards, 1972). When genetics is involved, the condition is identifiable by stage of puberty in heifers. These would be culled early, therefore, mutant gene effects would likely remain low (Edwards, 1972).

Mild to severe laminitis can occur often among heifers during the first 60 days of lactation. The condition seems connected with systemic disturbances attributable to high concentrate feeding with low fiber content in the total ration. Such feeding can result in an acute or chronic acidosis with excessive production of lactic acid, endotoxins and probably histamine. In the acute stage, the acidosis results in chronic changes in the pododerm and pedal bone. Laminitis increases susceptibility to sole ulcers, white line disease and double soles. Cows with a history often have repeats. Observations in North Carolina show that heifers on medium to low quality grass pastures, when switched to high concentrate diets at parturition, are high risks for severe laminitis.

Using discoloration of the horn of the rear feet due to hemorrhage, Ahlstron et al. (1982) found that Swedish Friesians had significantly higher incidence of discoloration (63%) vs. none for Swedish Jerseys.

In North Carolina (El-Sayed et al., 1981), areas of front and rear crowns (high crown desirable) were positively correlated with milk yield in Holsteins (r = .30 and .33) and for Jerseys (r = .36 and .38) and with body weight in Jerseys (.61 and .47). These values indicate high milk yield and larger cows are not predisposing factors to foot problems.

Acute laminitis is most associated with feeding in all breeds.

Other points on health are incorporated in sections on reproduction, blood, polymorphisms and crossbreeding.

STAYABILITY

Stayability as an estimate of herd life is in vogue. Although studies involving within herd-breed comparisons are few, the general implication is that Jerseys are regarded as being one of the best breeds.

In South Africa, Jerseys averaged 2.95 lactations completed vs. 2.64 for Friesians (Osterhoff and Couvarer, 1978). For Jerseys in the U.S., the range among studies is 2.47 ± 1.82 to 2.52 ± 1.76. In the northeast U.S., there is a positive genetic trend for stayability for Jerseys and Brown Swiss but a declining trend in Ayrshires, Guernseys and Holsteins (Everett et al., 1976).

Some studies, e.g., Dunk et al. (1977), show that Jersey heifers on high feeding from birth averaged only two lactations vs. three lactations for heifers on modest feeding. In stressful environments, stayability of Jerseys exceed most breeds, e.g., Nigeria 2.7 calvings vs. 2.3 for Holsteins. Similar observations come from India and Pakistan.

Although length of stayability is a current researchable topic, it basically reflects rate of involuntary culling rate which may have numerous causes. Attention to these causes individually appear more promising than attempting to select for stayability as though it were a single trait. Values in Table 13 show Jersey below Ayrshire, Brown Swiss and Holstein in percent females born alive completing two lactations 73.0% vs. 74.6 - 81.2% for the other breeds. Jerseys may look good on postcalving stayability but high losses prior to calving leads to the conclusion that the book remains open on what present research on stayability is conveying.

MORTALITY

In general, Jerseys are among the breeds with low precalving losses, average to slightly below in postnatal to prebreeding, but above average in rate of losses from puberty to first parturition. For the N.C. State University Jersey herd, averages over 11 years were: stillbirth 5.1%, birth to 3 months 11.2%, 3-12 months 9.4% and proportion calving of females born alive 72%. In this herd, rate of losses tended to decline under a program of selection for high milk yield. At the University of Florida (breeds in the same herd), Jerseys were similar in losses to Guernseys and Holsteins in calves born dead, similar to Holstein in losses 24 h to first breeding 10.9 vs. 9.4% but less than Guernsey 24.2% (Table 9). A report from New Zealand with commercial herds (breeds not always common to herds) showed Jerseys with higher losses than Friesians or Jersey x Friesian crosses (Table 10). In Europe, Jerseys are average or slightly higher than other breeds in losses, e.g., in Denmark, across all lactations, frequency of stillbirth was 4.3% in Jersey, Red Danish 4.2%, Black and White 3.2% and Red and White 3.2%. Rate of loss in Jerseys was lowest at first parturition (6.1%) but 3.0% in second and later parturitions while other breeds averaged 1.2 to 2.8% (Annual Rpt. Nat'l. Comm. Danish Cattle Husb., 1983).

There is some tenuity in the breed comparisons cited, e.g., in the Florida herd efforts were made to increase the number of Holsteins during the period of recording. The same holds for New Zealand where Friesians and crosses are expanding in numbers.

There is a possible question on need of closer examination of prenatal and neonatal losses as to possible cause(s) in Jerseys. For instance, does the

TABLE 9. PERCENT LOSSES PARTURITION TO BREEDING IN JERSEYS, GUERNSEYS AND HOLSTEINS IN UNIVERSITY OF FLORIDA DAIRY RESEARCH UNIT

Trait	Jersey	Guernsey	Holstein
Calves born dead	6.35	5.45	7.14
Died > 24 h, < 31 d	5.11	6.82	3.65
Died 30 d to 6 mo	4.49	9.55	3.82
Died 6 mo to breeding	1.39	7.82	2.00

Source: Simerl (1982).

TABLE 10. PERCENTAGE PRE- AND POSTNATAL LOSSES OF FEMALE JERSEY, FRIESIAN AND FIRST GENERATION CROSSES IN COMMERCIAL DAIRY HERDS OF NEW ZEALAND

	Losses as % of all births		
Period	Jersey (J)	Friesian (F)	F x J crosses[a]
Prenatal	3.4	.4	1.7
Calving to 24 hours	2.4	2.8	2.2
Rearing (1 d - 6 mo)	20.3	4.3	5.4
Post-rearing (6 mo to conception)	4.5	2.6	3.2

[a] All crosses produced from mating Holstein sires to Jersey females.
Source: Bryant and McMillan (1985).

fat content of Jersey milk create a marginal protein to energy ratio that increases susceptibility to health problems? Experiments in Eqypt showed that mortality in young buffalo calves fed milk from their dams with 7-8% fat was 32% compared to 7.8% in buffalo calves fed milk from Friesian cows (4.0 - 4.2% fat). In Florida, 11.7% of Jersey female calves were treated for scours vs. 5.4% for Holsteins. This lends support to a possible imbalance in the protein-fat ratio for young calves.

AGE AT PUBERTY

It is recognized that Jerseys exhibit estrus earlier than most breeds, as soon as 6 months (Becker, 1973). Many of the references on crossbreeding for beef production comment on the influence of Jersey breeding on low age at puberty. Likewise, it is accepted that the breed can be serviced satisfactorily younger than most other breeds.

In Australia, Jerseys and Friesians were compared for the relation of live weight to successful conception. Jerseys averaged 219 ± .3 kg vs. 319 ± .7 kg for Friesians. It was concluded that breeding Jerseys at 13 months and weighing at least 219 kg provided cows with longest herd life and highest yields (Thomas and Mickan, 1987). These results are worthy of note as visits to well-managed herds in the U.S. showed Jerseys were often being bred principally according to body weight at a minimum age of 13 months. Insemination commencing at 14 mo results in an average age at first calving of 24.9 mo (Wilk, unpublished).

Clearly Jerseys have a comparative advantage in early sexual maturity and can be bred one or two months sooner than other breeds without affecting reproduction rate or milk yield at later ages.

AGE AT FIRST CALVING

Values derived from studies of DHIA records indicate breed averages as: Jersey 25.8 mo, Ayrshire 27.0, Brown Swiss 27.5, Guernsey 27.0 and Holstein 25.5. In several studies, breed effects were statistically significant but usually year and season effects are greater. Jerseys averaged 4-5 months younger than Black and White, Red Danish or Red and White in Denmark (Table 8); 3.2 mo earlier than Friesians in South Africa; 2.57 mo lower than Friesians in New Zealand; 4.0 mo younger than Holsteins or Friesians in India and Pakistan; and 10.0 mo earlier than Holsteins in Kenya. This summation shows that under good feeding regimes Jerseys calve as young or younger than most breeds. Jersey appear to show even greater advantage under poor feeding. Records from DHIA herds of the U.S. prior to 1965 showed the difference between Jerseys and Holsteins more favorable toward Jersey. It could be that Holstein breeders have given attention to this trait over the past two decades.

Heritability estimates for age at first calving are similar to milk yield (.16 - .47). The estimates are lower under good feeding and highest in poor environments, e.g., .47 in India. Several studies have recommended that calving age be reduced by selection but no evidence could be turned up where the recommendation had been followed. It seems that in Bos taurus dairy breeds, age at first calving is largely a management decision with age of first estrus a major detriment, e.g., in India and Pakistan, average age at first calving may vary as much as 4 months between years due to variability in feed resources. Zebu breeds (Bos indicus) are known to be slow in reaching sexual maturity, 20-24 mo irrespective of level of feeding. McDowell et al. (1976) found that infusion of 50% Jersey reduced puberty to 459 (15.3 mo) and even 25% Jersey reduced age of estrus to where breeding could commence at just over 15 mo. Crossing Jerseys with beef breeds has consistently demonstrated an influence of the breed in lowering age at sexual maturity.

Season effects can be important, e.g., Jerseys calved 1.2 mo sooner than Holsteins in the warm season but 1.0 mo later in the cool season (Ruvuna et al., 1983).

GESTATION LENGTH

Time of fetal development varies among breeds, ranging from a high of 289 d for Zebu breeds, 284-288 d for most beef breeds and 279-288 d for dairy breeds. Means for breeds vary to some extent among data sets, e.g., in Florida herds 278, 277, 285, 284 and 276 d for Jersey, Ayrshire, Brown Swiss, Guernsey and Holstein; Oklahoma (Table 11) 281, 278, 285 and 278 d for Jersey, Ayrshire, Guernsey and Holstein: and for DHIA herds 279, 282, 288, 286, 280, 282 and 282 d for Jersey, Ayrshire, Brown Swiss, Guernsey, Holstein, Milk Shorthorn and Red and White.

TABLE 11. BREED DIFFERENCES IN BREEDING EFFICIENCY IN DAIRY HERDS OF OKLAHOMA

Trait	A[a]	G	H	J
Calving interval (d)	401	414	396	402
Calving to 1st breeding (d)	83	91	85	84
Services/ conception	2.24	2.29	1.95	1.95
Gestation length (d)	278	285	278	281

[a]A = Ayrshire, G = Guernsey, H = Holstein, J = Jersey
Source: Slama et al. (1975).

Variation of estimate within breed is expected according to Foote (1981). He found twinning, sex of calf, parity of cow and time of day on which estrus occurred were associated with differences in gestation length. In Foote's study, month of insemination had no effect while others have claimed that cows calving in summer were longer in gestation. Mates and sires of cows can also affect gestation slightly but selection for increased milk production appears to have little, if any, effect on duration of gestation. The beef and dairy crossbreeding studies show breed characteristic lengths are genetically fixed as values for crossbreds vary according to the mean of the parents (low heterosis).

Jersey ranks among the breeds with shortest gestation. Although there is a small positive correlation within breed for birth weight and days of gestation, gains through selection would take a long while to appropriately disentangle from the numerous effects cited. Selection for increased milk yield may result in a slight increase, e.g., Foote (1981) showed that Holstein gestation increased about 1 d in 20 years.

CALVING INTERVAL

This is another trait for which possible breed differences are difficult to verify due to large confounding with management decisions and environmental conditions. Estimates for Jerseys vary from 518 d in Nigeria to 360 d in Denmark. Generally intervals are longer from first to second parturitions. Frequently calving intervals are not recorded but estimated by addition of recorded days open and average days for gestation which adds caution in calling attention to breed differences.

In the U.S., range of intervals for breed from first to second parturition are: Jersey 391-411 d, Ayrshire 431-460, Brown Swiss 418-472, Guernsey 410-437 and Holstein 394-417; and for later intervals up to 6th parturition, Jersey 372-394, Ayrshire 399-414, Brown Swiss 407-437, Guernsey 401-423 and Holstein 389-402. Means from Denmark for first and later intervals are: Jersey 382,#368; Red Danish 400,#380; Black and White 383,#367; and Red and White 375,#362.

In a regional study for the southern U.S., Jerseys had shorter calving interval by 8.4 d in first interval, 15.9 2nd-3rd and 3.3 d for later intervals. This implies rate of rebreeding of Jerseys is faster in warm climates (McDowell, 1974). Crossbreeding tests for beef production have clearly shown shorter intervals for conception of Jersey x beef crosses.

In the Philippines (Hermosura and Mordeno. 1982) with hot, humid conditions, calving interval for Jersey was 394 d and Holstein 501 d. Under hot, dry conditions of Libya, Jerseys averaged 398 d vs. 411 d for Holstein and 440 d for Brown Swiss (Bhargava and Rojare, 1983). In Uganda, Kiwuwa (1974) concluded that Friesians produced more milk per lactation than Jerseys but due to differences in breeding efficiency, age of first calving, calving interval, size of calf crop and other management costs, Jerseys had 441 d advantage over Friesians in an average life of 8 years.

Estimates of heritability are usually quite low, e.g., in Denmark values were .10 for Red Danish, .03 Friesian and .03 for Jerseys (Hansen, 1979).

Overall, Jerseys can be expected to rank among breeds with shortest calving intervals. Like other breeds, environmental factors are quite important but on the whole it responds to rebreeding above average in hot environments and poor feeding conditions.

CALVING EASE AND DYSTOCIA

Examination of the accompanying bibliography will reveal that difficult calving can create problems and there is some evidence of differences among breeds. The Jersey is regarded as a breed with good calving ease and among the lowest in dystocia. In a Florida study, dystocia occurred in 2% of the calvings in contrast to 4% in Guernseys and 6% in Holsteins (Table 12). In another study (McDowell et al., 1974), with heifers bred 30% to sires of their own breed and the remainder to other breeds, found the incidence of dystocia under the mixed mating was higher than in Florida with purebred matings but McDowell et al. concluded Jerseys were slightly lower than Ayrshires and Brown Swiss and significantly better for dystocia than Holstein (Table 13).

TABLE 12. REPRODUCTIVE PERFORMANCE OF JERSEY, GUERNSEY AND HOLSTEIN HEIFERS IN THE UNIVERSITY OF FLORIDA DAIRY RESEARCH UNIT HERD

	Percentage		
Trait	Jersey	Guernsey	Holstein
Heifers never conceived	10.68	6.82	1.99
Conceived with normal birth	69.66	64.55	78.77
Overall losses, birth-1st calving	30.34	35.45	21.43
Services/conception	2.60	2.38	2.11
Retained placenta	.89	4.23	4.86
Dystocia	1.78	2.82	6.55
Metritis	4.22	15.49	14.17
Stillbirths	9.11	7.04	15.65

Source: Simerl (1982).

Occurrence of dystocia can be high (50% for dairy breeds and 60% in beef breeds) at first parturition particularly when undersized. Even when cow or heifer size is low, frequency in Jerseys is generally as low or lowest among breeds. During second and later parturitions frequency in most breeds declines to 15-20%. Sex of calf is a factor, higher for males. Subsequent milk loss may reach 500 kg per lactation and mortality of calf may reach 50% following a calving requiring strong assistance. Feeding of heifers and avoiding use of bulls known to sire large calves can be helpful.

TABLE 13. REPRODUCTION AND HEALTH PROBLEM PRIOR TO OR DURING FIRST LACTATION OF FOUR BREEDS

Trait	A[a]	B	H	J
Females born alive (%)				
Breeding, 0 conception	7.5	13.8	7.7	12.8
Completed 2 lactations	81.2	74.6	78.7	73.0
Reproduction problems (%)				
Disorder	6.1	8.2	6.2	1.5
Dystocia (1st part.)	12.3	11.3	9.2	9.0
Culled sterility	5.1	7.6	6.0	4.0
Death 1st lactation (%)	2.2	2.4	1.9	1.2

[a]A = Ayrshire, B = Brown Swiss, H = Holstein, J = Jersey.
Source: McDowell (1982).

Abnormal presentation of fetus may occur in 2-6% of all births but no breed effects are identified. Twinning rate is higher in Jerseys (3.0%) than Friesian (1.2%). Birth of twins is unrelated to dystocia in Jerseys but is related in Friesians (Scanlon, 1973).

Postpartum intrauterine treatment of Jerseys following difficult birth does not improve reproductive efficiency (Dowlen et al., 1983).

Jerseys are excellent for calving ease and general reproductive performance. No selective changes seem warranted at this time, especially when one considers that in Spain, Jerseys had less problems of calving than 14 breeds and crossbred groups involving both large and small breeds. Hansen (1979) points out that in most breeding programs and well-managed herds, females with calving problem history leave fewer offspring, therefore, genetic changes to increase problems at parturition should remain low.

LACTATION LENGTH

Historically, concern has been expressed over possible differences among breeds in their ability to lactate over an extended period (>10 mo). In some cases heritability estimates led to a recommendation for selection to increase lactation length. This recommendation has pertained largely to breeds or types native to Third World countries, but emphasis on need for selection has declined with recognition that: 1) a strong positive correlation exists between total yield and duration of lactation; 2) speed of rebreeding during lactation is quite important for days kept in milk; and 3) lowest economic level accepted within a herd environment determines level of yield at the time of drying off.

Jerseys usually average 2-6 days shorter lactations than Holsteins (Table 7). In New Zealand, Jerseys averaged 249 d, Ayrshires 252 and Friesian 254. Most studies have shown that Jerseys average slightly shorter periods because on average more rebreed sooner, therefore, earlier drying off for 60 d dry period.

Cows in first lactation are usually milked 1-5 days longer due to slower rebreeding, e.g., in New Zealand first lactation averaged 253 d, second 250, third 252, fourth and later 251. Where there is high dependence on grazing, year effects can be significant, e.g., 232- 262 d. For the period 1950-1985, average lactation length in New Zealand was near constant, 249 d in 1950 and 247 d in 1985. In countries of northern and eastern Europe, lactation length has increased about one day per year over the past 2.5 decades as emphasis on milk yield rose with less dependence on animals for traction. In poor environments, Jerseys will average about the same in lactation length as Holsteins, e.g., in Libya Jerseys averaged 297 d and Holsteins 293 d (Alim 1985); 248 d for Jerseys in Nigeria (Adeyene and Bamiduro, 1977).

The conclusions are that the literature search revealed no complaint over length of lactations for Jerseys. The breed has no comparative advantage but assuredly it ranks well with other breeds both in good and poor environments.

BREEDING EFFICIENCY

Time of involution of the cervix and uterus and return to estrus following parturition favors Jerseys (Agasti et al., 1985; Fonseca et al., 1983; McDowell et al., 1974; Ruvuna et al., 1986). Values in Table 14 favor Jerseys over Holsteins in all measures following first and later parities. This includes percentage conceiving to first service. Ruvuna et al. (1986) attributed advantage to the Jersey from a lower rate of weight loss following parturition. McDowell et al. (1974) also found Jerseys returned to estrus sooner than Holsteins following all parturitions; had fewer days open; and shorter calving interval; more pregnant by 95 d postpartum; had slightly fewer days from first breeding to conception in second and later parities but more after first parturition. Although more conceived by 95 days, Jerseys were only slightly ahead for conception by 200 days (Table 15). Advantages of Jerseys in these traits prevails among Jersey crosses with either native cattle in warm climate areas or beef breeds (Arya and Jain, 1986; Humes, 1973).

TABLE 14. MEANS AND STANDARD DEVIATIONS FOR MEASURES OF REPRODUCTIVE PERFORMANCE IN JERSEYS AND HOLSTEINS

Measure	Jersey Mean	Jersey SD	Holstein Mean	Holstein SD
Calving to 1st ovulation, d	20.0	14.4	20.8	13.2
Interval to cervix involution, d	20.9	4.6	23.7	6.9
Interval to uterus involution, d	21.7	5.3	23.8	8.4
Time from 1st to 2nd ovulation, d	17.2	4.4	17.1	4.2
Time from 2nd to 3rd ovulation, d	21.1	2.7	21.4	2.3
Calving to 1st detected estrus, d	37.2	27.3	66.9	33.9
Calving to 1st breeding, d	85.0	15.9	87.6	26.4
Days open	94.8	28.0	109.2	38.4
Conception to 1st service, %	72	45	49	50

Source: Fonseca et al. (1983).

Bell et al. (1987) report that in Tennessee the correlations of milk yield and breeding efficiency appear low (-.01 to .16). Most traits improved in a group selected for milk yield; 109, 2.1, 2.0 for days

TABLE 15. LEAST SQUARES ESTIMATES OF DIFFERENCES FROM HOLSTEIN FOR JERSEYS IN MEASURES OF BREEDING EFFICIENCY

	Days				% pregnant			
Parity	Calving to 1st heat	1st breeding to conception	Open	Calving interval	<95	<120	<145	< 200
1	10.9	-7.2[a]	5.6	8.4	4	0	-2	5
2	7.8	2.1	10.7	15.9	7	12	4	3
Later	8.5	4.6	4.2	3.3	5	3	1	1

[a]Sign in economic direction.
Source: McDowell et al. (1974).

open, number of prebreeding heats and breedings for conception versus 114, 2.2 and 2.2 for the unselected line.

Jerseys are medium to high in rate of culling for sterility (McDowell, 1982). Most breed rapidly with as many as 72% conceiving to first service (Table 14) but the proportion requiring three or more services or not pregnant by termination of lactation are above usual expectations. Causes remain obscure. The pattern described is observed both in well fed and in poor environments. First generation crosses among dairy breeds show similar characteristics. Jerseys and F_1 crosses have low body weight losses postpartum. Similarly, these groups commence gains in weight sooner, they show estrus earlier, but the 20-30% which do not conceive have sterility problems in spite of normal estrous cycle rhythms. It is possible that rapid weight gains lead to addition of abdominal fat near the ovaries and uterus which could influence functioning of the corpus luteum. Observations around the world agree that Jerseys are "excellent early breeders" but too many "go stale." Suggested cause(s) warrant further study as it increases involuntary culling rate. The hypothesis that fat accumulation can be a factor in some reproductive problems is supported by level of abdominal and thoracic fat (Table 6); dissection studies by Matthews et al. (1975), in females; and in Jersey steers by Blakely et al. (1978), Talamantes et al. (1986) and Williams et al. (1981).

UDDER CHARACTERISTICS

Breed comparisons for udder traits are few. Comments will deal with these together with findings within breed.

1. Teat Size

Jerseys are regarded as among the breeds with smallest teat size. Short, low diameter teats are regarded by some to afford advantage in lower susceptibility to mastitis and udder injury. But small teat size of Jersey and Jersey x Native breed crosses in countries where hand milking prevails, e.g., India, has hampered appreciation of the value of the breed and crosses.

In Denmark (Ovesen, 1972), Jerseys tend to have smaller and shorter teats than Danish Red or Danish Black Pied. Teat length influenced milk flow rate, milking time and yield of hand strippings. According to Ovesen, optimum teat length of fore teat is about 6 cm and for rear teats 5 cm. Diameter did not effect flow rate. Flow rate was highest and strippings lowest in cows with flat and concave teat tips.

In North Carolina (Weinberg et al., 1980; Wilk and McDaniel, 1988), selection for milk yield increased output per lactation by 900 kg but the higher milk had no detectable influence on teat length or diameter. This indicates breed characteristic teats are well established even though estimates of heritability of approximately .25 in teat characteristics can be changed by selection for both length and diameter.

2. Udder Volume

The most extensive work on the relationship of udder volume and milk yield comes from New Zealand (Davis et al., 1983, 1985, 1985). High and low breeding index cows were used within and across breeds. One-half the product of height of rear quarter from the base of the teat, average width measured 8 cm above front and rear teats and length from base of rear teat to anterior junction of udder with the abdomen were used to estimate volume. The volume was positively correlated with milk yield. Heifers from the high index line had larger udders after P.M. milking than the low line (9.1 vs. 7.3 l). Differences in udder volume between heifers and mature cows were due primarily to differences in body size but line differences were not totally attributed to size.

Equations linking peak daily milk differed in Jerseys and Friesians: (y, l) with udder volume (v, l) was: $Y = .932v + 7.3$ for Jerseys; $y = 1.16v + 8.6$ for Friesian. Difference in milk yield of high and low index Jerseys was attributed to contrast in udder volume developed during late pregnancy. The high index group had 35-40% more volume up to week 20 of lactation. There was no difference in udder volume between high and low index Friesians. Davis and colleagues concluded that selection for milk yield resulted in high yielding cows in both breeds but through differing mechanisms. In Jerseys, udder size and weight increased while in Friesians udder productivity rose; Jerseys produced 1.8 l of milk per liter of tissue vs. 2.0 l for Friesians.

3. Udder Strength

Estimates of udder strength based on one or more measurements of udder to floor distance, shape and teat length, size, shape, distance between teats and their position and placement are being used by AI organizations to project strengths and weaknesses of sire progeny and also to guide in making corrective matings. In Denmark, all the traits enumerated are included in their S-index for sires. Overall Jersey sires rank higher for udder strength than Danish Red or Black and White (Nat'l. Comm. on Danish Cattle Husb., 1983).

Using measures of teat length, diameter and distance, Wilk and McDaniel (1988) concluded that changes in udder and teat traits that occurred following selection were small and not of practical importance (Table 16). Distance between teats increased slightly. Udder clearance from the floor decreased after one generation of selection, then remained nearly consistent in subsequent generations.

TABLE 16. MEANS AND STANDARD DEVIATIONS FOR UDDER AND TEAT TRAITS OF JERSEYS SELECTED FOR MILK YIELD FOR THREE GENERATIONS VS A CONTROL LINE

	Select		Control	
Measure	Front	Rear	Front	Rear
Teat Length, cm	4.93	3.85	4.89	4.16
Diameter, cm	1.96	1.80	1.88	1.79
Distance before milk, cm	16.30	9.79	16.51	9.65
Distance after milk, cm	13.37	6.87	13.26	7.26
Udder Clearance, cm	47.21	46.85	50.52	49.93
Cleft	3.16		2.95	

Source: Wilk, J. C. and B. T. McDaniel (1988).

Although number of investigations are limited, all evidence shows Jerseys tend to have good udder qualities. They are above most breeds in teat placement and depth of cleft; are better than Brown Swiss, Holstein and Guernsey and many breeds of Europe in fore and rear udder attachment but not as good as Ayrshires in fore udder attachment. Jersey also appear well above average in low rate of culling for poor udders.

BLOOD CONSTITUENTS

Possible differences or lack thereof among breeds was searched. Some results are discussed in order to extend the profile of Jerseys.

Compared to Friesian cows in Britain, Jerseys had higher copper and aluminum concentrations, lower globulin concentrations and higher free fatty acid (FFA) in blood. Changes in plasma concentrations of FFA, ketones and glucose around calving were consistent. This suggests that in first and second lactation Jerseys had greater energy deficit in early lactation than Friesians. These results also indicate Jerseys being more susceptible to hypocalcemia in later life.

In Poland (Kalataj and Guszheirwicz, 1971), mature Jersey cows showed higher glutathione content (30.86 mg %) than Polish Red Cattle (19.42 mg %). The authors concluded there could be genetic control of blood glutathione level in cattle.

Tests were made for glucose and leukocytes in blood, along with urea, creatine, calcium, inorganic phosphorus and magnesium in plasma of growing calves of four breeds (Berglund and Oltner, 1983). Breed effects were statistically significant but only creatine content showed marked differences. But in later studies with three Swedish breeds of cows (Oltner and Berglund, 1982, 1984), breed differences were not distinguished except for plasma urea which was highest in Jerseys (6.87 mmol/L).

In Denmark (Flensburg and Wilkberg, 1976), Jerseys less than two years of age had lower blood leukocyte counts than other breeds. At later ages, breed differences were small but Jerseys were lowest in lymphocyte counts. These observations can be interpreted two ways. Jerseys with low counts were healthier than the other breeds. This is supported by work at the Georgia Station, Tifton, where Jerseys had lower leukocyte counts than Holsteins on BST feeding. On the other hand, the low counts could indicate lower capacity of Jerseys to produce normal defense mechanisms.

Tests with Angus, Guernsey, Holstein and Jersey bulls showed no breed effects, either in pituitary gland histology or LH concentrations (Combs et al., 1983).

In a study involving Jersey and Holstein heifers (Hurley et al., 1982), the feeding of supplementary phosphorous altered inorganic P of blood serum but did not affect estrus behavior or blood serum progesterone, estradiol or luteinizing hormone levels. Breed differences were nil. Results of this test are supported by others in the bibliography.

Interpretation of observations on blood constituents is difficult relative to genotype differences. In most studies number of animals per breed were low, repeatability of measures between samples on the same animal was modest and often the results may have been confounded with age of animals and level of feeding. The general conclusions at this time are that Jerseys have acceptable levels of normal blood constituents for efficient performance. No notable deficiencies are evident. The breed may have some comparative advantages, e.g., low leukocyte counts, but further testing is required.

NUTRITION

There are many experiments conducted in numerous countries on response to feeding in which Jersey and its crosses were involved. However, it is quite difficult to relate most results to the theme of the review. Often Jerseys were included to make up experimental groups but possible breed differences in responses or breed x treatment interactions were not determined. When tests were made with only Jerseys, response to treatment was the objective. Seldom did the author(s) relate their findings to those of others and comment on responses relative to similar studies with other breeds. To say the least, findings on breed effects in nutrition are disappointing. This section deals with tests with Jersey or other breeds but readers interested in more detail must use the index to search the bibliography.

Research at the Dairy Station, Lewisburg, Tennessee, and a number of others have shown Jerseys are excellent users of forages, e.g., Baxter et al. (1986), etc.; they have good flexibility for maintaining high intake with changes in physical form of forages and cereals (Bertoni et al., 1986); show advantages in efficiency of FCM production over Holsteins on diets high in forage with restricted concentrates (Evans, 1976); but take more time chewing their feed (Bae et al., 1983).

Compared to three large breeds in the Netherlands, Jerseys were most efficient in milk production (energy in milk as percentage of net energy in feed), 65% for Jerseys in first lactation and 56% in the other breeds. Baron et al. (1980) reported Jerseys exceeded Holsteins in DM intake as percent of body weight and N conversion. There are many citations in the bibliography on crossbreeding for beef production and the later discussion on feed efficiency lend support of the energy input-output ratio.

Workers at Texas A&M University found from digestion trials that Jerseys and Holsteins were similar in efficiency of converting dietary protein to milk (51%), conversion of body protein to milk (30%) and replacing body reserves (30%). Breed differences were low in nitrogen conversion (N) to milk after adjusting for DM intake and N balance; energy conversion to milk was similar in the first third of lactation but favored Holsteins in the second third. The conclusion reached was there was no real difference between breeds in feed conversion to milk on the diets used although Jerseys produced more milk in proportion to body weight and had lower feed intake (Blake et al., 1980, 1980, 1986).

Van Horn et al. (1979) showed there was an interaction of breed with protein source (15.3 or 16.3%) and digestibility of organic matter of Holsteins and Jerseys. This may be due to Holsteins' little or no effect of protein on digestibility of organic matter, whereas Jerseys showed an effect of protein level. Since breed and body size were confounded in this test, it is difficult to determine whether the interaction effects are due to breed or differences in size (Table 17).

TABLE 17. DIGESTION OF ORGANIC MATTER (OM) AND RUMEN AMMONIA PRODUCTION OF JERSEY AND HOLSTEIN COWS FED RATIONS 13.5 OR 16.3% IN CRUDE PROTEIN FROM THREE SOURCES

	Jersey		Holstein	
Ration	OM Dig	Ammonia[a]	OM Dig	Ammonia[a]
13.5% CP				
Cottonseed meal	62.1	6.4	60.0	3.3
Peanut meal	66.7	11.8	64.3	5.7
Soybean meal	65.8	3.9	66.1	3.3
16.3% CP				
Cottonseed meal	62.9	10.2	65.8	5.1
Peanut meal	69.0	16.4	72.4	8.4
Soybean meal	70.0	9.6	69.2	3.7

[a]Rumen ammonia, mg/100 ml rumen fluid.
Source: Van Horn et al. (1979)

Following tests on response to feeding of supplementary fat, Palmquist and Conrad (1978) concluded Jerseys produced more FCM per unit of body size than Holsteins and recommended 7-8% fat could be included in diets to increase energy intensity thereby allowing use of high forage to concentrate ratios to maintain milk fat percent without negative effects on digestibility. But when fat is added level of calcium in the diet should be increased.

Incorporation of inophores (lasalocid or monensin) into the diet increased proteolytic activity in the rumen, thereby permitting intact protein to escape to the abomasum. Lasalocid was added to high fat diets in Georgia. Jerseys responded better than Holsteins with lasalocid supplement. Dietary lasalocid reduced FCM, percent fat and fat yield without lasalocid-fat interactions, however, these reductions were larger in Holsteins. Feeding lasalocid reduced rumen acetate and increased propionate but changes were best in Jerseys (Johnson et al., 1987 unpublished).

A number of studies show that although Jerseys are lower in milk yield than Holsteins, they are more efficient in production. Jersey crossbreds have consistently rated as highly efficient in input-output ratio when measured as FCM or in beef tests in weight of calf per unit of cow weight. In India, for example, Jersey x Red Sindhi crosses were 32% more efficient in conversion of feed materials for milk than local breeds.

The studies enumerated are but examples of research on feeding from which some generalizations can be gleaned, such as recognized high merit in feed energy conversion, but the research is so fragmented during the period of review it would be difficult to derive profiles of merits and limitations of Jerseys which need adjustment or could be exploited with confidence. Some of the best work on feeding dates earlier, e.g., Britain in the 1950s and 1960s and about the same period from the Ruakura Animal Research Station of New Zealand. Points made by Taylor et al. (1986) related to this period appear sound. The greater the maximum efficiency of a breed for meat or milk production, the less efficiently it maintains itself, not because of any difference in fasting metabolism, but because of reduced efficiency of food utilization for maintenance. Additional research is needed. Suggestions could be gathered from several studies, e.g., work in East Germany (Brischke et al., 1980) which showed bulls of seven dairy breeds and three beef breeds under test station conditions required 98.5 - 110.6% of the East German standards for energy requirements versus 139.3% for Jerseys. An equation for prediction of DM intake (Bigstorke et al., 1982), showed values for Jerseys too low. There is the work of Eppard et al. (1982) on digestive stimulators and work in Italy on absorption of minerals in various portions of the digestive tract. The bottom line, so to speak, is that Jersey feeding guidelines are coming from linear regressions of feeding level on body weight or metabolic size which are heavily weighted by volume of data from Holstein; yet, there are bits and pieces of evidence showing Jerseys have certain unique features in physiology of digestion and intake of DM which should be further tested to determine the best feeding practices.

BODY COMPOSITION

Most of the determinations of body composition deal with fat deposition, consist essentially of observations on bulls or steers and were conducted largely in conjunction with test of crossbreeding of dairy and beef breeds. The values in Table 18 portray the general findings. Jerseys were lowest in slaughter weight, dressing percentage, carcass length, area of longissimus dorsi muscle and quality grade; highest in fat thickness; but equal to or better than other breeds in marbling score and percent trimmed boneless cut. An interesting point is how Jersey sired crosses and the reciprocals moved up in ranking for these same traits (Table 18). Similar observations come from, e.g., New Zealand (Barton, 1975, 1977; Barton and Armstrong, 1974; Bass, 1980; Bass et al., 1976, 1981); Canada (Blakely et al., 1978; Bouden, 1976); Maryland (Bond et

TABLE 18. SLAUGHTER CHARACTERISTICS OF FIVE PURE BREEDS OF BULLS AND THEIR CROSSBRED PROGENY IN TEXAS (AVERAGE FOR SLAUGHTERING AT 6, 9, 12, 15 AND 18 MO)

Trait	Jersey	Angus	Brahman	Hereford	Holstein
Purebreds					
Slaughter wt (kg)	221	310	295	287	364
Dressing, %	53.7	59.7	58.7	58.0	56.7
Carcass length (cm)	101	102	103	101	117
Longissimus dorsi muscle area (cm^2)	16	24	22	23	23
Fat thickness (cm)	5.8	4.0	4.0	4.5	4.5
Yield grade	2.3	1.6	1.6	1.8	1.8
Marbling score	6.1	8.1	7.0	7.1	5.3
Quality grade	12.9	15.4	15.2	14.6	13.9
% trimmed boneless cut	74.2	76.2	74.2	74.7	74.4
Crossbreds					
Slaughter wt (kg)	303	327	339	317	336
Dressing, %	57.1	58.3	59.3	55.7	57.5
Carcass length (cm)	106	106	109	105	109
Longissimus dorsi muscle area (cm^2)	21	23	24	24	25
Fat thickness (cm)	.20	.38	.33	.33	.22
Yield grade	1.7	1.7	1.7	1.7	1.7
Marbling score	6.2	7.4	6.5	6.9	6.6
Quality grade	14.0	15.0	15.0	15.0	14.4
% trimmed boneless cut	74.6	74.8	74.9	74.6	74.8

Source: Long et al. (1976)

al., 1972); Oklahoma (Boyd et al., 1978); Britain (Butler-Hegg and Wood, 1982; Williams et al., 1981); Nebraska (Crouse et al., 1975); and Texas (Talamantes et al., 1986).

While studies using one or two measures of fat have implied greater fat content in Jersey crosses, estimates on more areas conclude there is no significant difference in total body fat among breeds but there is significant differences in distribution, e.g., Talamantes et al. (1986). Following points made in other sections of the report, the beef studies further confirm that Jerseys tend to deposit more fat in and around the abdomen than most dairy or beef breeds. In the meat studies, Jerseys or its crosses do consistently rank highest in meat tenderness. The Jersey and its crosses were used globally in the 1960s and 70s in studies on beef production but this type of research virtually ceased in the 1980s mainly because of smaller size and carcass quality evaluations in effect during that period. Changes occurring in meat evaluation procedures stressing tenderness and lean, coupled with weight of calf weaned per cow and lighter weight at slaughter for more rapid turnover, could lead to a resurge in use of the Jersey, especially as a crossbred cow. Consumer education will also be needed because the high color of carcass fat gives the impression more fat is present than on carcasses with white fat. High color in the fat has been a deterrent for use of Jersey in Latin America because consumers want the appearance of "lean meat."

TEMPERATURE STRESS

From the late 1940s to late 1950s, the author and colleagues studied the tolerance to heat stress of several dairy breeds with Jerseys recorded as superior. This ranking in response also held when Jersey, Brown Swiss and Holstein were crossed with Red Sindhi, a Zebu breed from India. These findings, together with research in Britain and New Zealand, have resulted in the conclusion that the Jersey, even after adjustment for differences in milk yield and body weight, are less affected by thermal stress than other dairy breeds and less tolerance is lost in crosses with breeds native to warm climates than for other dairy breeds. Acceptance of the hypothesis has markedly reduced research on the effects of heat stress conducted in the years under review.

In recent years, most of the work in the U.S. was at the University of Florida comparing response of Jerseys and Holsteins with shade or no-shade provided during the summer months. Briefly, the findings are: rumen contraction rate is reduced under heat stress with Jerseys less affected than Holsteins (Collier et al., 1981); yields of milk and constituents of Holsteins are more sensitive to climatic variation but Jerseys undergo more change in percentages of constituents (Rodriguez et al., 1985); frequency of mounting during estrus declines under high temperatures but Jerseys are less affected; and in tests of possible benefits of supplementary potassium (K) to reduce the impact of thermal stress, Holsteins responded to added K but not so for Jerseys, indicating the breed did not need to mobilize additional K to promote sweating for aid in maintaining heat balance (Mallonee et al., 1985).

Additional "one-liners" are: Jerseys calving during the summer showed less decline in milk yield and breeding efficiency than Ayrshire, Brown Swiss and Holstein (Ruvuna et al., 1983); following walking 3 km during mid-summer, Jerseys proved more responsive to use of progesterone releasing intervaginal device for estrus than Holsteins (Ngah, 1984); and in Uganda, U.S. imported Jerseys outperformed imports from Kenya (Phipps, 1974). The number of LH pulses on day 5 of the estrous cycle is reduced by heat stress. The stress of temperature can suppress anterior pituitary gland release of LH without measurable influence on ovarian steroid hormone secretion (Wise et al., 1988). Jerseys appear less susceptible to restriction of LH pulses than Holsteins. There is some evidence, e.g., Mishra et al. (1987), that hemoglobulin (Hb) concentration can be used for ranking individuals within breed or compare breeds for tolerance to heat stress (adaptation). Using Hb concentration, Jersey and its crossbreds have ranked lowest in Hb and highest in tolerance.

There is some evidence that metabolic heat production of Jerseys is more susceptible to the effects of cold (Holmes and McClean, 1974).

In sum, the Jersey is generally regarded as having comparative advantage over other European dairy breeds in toleration to high temperature conditions; is slightly less tolerant to heat than breeds or types native to the tropics; and is higher in cold tolerance than native types but not as good as large dairy breeds.

BIOCHEMICAL POLYMORPHISMS

Antigens are used to characterize blood type for identification, which in turn may be used to solve problems of questionable parentage. The procedure is also used in diagnostic and prognostic tests of neonatal isolrythrolysis to determine associations with observed abnormalities.

In the F-blood group system, the Jersey has three identified alleles -- more than other breeds in Denmark but less than the six alleles characteristic of Zebu cattle (Lauren, 1982). Jerseys have three hemoglobulins (AA, BB and AB) with the gene frequency for the two main types (AA, BB) near similar, 51.4 vs. 48.6% (Costa et al., 1985). Studies of polymorphic composition of milk casein samples show Jerseys produce casein higher than average in stability both before and after freezing (El-Negoremy, 1974).

For the period covered in the review, certain lethal or near so problems were investigated, most of which are the result of autosomal recessive gene action.

RVC (rectovaginal constriction), its causes and effects on performance have received attention at Kansas State University under Leopold and associates (Taylor et al., 1985, 1986) and in Denmark (Larson and Hanson, 1986). The condition usually affects several anatomical features and certain physiological functions. It stems from a recessive gene (Allaire et al., 1982). Fortunately, the frequency among Jerseys remains low and carrier animals are identified by AJCC. A current major thrust is to develop a reliable method for routine screening of sires.

Research on the condition of limber legs indicate this semilethal abnormality is inherited as a simple autosomal recessive. During the 1970s, the frequency of that disorder rose suggesting a rise in gene frequency probably due to the popularity of a carrier bull, Favorite Commando, his daughter, Marlu Milady and a number of their descendants (Lamb et al., 1976). Since publication of this report, AJCC has taken measures to control the abnormality by identification of carrier animals.

Simersen and colleagues (1979) of Denmark report finding in one herd a syndrome characterized by lack of udder development and incomplete maternal preparation. Affected cows calved 8-14 d before expected, had marked reduction in udder size and secretory activity coupled with signs of ovarian malfunction and a different estrogen-progesterone pattern. These findings suggest a disorder in the complex hormonal regulation of maternal preparation and parturition. The syndrome has not been reported in the U.S.

In Australia (Allen, 1977), circumstantial evidence indicates that if congenital cerebellar hypoplasia is heritable, a single autosomal recessive gene is responsible; however, its being inherited is not widely accepted.

Results of test matings involving the production of 50 male Danish Jersey calves indicated that the Dag defect of the sperm tail is associated with an autosomal recessive gene. This condition is known to occur in Charolais cattle but does not appear common among most breeds.

Identification of a lethal or semi-lethal condition frightens breeders. There is real concern that a popular sire will transmit a gene but its effects will not appear until later (Allaire et al., 1982). Inherited abnormalities are a threat to all breeds, therefore breeders are encouraged to support research and routine testing. Kansas State University, with support from the U.S. Department of Agriculture and other organizations, is commended for its efforts over the past 40 years in identification and testing inheritance patterns of traits which may be lethal. On the whole, Jerseys appear above average in conditions resulting from autosomal recessive gene action, hence, there should be interest in research.

SEMEN CHARACTERISTICS

There is no evidence in the literature of differences in characteristics of semen among cattle breeds being such that require special practices in collection as well as processing and use. A few studies do provide indications of some advantages of semen from Jersey sires.

Jersey semen showed significantly better forward motility at five minutes after immersion in a water bath than Holstein semen. It was concluded that thawing Jersey semen at 37°C was better than at 25 or 4°C as the loose acrosomes were lower following the 37°C immersion (Bhasrehan et al., 1984). Fructose concentration in semen tends to remain higher for Jersey than Holstein with advancing age of sire (Alamy et al., 1976). The relative content of DNA in spermatozoa presumed to be the X- and Y-chromosome bearing gametes of several breeds was studied at Oklahoma (Gardner et al., 1983). Spermatozoa from Jersey bulls had larger X-Y peak differences than from Holstein, Hereford or Angus.

It can be said that research from 1970-87 on spermatozoa does not indicate need for special consideration in the handling of semen from Jersey bulls.

ECONOMICS

Observations from Eastern European countries (e.g., Hungary, Poland, Rumania), the Netherlands and Japan, where pricing favors milk composition and land is scarce or in small holdings, recommend Jerseys. Examples to illustrate are: in the Netherlands (Brandt et al., 1983), Jerseys were compared to the Zwarthout breed. Jerseys required 20% less feed and yielded 33% higher in price value for milk. Jersey calves and carcass value of steers were lower but Jerseys needed only 20% replacement annually vs. 25% for Zwarthout; therefore, on small farms of 10 ha the lower feed required made it possible to keep 10 more cows.

In Japan, economic returns were compared for Holsteins and Jerseys. Reproduction rates were similar; milk yield averaged 4359 kg (H) and 3391 kg (J); the proportion of TDN from roughages and farm produced feeds were higher for Jerseys (62.2 and 54.3% vs. 43.7 and 32.3%); production costs were higher for Jersey than Holstein (18.2 vs. 12.8 million yen); net income was similar, 5.25 and 5.50 million yen for Jersey and Holstein; but better use of farm produced feeds and longer herd life by Jerseys strongly favored their use (Thomyama, 1984).

A study in Britain showed that gross margin per cow of Jerseys was 94.5% of that for Friesians. Profitability of Jerseys was improved by increased premiums for milk components but low price of cull cows (40% Friesian) remains a disadvantage (Nix and Wilson, 1986).

In Florida DHIA herds, margin returns favored Holsteins ($542 per lactation) but cost per lactation favored Jerseys by $323. Net return difference was $126 in favor of Holsteins (Table 19). The difference in net return would have approached zero or been plus for Jersey had the Florida model included cost of support for a higher replacement rate as found in the Netherlands study and utilization of farm produced feeds as pointed out in the Japanese study.

TABLE 19. MARGIN, MARGIN COSTS AND MEANS FOR PERFORMANCE TRAITS FOR JERSEYS AND HOLSTEINS IN FLORIDA DHI HERDS (UNITS $ PER LACTATION UNLESS OTHERWISE STATED)

	Jersey	Holstein	Diff.
No. cows	294	668	
Margin (returns)			
Margin/lactation, milk	1109	1304	-195
Margin/d calving interval, $/d MPD	2.7	2.9	-.2
Milk carrier revenue	502	736	-234
Milk fat revenue	814	797	17
Milk protein revenue	507	637	-130
Margin costs			
Feed, production	405	487	-82
Feed, maintenance	250	343	-93
Feed, dry	67	92	-25
Insemination	19	44	-25
Mastitis treatment	99	197	-97
Cow performance			
Calving interval, d	402	434	-31
Days in milk	329	362	-33
Days open	122	159	-37
305-day milk, kg (ME)	5650	8221	-2571

Source: Univ. Florida 1986 Annual Report to Regional Project S-49 (1987).

Collectively, the studies cited show that better utilization of roughages suggested by some of the nutrition studies and merits in reproduction ought to be considered in evaluation of returns from Jerseys.

BEEF PRODUCTION

1. Pure Jersey

As a purebred, the Jersey is not highly valued for either veal or beef production. In comparisons made, it has almost been exclusively compared to large dairy breeds or beef breeds such as illustrated for veal production in the Netherlands in Table 20. Except for low fat score, meat color and weight of salable carcass, the Jersey ranked below the Meuse-Rhine-Yssel, a large breed, and the F_1 crosses (ranked as medium in size). This same trend prevails throughout the published reports.

TABLE 20. THE NETHERLANDS BREED MEUSE-RHINE-YSSEL VS. JERSEY FOR VEAL PRODUCTION

	Breed group		
Trait	Meuse-Rhine-Yssel (MRY)	Jersey	Jersey x MRY
Weight at 10 days, kg	46.0	30.6	39.4
Duration of fattening, d	153	163	155
Final weight, kg	226	160	206
Daily gain, kg	1.18	.79	1.07
Feed/kg gain	1.68	1.96	1.78
Dressing, %	64.0	57.9	61.8
Meatiness score (scale 1-15)	7.6	2.4	5.3
Fat cover score	5.6	4.9	5.9
Meat color score (1=light, 9=dark)	3.5	3.6	3.4
Weight salable meat, kg	66.7	65.2	65.6
Profit/carcass (Df)	1668	462	605

Source: de Roory et al. (1987)

Overall, Jerseys come out on the low end as steers or bulls. There are, however, some suggestions that the breed holds its own or excels. For example, in Britain, Hind (1978) found Jersey bulls did not differ from Friesian in efficiency of growth of lean tissue when slaughtered at 1, 12, 24, 28 and 72 wk of age. The two breeds had the same allometric coefficient (.61) and when the breeds had equal maximum efficiency, the Friesian to Jersey ratios of prenatal input, total feed eaten and total lean produced were 2.6:1. Several studies, e.g., Spiker and Hollet (1978) have found Jerseys vs. Holstein in dressing percentage, weight of bone and meat quality favored Jersey. Tests have all agreed that Jersey meat is among the most palatable to humans.

The Jersey cow in beef production systems has been universally extolled for its early breeding, faster rebreeding and low rate of dystocia. Norris and colleagues in New Zealand (1985) contend the value of Jersey in meat production goes unappreciated because of a common standard for all breeds. They state that using the same weight target for live weight or condition score for different breed groups is unrealistic and total efficiency measures must encompass more than carcass weight or marbling score. Along the same line, Marshall and Frahm (1986) of Oklahoma point out that on a 405-ha farm 106-108 Jersey cow-calf units can be carried vs. 84-88 for Simmental crosses.

In numerous Third World countries, the small, native breeds are being "rediscovered," e.g., the Criollo type in Colombia rates way ahead of Brahma in reproduction rate; the N'Dama breed of West Africa is more efficient in several countries than Zebus; local types in the Philippines and in Thailand have proven superior in returns over large breed crosses, e.g., Charolais. Mature females of these breeds weigh 230 kg (N'Dama) to 360 kg (Colombia) and males 290-440 kg. In Thailand, Brahma and Charolais x native crossbreds were compared to native cattle on pasture feeding. Birth and slaughter weight favored the crosses but based on an index to include percent weaned, age at first calving, calving ease, calving interval, mortality, weight of calf weaned per cow per year and stocking rate, the native excelled. Based on best slaughter weight as being 80% of mature weight, the average age of slaughter was 2.0 to 2.3 years versus 3.8 to 4.7 years for the large breed crosses, hence the native had the lowest risk. The feeling at this time is that when dependence on grazing is up to 100%, small cows excel in efficiency in production of beef and carcass quality is equal to the "new emphasis" in beef production on lean carcass.

2. Jersey-Sired Crosses

The bibliography includes about 30 citations on use of Jersey bulls in at least 10 countries to produce crossbreds with either large dairy or beef breeds. Most of these tests were conducted in the early 1970s. With a known 30 to 40% difference in mature weight between Jerseys and the large beef breeds and assessment based on weight and fat, one wonders about the hypothesis of the planning as heterotic effects would have to be exceptionally large for Jersey crosses to excel.

The means in Table 21 from Oklahoma on Jersey x Angus or Hereford crosses vs. Angus x Hereford or Brown Swiss and Simmental x Angus or Hereford illustrate the general findings based on weights and carcass score. Many of the tests stopped their assessment at this point with a negative impression of the Jersey for commercial beef production. Jersey sires were used in Oklahoma State University, Texas A&M University, the University of Wyoming, Washington State University and the Roman L. Hruska U.S. Meat Animal Center in Nebraska. A typical example of assessment of results can be taken from Baker and Long (1982) and Belmer et al. (1984) from experience in Texas with Jersey, Angus, Hereford, Holstein and Brahma. Holstein and Jersey ranked lowest among purebreds for fat thickness; second for kidney, pelvic and heart fat; with Jersey crosses lowest in conformation score, marbling score and final grade; third in percent retail cut; Jersey crosses had significantly less longissimus dorsi area and less external fat; but Jersey crosses showed no significant deviation in cutability. Jersey sired cross steers were, however, consistently best in low proportion of bone in the carcass, tenderness of meat and well above average in acceptability.

TABLE 21. CHARACTERISTICS OF TWO-BREED CROSS STEERS FED AT WEANING AGE AND AS YEARLINGS IN OKLAHOMA

	Breed of Sire			
Trait	Jersey	Angus	Brown Swiss	Simmental
Initial wt, kg	210	227	230	216
Age slaughter, d	489	497	519	522
Final wt, kg	420	474	516	499
Feed efficiency[b]	8.84	8.14	7.98	8.84
Carcass growth	9.4	10.1	9.8	10.1
Dressing, %	59.0	60.9	61.0	61.4
Fat thickness, cm	1.7	2.4	1.9	2.2
Rib eye area, cm^2	28.2	30.5	33.2	31.8
Cutability, %	48.1	46.6	47.5	46.8
ADG, kg	1.1	1.3	1.3	1.2

[a]Jersey x Angus or Hereford; same for the three breeds.
[b]kg feed/kg gain.
Source: Frahm et al. (1973, 1975, 1976).

The conclusion is most of the experiments were set up to produce F_1 cross cows. The beef operations did not have Jersey females, therefore, Jersey sires served as the lowest cost means for introduction. As will be shown in the section to follow, the Jersey x beef breed cross is an outstanding mother.

3. Crosses from Jersey Cows

Except for Texas A&M University, reports on the use of Jersey cows for beef crossing come from outside the U.S. In these tests, greatest emphasis is given to reproduction rate and cow efficiency (calf weight weaned per cow exposed for breeding or per 100 kg cow weight). The findings are summarized as follows:

In Texas (Cartwright et al., 1973), Jersey cows on pasture had a calving interval of 279 d and 395 d in drylot versus 397-411 d for other breeds.

In Australia, Jersey cows were mated to bulls of Charolais, Hereford, Shorthorn, Santa Gertrudis and Brahma (Deland et al., 1979, 1983; Gifford, 1977). Progeny of Jersey cows were highest in daily gain on pasture; had leaner carcasses; were lowest in dystocia; and their heifers were the earliest in fertile estrus and had highest frequency of estrus on pasture rearing. It was recommended that low yielders or mastitis cows in dairy herds be mated to any beef breed to produce breeding females for beef herds or leaner males for fattening.

In the southern U.S. in the late 1950s and 1960s it was recommended that Jerseys near culling be bred to Angus or Hereford sires to produce replacement cows for beef herds.

In South Africa, Friesian or Jersey cows were mated to Charolais, Brown Swiss or Hereford sires (Naude, 1977). Again, Jersey cows were lowest in dystocia, had the shortest gestation (282 d) and the crossbred progeny were lowest in mortality (6%).

Obviously, the Jersey cow has comparative advantages as a mother for beef production through excellent reproductive efficiency, high quality milk and lower maintenance requirements.

4. The Crossbred Cow

The literature from the mid-1970s to the mid-1980s abounds with reports principally on first generation crosses (F_1) and some 1/4 crosses in a number of countries and include combinations with over fifteen breeds. Overall, the F_1 Jersey cross cow has an excellent record as a dam.

Among the major findings are: Oklahoma (Belcher and Frahm, 1979; Belcher et al., 1978; Chenette and Frahm, 1981; Frahm et al., 1979, 1981, 1985; Marshall, 1985; Marshall et al., 1982); Jersey x Angus cows produced more milk (8.2 kg); had higher fat content than Hereford or Brown Swiss and Simmental cross cows; had greatest number of calves born alive; were lowest in calving difficulty; were earliest for first estrus (312 vs. 347-478 d); second highest in 244 d calf weight (272 kg); for 365 d production cycle consumed 6.4% less TDN; were highest in calf weaning weight (kg of TDN/kg calf); cows weaned 17% greater weight of calf per cow exposed; highest in calving percentage (93%); required calving assistance only 11.4% of calvings vs. 48.5% for other crosses; best in net superiority when mated to Limousine and Charolais sires; most productive as 2-yr-olds (90% exposed to breeding weaned calf vs. 53% for beef crosses); as 2-yr-olds were 37.4% more productive in kg of calf weaned per cow; and progeny of Jersey crosses were below average in birth weight but excellent in acceleration rate for growth. Three breed cows (1/4 Jersey) also were highest in percent of cows weaning calf exposed to breeding and lowest in assistance needed at parturition (3.7 vs. 13.5%).

Nebraska (Notter et al., 1978, 1978, 1978): progeny of Jersey sired crossbred cows produced progeny that grew fastest and were heavier at 120 d of age and the cows were best in calving ease; lowest in calf mortality; and rated highest in overall efficiency.

Wyoming (Wingert et al., 1985, 1985): Jersey x Hereford cows were lowest in total culling rate (53 vs. 54-71%); lowest culling rate at young ages; calves born earlier; calves gained fastest; and had heavier weaning weight. Also the Jersey cross cows were significantly more mature in body weight at all ages and were significantly above average in maturation rate.

Washington State University (Gaskins et al., 1982): Jersey x Angus and Simmental x Angus bulls were compared. Jersey crosses required less feed for gain which was confirmed by Long et al. (1976) in Texas.

Canada (Bourden, 1977): Jersey x Angus cows had lowest frequency for calving assistance; and calves were lowest in mortality; were second in growth rate; and had lowest bone weight in carcass.

New Zealand (Barker and Carter, 1976; Baker et al., 1976; Bass et al., 1976; Carter and Jones, 1976; Carter et al., 1976; Morris et al., 1985; Nicoli and Everett, 1978): Jersey crosses from Friesian sires were highest in pregnancy rate (87%); lowest in dystocia rate (1%); weight of calf weaned per cow weight; youngest age at puberty (255 d); and produced offspring with highest percent lean in carcass and lowest in bone weight; were average in cutability; but had less longissimus dorsi area and less external fat.

A number of the observations among locations are repeated to emphasize breadth and common findings. Use of Jerseys in beef crossing has declined principally because of timing of the tests and the low standing of the Jersey cross males in carcass standards. As stated by Morris et al. (1985), it is unfortunate that one target of performance, based on dressing rate and fat covering of carcass, is used. This group contends that various breeds and crosses should have separate condition scores at slaughter because a single system is unrealistic. Seemingly, the Jersey x beef breed crossbred cow is so superior as a producing unit that the economics of their use should be explored to include reproduction rate. Clearly, the Jersey breed ranks high in combining ability with all breeds (high heterosis), e.g., a Jersey x Angus cow handles fetuses of both small and large breeds with low difficulty.

CROSSING FOR MILK PRODUCTION

This is a role the Jersey has played worldwide. Those experimenting had one or more goals: using the advantage in reproduction rate, high quality milk or to produce an intermediate size cow with high efficiency, fitness to poor environments and recognized good combining ability with most all known breeds. Because of limited availability of Jersey females in Third World countries, the literature citations are by-in-large the product of the use of Jersey sires.

Jerseys and Shorthorns were the most popular breeds for crossing or grading-up dating back to the late 1800s in Australia, India, Pakistan, Egypt and in the Caribbean Islands. Popularity of these two breeds exceeded all others until the late 1940s. Interest in the use of the breed in tropical and subtropical areas was to increase size of small local stocks up to 360-400 kg and to have milk of high quality. In Australia, it was to shift from a dual-purpose Shorthorn to cattle more profitable in the world butter market and high probability of annual breeding when feeding on pastures. For Eastern Europe, interest in Jersey lay in shifting large breeds normally used for draft to medium size types with high fat content in the milk, e.g., the Rhodope Shorthorn of Bulgaria was crossed with Jersey. The local breed had a milk yield of 1300-1800 kg with 4.5-4.8% fat. The crosses averaged 2500-3000 kg with 4.7-5.0% fat. Intermating of the F_1 crosses then produced the "Improved Rhodope" (Vladimisos et al., 1985).

The USSR has developed a new type of Russian Black Pied cattle with 75% Jersey breeding based on yield of FCM per 100 kg of body weight (Ioannisyan, 1985).

In Britain, Jersey crossing received attention due to higher overall efficiency than Friesian as a milk producer (Donald et al., 1977).

For tests of crossbreeding in the U.S., objectives of use of Jerseys has varied. One of the earliest recorded tests was in Maine where Angus, Ayrshire, Guernsey, Jersey and Holstein were crossed to determine the effect on color patterns and other phenotypic traits. The studies, conducted by the U.S. Department of Agriculture (1939-1955), among Guernsey, Jersey, Holstein and Red Dane; the test at Clemson University (1938-1952) with Brown Swiss, Guernsey, Jersey and Holstein; and in Georgia with Brown Swiss, Jersey and Holstein (1950-1968), were based on breeding stocks available for testing of possible differences in combining ability and heterosis obtained by crossing. Jersey was the breed chosen for crossing with Red Sindhi from India for its size, tolerance to heat stress and milk quality (McDowell et al., 1976).

An overview of the Jersey programs directed to milk production for the period under review are interpreted with differentiation between Jersey dam and sires.

1. Jersey Dam

Donald et al. (1977) found that 2- and 3-breed crosses among Ayrshire, Friesian and Jersey with 25-50% Jersey were highest in efficiency expressed as output of milk energy per unit of cow size, were lowest in calving interval and showed the highest level of heterosis (best combining ability). Jersey crosses were, however, lower in milk yield. Crossing with Jersey would have remained popular in Britain had there not been a strong shift to the U.S. Holstein.

In New Zealand, Friesian sired crosses were 16% larger than Jersey, yielded 16% more milk, 4-9% higher fat yield, 9.0% greater protein production and 16% more lactose, but total milk fat production and financial returns favored purebred Jerseys (Campbell, 1977). MacMillan (1981, 1985) found the Jersey to have excellent combining ability. Crosses with Friesian averaged 16% greater than the parental mean in body weight, 5% greater fat yield and were 17% higher than the mean in milk production. The crosses were rated above both parent breeds in calving rate after first lactation. Similar observations come from Denmark when Jersey females were crossed with Danish Red bulls. There is a common comment among tests that Jersey crosses conceive well on first service but an unexpected number become non-breeders as they pass one or two services.

2. Jersey as Sire

Jersey sired crosses have been a group in almost all crossbreeding studies over the past 50 years. First generation females have on average shown higher performance than reciprocal crosses. These crosses have been highest in percent fat and solids-not-fat yields, above other crosses in breeding efficiency and near the top in yield of milk per unit of cow size. It should be noted that Jersey sired crosses do not have as high proportion of slow or non-breeder problems as those from Jersey dams. F_1 females mated to produce 3- breed crosses either excel or near so over other crosses in most traits (McDowell, 1982; Hollon and Branton, 1975; McDowell et al., 1974, 1976).

Crosses by Jersey sires are especially popular in eastern European countries, e.g., Bulgaria, Poland, Hungary and USSR. In Bulgaria, Jersey crosses are liked for fat content of milk as a readily marketable product from remote rural areas and low feed requirement per kg of FCM. Jersey crosses are highly recommended for small farms in mountainous areas (Zabarier et al., 1983). The Jersey cross is also valued in Poland and Hungary since it has the highest milk yield per unit of cow size.

There are many reports from the USSR and they continue to come. Jersey crosses have performed well compared to local breeds in a number of areas, e.g., Gotsrirdze (1984) and Guri et al. (1983, 1983) claim Jersey is best for crossing in central USSR based on high performance and response to domestically produced milking machines. Productive life is good, up to 6.76 years for 1/4 Jersey crosses (Zhivotnovodstvo, 1987; Prokhorenko, 1985). Milk of Jersey x local cattle crosses is richer in amino acids and gives higher quality butter. Receipts for quality milk favored crosses by 20% (Prudov, 1974). Jersey x Russian Black Pied (RBP) crosses had lower age at first breeding and feed units per kg of gain than Friesian x RBP, Russian Red x RBP or pure RBP or pure Kortroma (Stickum, 1982; Denisona, 1981).

In Sweden, Jersey x Swedish Polled crosses were slightly below Friesian x Swedish Polled crosses in rate of daily gain but the Jersey crosses exceeded in feed conversion (Dim, 1977).

The bibliography includes over 40 reports on crossing of Jersey with local breeds in tropical areas of Africa, Asia and Latin America with the largest number in India. During the period of review, there have been over 300 publications from 28 countries in Animal Breeding Abstracts. Highlights of findings are illustrated.

Jersey x local Damietta (D) crosses exceeded Shorthorn x D crosses and pure D in Egypt for milk yield, FCM and calved younger (32 vs. 35 mo) (Gabr et al., 1985).

In Ethiopia, Jersey x Arsi (local breed) ranked lower for milk yield than Holstein x Arsi or Holstein x Zebu crosses but based on the recommended index of milk yield + milk quality + maintenance requirements, the Jersey crosses ranked highest (Kiwuwa et al., 1983).

The author has assisted the Ministry of Agriculture, Pakistan, in evaluating fractional crosses of Jersey or Holstein x Sahiwal (native Zebu breed of central Pakistan and best of all Zebu breeds in milk production). Values for the crosses are given in Table 22. Environmental conditions in the herds

TABLE 22. MEANS FOR JERSEY X SAHIWAL AND HOLSTEIN X SAHIWAL

Trait	Jersey crosses[a]						Holstein crosses[a]					
	3/4	5/8	F_1	F_2	3/8	1/4	3/4	5/8	F_1	F_2	3/8	1/4
Milk yield, kg	1697	1114	2182	1599	1196	1243	2099	1859	2529	1966	1432	1558
Lactation length, d	242	242	265	241	232	220	264	259	273	264	230	226
Services/conception	2.27	2.11	2.26	1.42	1.21	2.53	2.50	2.28	1.89	2.09	1.50	2.66
Age 1st breeding, d	560	485	491	693	730	624	570	687	491	735	767	735
Age conception, d	618	667	526	741	740	783	650	778	517	751	764	804
Length herd life, mo	62.9	69.1	73.1	51.2	50.4	60.9	60.7	48.7	74.1	48.2	49.9	58.0
Mortality or culled, %												
0-1 mo	28.6	20.0	12.2	18.1	5.0	20.4	28.7	27.0	20.9	12.7	5.6	22.5
0-calving[b]	57.1	60.0	83.7	36.4	77.7	52.6	48.5	40.5	66.0	52.2	54.5	50.0
Lactation > 60 d[c]	47.6	60.0	77.6	36.4	61.1	52.6	47.5	37.8	63.6	47.0	45.4	45.0
Rate of development												
Birth/48 mo[d]	5.7		5.7	6.0	6.3	6.0	6.3	6.4	6.0	6.3	6.5	5.4
3 mo/birth[e]	268		301	256	246	253	224	226	250	212	226	232
12/48 mo[f]	46.9		56.8	44.2	39.8	40.8	43.6	37.5	45.0	41.6	35.4	39.7

[a] 3/4, etc. represent fraction of Jersey or Holstein breeding; F_2 from inter se mating of F_1 crosses.
[b] Mortality birth to first calving.
[c] Percent calved that completed lactation at least 60 d.
[d] Calf weight as percent of dam weight at 48 mo.
[e] Ratio of change from birth to 3 mo.
[f] Ratio of 12 month to 48 month body weight.
Source: McDowell (unpublished).

were poor due to fluctuations in feed resources resulting from either excess (flood) or deficiencies (drought) in rainfall; but not dissimilar to prevailing conditions in many of the developing countries. In this evaluation, overall (1/4, 3/8, 1/2, 5/8, 3/4) the Jersey crosses were 26% lower in lactation milk yield, had 5% fewer days in milk and required 9% more services for conception. But the Jersey crosses averaged 11% fewer days to time of first breeding, were younger at conception (5%), remained in the herd 8% longer, had lower mortality rate from birth to one month of age (13%), more cows that completed a lactation 60 days by 17%, and yielded 8% more milk per 100 kg of body weight. Although the Jersey cross calves averaged 3% less at birth in proportion to dam weight (birth/48 mo), they grew 11% faster from birth to 3 mo (3 mo/birth) and showed a similar advantage in ratio of change from 12 to 48 mo (12/48 mo) (Table 22). Based on the index used by Kiwuwa et al. for Ethiopia, the "net merit index" values favored Jersey crosses by 9% over Holstein crosses.

Syrstad (1985) summarized the relative merits of various Bos taurus dairy breeds for crossing with Bos indicus (Zebu) cattle using Friesian or Holstein (F), Brown Swiss (BS) and Jersey (J). Age at first calving average F, 32.6 ± .2, BS, 34.5 ± .3 and J, 31.6 ± .2 mo; and milk yield 2166 ± 31, 1917 ± 58 and 1725 ± 36 kg. Jersey crosses had a significantly shorter calving interval 410 ± 3 vs. 429 ± 3 and 432 ± 5 for F and BS crosses. Syrstad concluded ranking of crossbreds was consistent across different studies.

Some indications which can be drawn from experiences using Jerseys for crossbreeding are: the breed is highly respected for its general combining ability with all other breeds; its crosses are well regarded for reproductive efficiency; but popularity of Jersey crosses is waning because of about 25% less milk yield than Holstein crosses. This is not as it should be especially in the developing countries. Unfortunately decisions have been made purely on total milk yield. Where feed resources are limited a "net merit index" such as proposed by Kiwuwa et al. would be more appropriate to estimate returns. In India, over 50% of the 3/4 Holstein crosses born alive do not live to calve (McDowell, 1984). Farms with limited resources cannot tolerate such losses. Jersey breeders have a challenge to promote their breed considering its unique characteristics.

OTHER TRAITS

Some additional traits receiving attention in only a few studies are enumerated to indicate differences among breeds or lack thereof as additional guidelines in projecting the future of Jerseys.

1. Coat and Hair Characteristics

Jerseys are similar to other European dairy breeds in number of hair follicles per unit of body area, number of sweat glands per unit of surface area, number of sebaceous glands per cm^2, but there is evidence that the "oil" or sebaceous gland secretion rate is higher for Jerseys. Such would provide somewhat more protection to the skin under heat or cold, plus adding some resistance to the presence of ticks. Length of hair or pelage is similar to other dairy breeds and so is the cyclic seasonal changes in length. Jerseys do appear less susceptible to the condition "wooley coat" in tropical areas than Holstein or Brown Swiss. Today's Jerseys seldom have areas of non-pigmented skin which leads to low incidence for sunburn.

Hair weight per cm^2 of skin, skin thickness or hair diameter are not significantly correlated with milk yield or fat percentage in Jerseys or Friesians (El-Halawamy et al., 1984).

The consensus is that present appreciation of the relationship of hair and skin characteristics to overall performance and selection to produce changes does not appear warranted.

2. Other Physiological Characteristics

Rates of respiration and heart are similar for Jersey and Holstein with Jersey having slightly greater heart stroke volume per unit of metabolic size. Rates of water transudation through the skin and sweat output per gland are similar to Holstein. Some differences in digestive capacity possibly favoring Jersey if exploited were cited in earlier sections.

In a non-stress temperature environment, levels of blood hormones per unit of metabolic size appear equivalent to Holstein. Blood hemoglobulin may be higher in Jersey.

For the period of review, no studies were found where there was concern over breed differences in digestive physiology, rumen fermentation rate, rate of passage, rumen microflora or feeding behavior; yet, there are tidbits or inferences that all of these could show breed differences. The author has shown, for example, that Zebu cattle have a different feeding strategy; being more selective feeders than Bos taurus cattle. This has been of most significance in dominance of Zebu in the north-south 30° latitudes around the world. The difference in selectivity for Zebu and rate of intake of DM (g/h) of feed by Bos indicus and Bos taurus have shown important specie differences in the utilization of forage DM.

3. Poll vs. Horns

There is the odd report recommending more emphasis on selecting for pollness in Jerseys. Time has seen a decrease in investigations on pollness because of possible higher risks in autosomal recessives and reduction in population size for selection. Additionally, poll stock have not been meritorious in performance. Polled animals are pedigree identified by AJCC with a P suffix to registration name. Currently high ranking progeny tested bulls are identified as polled

4. Type Score

As stated at the outset, type appraisal was not reviewed, however, had the study been restricted to U.S. publications, the topic would have been a must. About 20% of the U.S. reports are devoted to studies of type appraisal. No data was found on long time studies involving herdmates of two or more breeds undergoing the same scoring.

Some comments are offered to support the image of Jerseys outside the U.S. In New Zealand, Ahlhorn-Breier and Wickham (1987) stated that Jersey farmers appeared to consider more conformation traits than Holstein farmers. This concerned them in a period when Jerseys are experiencing strong competitions from an expanding Holstein population.

During the mid-1970s, the author reported that Holstein breeders in Mexico and Puerto Rico were likely giving 3 to 5 times greater emphasis to type score than PD milk in selecting sires from Canada and the U.S. This was logical because the press on sires emphasized the high prices paid for high type scored sires and their progeny. Foreign breeders deemed these were our "best sires." When sire summaries were made for progeny in Mexico and Puerto Rico, high PD milk sires proved best. This resulted in a shift of attention from type in sire selection. The indication is that type score in any dairy breed may have important merchandising value in the U.S. but may prove much less valuable in overseas promotion for either pure breeding or in crossbreeding programs particularly in developing countries where we hope to develop markets for semen and cattle.

5. Temperament

The Jersey is recognized as a breed that is docile and having excellent overall temperament. This characteristic is accepted as standard in the U.S. but is still a strong consideration overseas. The Jersey and its crosses are preferred by farmers in India because they can be milked without restraint. Pritchard (1975) stated that Jerseys were popular in Saudi Arabia over other breeds and the local Baladi cattle because of their excellent response to either hand or machine milking without restraint. Mountain farmers near San Jose, Costa Rica like Jerseys because of their easy response to tethering either as calves or as cows.

6. Draft Power

In India (Ray et al., 1972) and in countries of West Africa where draft power in agriculture is rapidly expanding, 300-400 kg bullocks are preferred. With constraints in feed resources, smaller bullocks hold up better (longer life) and are considered more efficient workers (lower resting time required) than breeds with expected mature size > 500 kg such as Holstein or Brown Swiss crosses. Small fields prevail and lighter, less expensive implements are favored to include light, 2-wheel carts.

SELECTION

1. Heritability

Almost universally, selection programs for genetic change give primary emphasis to milk yield with hopes that performance in other traits will also improve or not decline to the point that the primary objective is hampered. However, a number of reports, especially outside the U.S., recommend use of one of several indices which include weighted constants for additional traits. Most of the additional traits, such as fat yield, have a high genetic correlation with total milk yield (.80) while others are lower, e.g., .20.

Table 23 contains some representative repeatability and heritability estimates for characteristics of European dairy breeds in temperate areas. Most rapid genetic change could be expected from selection for fat. Correspondingly changes in protein content could be realized fairly rapidly, but change in milk yield is slower and much lower in reproductive traits. All the heritability estimates in Table 23 show considerable range due to data sets from which the estimates were made, method of estimation and to some extent an effect of calving year.

TABLE 23. SOME REPRESENTATIVE REPEATABILITIES AND RANGE OF HERITABILITY ESTIMATES FOR PERFORMANCE TRAITS OF DAIRY BREEDS

Trait	Repeat-ability	Herit-ability	Genetic correlation with milk yield
Milk yield	.35-.60	.20 to .30	
Fat yield	.49	.20 to .30	.85 to .95
Total solids yield	.47	.20 to .30	.85 to .95
Fat %	.70	.50 to .60	-.20 to-.50
Protein %	.42	.45 to .55	-.20 to-.45
Feed efficiency	.60	.30 to .40	.50 to .60
Clinical mastisis	.31	.10 to .30	?
Mature size		.30 to .50	-.20 to .10
Milking rate	.52	.30 to .54	.49
Type score (overall)	.48	.15 to .30	.20 to .94
Reproductive efficiency	.04	.0 to .10	?
Services/ conception	.00 to .22	.0 to .10	?
Calving interval	.07 to .13	.0 to .5	
Days 1st service to conception	.11	.07	
Days open	.12	.04 to .10	
Twinning	.01	.07	
Gestation length	.74	.20 to .38	

Heritability estimates derived for Jerseys only or mixed breeds where Jerseys were included during the period under study are in Table 24. All those traits common with Table 23 show that estimates for Jerseys fall within the ranges for European breeds in general. Since the magnitude of the heritability value can be important as a constant in current methods for estimating values for sires, Seeland et al. (1984) and others feel estimates for Jerseys in common use may be lower than for Holstein (Table 25). These authors accentuate possible differences by showing that first and second generation crosses tend to fall near the parental mean. Seeland and colleagues may have a point but there is tenuity in accepting a heritability of milk yield as low as .12 as their sample size, method of determination and other factors may not be comparable for other estimates, as for example, values in Table 23.

At this point, the position is taken that the prepondence of reports (Table 23) indicate differences in heritability estimates among recognized dairy breeds undergoing selection through use of progeny tested sires is likely small or nil, but the topic should be kept open to further examinations.

2. Results from Selection

Studies from DHIA records show positive genetic trends in milk and fat production and fat percent (Verde et al., 1972). In New York, the percent genetic trend for milk yield was found similar for Jerseys and Holsteins even though there were more kg because of scale effects. It has also been concluded that Jersey breeders are making positive assortive matings (good sires and good maternal grandsires) (Everett et al., 1979).

Over the last 15-20 years, selection experiments have been conducted in the U.S. in conjunction with the Southern Regional Dairy Cattle Breeding Project (S-49), New Zealand and Britain.

The program in New Zealand was based on an index for milk and fat yield to develop high (HL) and low index (LL) lines of Friesians and Jerseys. Female calves from the HL weighed 223 kg at 365 d vs. 193 kg for LL (Bryant, 1984). After first calving, HL cows averaged 40-50 kg heavier (Macmillan and Bryant, 1985).

It was indicated that the differences were of genetic origin. The HL had higher milk and fat yields and larger udder volume. In both Friesian and Jersey lines, udder volume was positively cor-

TABLE 24. HERITABILITY (h^2) ESTIMATES FOR VARIOUS TRAITS OF JERSEY OR MIXED BREEDS

Location	Breed	Trait	h^2
U.S.	Jersey	1st lact. milk	.34
U.S.	Jersey	1st lact. milk	.40
Brazil	Jersey	1st lact. milk	.26 ± .09
U.S.	Jersey	2nd lact. milk	.20
U.S.	Jersey	2nd lact. milk	.27
U.S.	Jersey	3rd lact. milk	.23
U.S.	Jersey	1st lact. fat yield	.29
India	Jersey	Persistency milk yield	.31
U.S.	Mixed	Age 1st calving	.16-.47
Denmark	Jersey	1st calving interval	.031
Denmark	Mixed	Non-return rate	.01-.036
Brazil	Jersey	Gestation length	.38 ± .085
U.S.	Mixed	Gestation length	.24 ± .10
U.S.	Jersey	Days to 1st service	.06 ± .03
Brazil	Jersey	Days open	.04 ± .04
Brazil	Jersey	Calving interval	.03 ± .04
Brazil	Jersey	Services/conception	.06 ± .04
U.S.	Jersey	Services/conception	.08 ± .03
U.S.	Mixed	Services/conception	.05 ± .08
U.S.	Mixed	Days calving-1st estrus	.14 ± .11
U.S.	Jersey	1st services to conception	.04 ± .03
U.S.	Jersey	Stillbirth	.019
U.S.	Jersey	Dystocia	.069
U.S.	Jersey	Incidence clinical mastitis	.42 ± .14
U.S.	Jersey	No. separate cases/lact.	.12 ± .13
U.S.	Jersey	Type score 14 traits	.13 to .33
U.S.	Jersey	Type - final score	.23
		- general appearance	.19
		- dairy character	.20
		- mammary system	.26
		- fore udder	.22
		- rear udder	.21
		- teats	.19
		- suspensory ligament	.11

TABLE 25. HERITABILITY FOR SEVERAL TRAITS FROM GERMAN RECORDS FOR PURE JERSEY (J) AND HOLSTEIN (H) AND BLACK PIED (BP) X JERSEY CROSSES WITH 50 OR 25% JERSEY

	Breed groups			
Trait	J	1/2 J x BP	1/4 J x BP	H
1st lactation yield				
Milk	.12	.10	.25	.35
Fat	.19	.11	.20	.33
Protein	.11	.08	.19	.31
Percentages				
Fat	.29	.25	.34	.47
Protein	.14	.19	.20	.25

Source: Seeland et al. (1984)

related to milk yield at all stages of lactation (r^2 = .22 to .66) (Davis et al., 1985). Each one unit increase in milk-fat breeding index was associated with an increase of .85 units in milk breeding index for Jerseys but lower (.55) for Friesians (MacMillan and Bryant, 1985). Based on energy balance trials, the metabolizable energy (ME) intake per unit of metabolic weight ($W^{.75}$) in early and mid-lactation was 10-20% higher for HL cows. Partitioning of ME was not significantly different for HL and LL cows but favored HL. The HL cows partitioned 34 Kg/$W^{.75}$ more gross energy to digestible energy in early lactation. It was concluded that under the selection program efficiency of performance could be increased (Trigg and Parr, 1981). Line differences for Jerseys were most striking under grazing conditions. At a stocking rate of 4.01 cows per ha, the HL cows gave 23% more fat, 18% more protein and 21% more lactose. The superiority was attributed to higher annual feed intake (more drive) and feed conversion efficiency. Differences between the high and low lines were not overcome by changing stocking rates (Bryant, 1985). Increased yield speeded milking rate but not total time (MacMillan et al., 1987).

In Britain, Gibson (1986) and Gibson et al. (1986, 1987) studied efficiency and performance of genetically high and low producing Friesians and Jerseys produced from random mating selected dams to the "best" and "worse" nationally available progeny tested sires. Differences between high- and low-potential (HL, LL) were similar for the two breeds. HL cows produced more milk, fat and protein but had lower fat and protein concentrations. The HL cows consumed more feed from calving to calving, had higher feed conversion efficiency and lost more body weight during lactation implying a greater withdrawal from body reserves. The HL groups were neither heavier or taller but were marginally narrower at the hooks suggesting the possibility of increased calving difficulty with selection for increased milk yield. Friesians were more efficient than Jerseys at producing milk (23%) but no more efficient at producing milk energy. Gibson cautions that the validity of the test of breed differences in efficiency probably operated against Jerseys using the accepted feeding standards as they underestimated observed total feed intake of Jerseys by a factor of .8. Regressions indicate the deviation from standard as due to maintenance requirements.

At the University of Florida (FL), North Carolina State University (NCSU) and the Dairy Experiment Station, Lewisburg, Tennessee (TN) preliminary evaluation of lines of Jerseys selected for increased milk yield (SIMY) have attained an advantage over control groups (CG) of 800-1000 kg in milk along with increased yields of protein and fat. Such gains are desirable but of interest in developing recommendations to herd operators are possible positive or negative associations (trade-off) with other traits in overall performance.

Thus, selection for higher milk yield has led to some depression in fat and protein percentages with the decline in protein content about half the rate of fat depression. Whether the declines are related to the pressure of selection for total yield on a shift in the roughage to concentrate ratio in feeding the higher producing cows is not yet determined.

At TN, the SIMY group has been heavier at birth and 21 months of age but there were no differences in body measurements at 6 and 15 mo (Moore et al., 1979). At NCSU, the average body weight for SIMY cows averaged 34 kg less in body weight than CG cows.

For TN Jerseys, gross efficiency measured at mid- and late-lactation indicated selection for milk yield did not lead to differences over CG cows in gross feed efficiency or direct conversion of nutrients into milk energy when fed according to yield (Smothers et al., 1986). But at NCSU, gross efficiency (kg FCM/ENE consumed) favored SIMY significantly both before and after adjustment for differences in body weight (.76 and .74 vs. .61 and .63). SCM efficiency (ENE produced/ENE consumed) values were also significantly higher for SIMY cows (.50 vs. .42) before adjustment for body weight but the differences declined (.49 vs. .43) after consideration of body weight.

For NCSU Jerseys, selection for milk yield (+ 986 kg) has not resulted in detectable line effect following three generations in udder shape, depth of cleft or teat characteristics (Wilk and McDaniel, 1988).

In TN, the SIMY cows had significantly greater tendency for clinical mastitis and greater general health costs (Short, 1986). These findings agree with preliminary evaluations at NCSU where the incidence of mastitis, treatment for improvement of breeding efficiency, metritis, udder edema, and total disorders increased as a result of selection for milk. The increase in milk yield after adjustment for days open through four generations was accompanied by a significant increase in total disorders.

Preliminary conclusions from NCSU on selection for milk yield are:

i. regression of milk yield on progeny of the PD milk sires (SIMY) is greater than 1.0 and the regression of fat yield is also greater than 1.0.

ii. PD milk of sires can be used to predict milk yield of progeny but has small value in prediction of fat yield.

iii. PD fat predicts fat yield but has no value in future milk estimates.

iv. Combining PD milk and PD fat does not significantly improve accuracy of predicting yields over using the corresponding PD alone.

v. When the goal of selection is increased milk and fat output, more gain can be made by selecting on both PD milk and PD fat (index) rather than sole emphasis on one trait as either is not a good predictor of the other in Jerseys (Wilk et al., 1979, J. Dairy Sci. Suppl.).

Although health costs are likely to rise with high selection emphasis for milk, there is general agreement that additional milk revenue will offset the added costs (Short, 1986). At least two authors suggest improved management in early lactation during all parities may decrease health costs. Certain Jersey breeders may be reluctant to increase selectivity for milk yield because of higher management requirements and increased operating costs (feed and veterinary) but a study by Stewart et al. (1978), using data from commercial dairy herds, strongly argues for selection among Jerseys. In their study, Holsteins had the highest weighted average value of discounted returns over variable costs followed in decreasing order by Ayrshire, Guernsey and Jersey. They concluded that Holsteins, and to a lesser extent, Ayrshire, would benefit from increased emphasis on milk fat percent as an effective method of increasing discounted 10-year returns over variable costs. Values for Jerseys and Guernseys would increase substantially if major emphasis were placed on milk yield. Little would be gained by increases in milk fat percentage.

There remains a paucity of published information on changes in mortality among young stocks, breeding efficiency of heifers and cows and stayability of cows under high selection for milk yield. It is reasonable to assume that had there been serious negative relations arising in milk yield, some sorting out would have occurred. The S-49 (Southern Regional Group) is being encouraged to take closer looks for the traits enumerated and others. This is important because breeders will want to access degree of risk as they are encouraged to pressure the selection process.

To this point, the results on selection in New Zealand, Britain and the U.S. are similar even though the approaches vary in some details. This research is quite important to the breed. AJCC should take a strong interest in the results and encouraging analysis and publication of data.

SOME INDICATIONS

Following screening of more than 2,000 reports and evaluation of approximately 1000 reports of research published 1970-1987, the term "indications" is chosen to convey the results rather than "conclusions." The choice was made as "nothing is fixed" to the point that conclusions can be drawn. The Jersey and other breeds consistently undergo change which is the way it should be. The information gleaned was sorted for discussion by over 50 traits in order to formulate as complete profile as feasible. The main indication for each trait chosen is briefly stated in Table 26. A ready conclusion from the table is that Jersey is an excellent breed for dairying and to a lesser extent for beef production as well as providing other services, e.g., draft power for agriculture in developing countries. There are definite indications that the breed has comparative advantages in several respects relative to other breeds. There are also indications that like all other breeds it has some limitations which can be adjusted with time if given appropriate attention.

Of concern to the author, as well as others, is that in the major dairy countries breed numbers are static or declining. Research is following the same pattern. For the year 1976, Animal Breeding Abstracts, published by the world's largest abstracting service (C.A.B. International), covering reports on: breeds, genetics, progeny and performance tests, growth and production, milk production, meat production, reproduction and AI as well as miscellaneous topics, work involving Jersey or its crosses, made up 9.3% of all abstracts. During 1988, from May-September the same journal listed 942 abstracts on 41 breeds of cattle. Of these 15 or 1.6% included Jersey; one was from the U.S. based on all breeds and DHI data with the rest, (14) foreign, one on carcass characteristics of Jersey steers, 10 on crossbreeding for milk production in Europe and Asia and three on performance of purebreds in Ethiopia, Hungary and India.

The author found considerable data collected in files at several experiment stations. In some in-

TABLE 26. SOME INDICATIONS FOR JERSEYS

Trait	Indication
Growth	
Birth weight	Low but good calf vigor
Heifers	Among most rapid breeds
Skeletal dimensions	Good rate of frame development
Postpartum	Weight loss low, rapid return to energy balance and estrous cycle
Rate of maturity	Among fastest breeds
Milk yield	Low among recognized dairy breeds
Mobilizing body reserves	Capability among highest
Persistency of milk yield	Above average
Milking rate	Average or slightly below
Milk constituents	
Colostrum	Excellent in quality; protein to fat ratio could be low for Jersey calves
Fat characteristics	Excellent for most markets
Protein	High to highest in % and quality of protein
Minerals	Breeds appear similar
Cheese production	Best for quality cheeses and yield
Health	
Mastitis	Low in clinical incidence
Milk fever	Among the high risk breeds
Udder edema	Breed is average
Displaced abomasum	Breed effects negligible
Laminitis	Lower risk than most breeds
Stayability	Among best post 1st calving but not in % born completing 2 lactations
Calf mortality	Undesirably high, needs attention
Age at puberty	Has comparative advantage
Age at 1st calving	On average has comparative advantage
Gestation length	Among breeds with lowest days
Calving interval	Among best breeds with advantages in certain environments
Calving ease and dystocia	Among best of all breeds
Lactation length	Average among dairy breeds
Breeding efficiency	Above average but losses from sterility remain too high
Udder characteristics	
Teat size	Smaller than most dairy breeds
Test placement	Among best breeds
Udder volume	May have slightly lower secretory rate per l tissue than Friesian
Udder strength	Well above average, overall high quality udders
Blood constituents	Breed differences usually quite small; may have merit in low leukocyte count
Nutrition	Shows advantages but uniqueness of digestion need further investigation; excellent user of forages
Body composition	Deposits excess abdominal fat; excellent capability to mobilize fat reserves
Temperature stress	Highest in tolerance among European dairy breeds
Biochemical polymorphisms	May have unique hemoglobulins; but among highest breeds in autosomal recessive gene frequency
Semen characteristics	May have comparative advantages in quality; post thaw motility
Economics	Comparative advantages but must investigate further

TABLE 26 (continued)

Trait	Indication
Beef production	
Pure Jersey	Low performance in intensive systems; on all grazing may equal or exceed several breeds in lean and meat quality
Jersey sired crosses	No comparative advantage
Crosses from Jersey cows	Highly regarded as dam for terminal crossing; medium in beef yield
Jersey crossbred cow	Especially good brood cows
Crossing for milk	
Jersey dam	Produces excellent cross with good efficiency
Jersey as sire	Below Holstein crosses in milk; low environments net indexes high
Other traits	
Coat and hair	Among best breeds for tolerance to environmental conditions
Physiological	Has some unique qualities
Type score	Good for merchandising U.S. but may be deterrent in international markets
Temperament	Excellent, one of best breeds
Draft power	Crosses preferred in several countries for small farm agricultural power
Selection	
Heritability	Estimates lie within range of other dairy breeds
Results from selection	Responds to selection for milk yield and composition as readily as other breeds; best to use index; with rise in milk yield may be trade-offs of economic importance; need more information

cidences, enthusiasm for data evaluation and publication were not high because the workers felt interest in their results would be low with the strong drift to Holsteins. Assuredly, the author is sympathetic with similar experiences in efforts to publish on crossbreeding. Indications are that AJCC and its supporters should help boast enthusiasm and support for evaluation and publication of performance data on the breed.

With research funds on the decline generally in terms of constant U.S. dollars for animal research, there is strong indication that Jersey organizations in several countries should follow the recommendation made to developing countries in forming networks. This seems feasible as the author found Jersey researchers in several countries most willing to share not only their publications but informal ideas and frustrations in research. The most logical strategy for networking is making effective use of available funds and talent through a series of collaborative programs on a range of relevant topics. The following types of networks are most common:

i. Information Exchange - which organize and facilitate exchange of ideas, methodologies.

ii. Scientific Consultant - which involve country-by-country or participant-by-participant focus on common priority research areas but implemented independently by the participating institutions; the thesis of the Regional Research Projects in the U.S., such as S-49.

iii. Collaborative Research Networks - which involve joint inter-country planning and monitoring of research problems of mutual concern.

The author can attest to successful examples, e.g., of operation of the Tropical Dairy Program while at Cornell University involving up to 15 institutions in 12 countries and while serving as Chairman of the Board of Trustees of the International Livestock Centre for Africa implemented four networks on as many areas among 5 to 13 countries in Africa which researchers appreciated. Researchers appear readily willing to collaborate in country and among countries but the breed organizations need to become more supportive. Representatives from the governments of say, Ethiopia, India or Pakistan, who plan to purchase stock get the pitch by country of origin such as: "My Jerseys are best for type, mine are highest in milk yield, we have the most high PD bulls or ours are all solid color." This is competition but what can be more critical at the outset is getting the breed established in these countries. Recall that competition in number of breeds has grossly expanded.

As attempts are made to interpret the points in this review, U.S. personnel should pay attention to results from other countries, e.g., the work under way on selection for higher performance in New Zealand, Britain and the U.S., generally have common objectives. Exchange of ideas on needs for research could permit complementary studies and minimize duplication as well as promote expansion. The review covered many more traits than have emerged from the selection experiments thus far, for example.

There are also indications that the welfare of the breed can be enhanced through generation of more information. The review indicates several areas worthy of investigation. Among these are:

i. More careful study of possible uniqueness in digestive physiology and feeding behavior to develop better guidelines for feeding of Jerseys.

ii. Mortality rate of young stock and above expected losses from slow or non-breeders as heifers and cows.

iii. Test expansion of current indexes for estimates of "net merit" to include reproductive efficiency and input-output ratio per unit of cow size (approach is proving effective in parts of Africa).

iv. In nutrition the Jersey needs researching for its "own sake;" there is too much drift to fit only linear regressions with cow size; there must be more curvilinearity than in evidence.

v. Possible merits of Jersey milk nutritionally and for cheese production are spotty and haphazard; dairy technology scientists need to be made strong collaborators in research.

A final indication is that the Jersey breed needs a boost to meet competition. This is urgent because more and more institutions which can conduct research on the breed are losing their Jersey herds. Scientists can do much to change the dairy cow but often policies on marketing can change the course of events much more effectively. Market policies in the U.S. have been slow to change but there are signs of major changes arising as component pricing comes into favor.

APPENDIX I. SOURCES FOR LITERATURE SEARCH

In seeking the most viable sources for literature on research with Jerseys, contacts were made with several U.S. University libraries and the USDA National Agricultural Library (NAL). The latter had the most ready access to DIALOG database files including some commercial listings and files from abroad. The staff of NAL expressed interest and willingness to provide assistance. A contract was initiated for a search.

The initial screening was made using 21 key words in 19 files. Too many references of marginal value emerged with the large number of key words. The number was reduced to 10. Even this number identified listings of low value or were duplicated in other files. For convenience and to curb cost, the number of files searched in depth was reduced to 9 (Table 1). The file of the International Livestock Centre for Africa on Jerseys in that continent was added. A brief description and extent of the various files are included in Table 1.

From the 10 files, 4,307 citations were obtained for publications issued 1970-1987. The program used enabled screening of abstract where available. This was especially helpful in studies when Jerseys were included but breed comparisons were not determined. Nearly 3,000 were deleted in the second stage largely because of duplication or contained little or no supportive data.

NAL supplied floppy disks and a printout of all the information for each publication. Due to inconsistency among files in format, no software programs could be located to meld the files. Sorting for duplication or low value, therefore, required visual review. Additional problems were encountered as the computer screen displayed only 40 lines. When the abstract exceeded the screen there was no indication the abstract was continued, thereby the risk of loss. Satisfactory adjustments were worked out.

The files have been coordinated into a common file alphabetically by senior author. To assist users, the references have been coded and indexed for subject matter. The file is now usable on most PCs using SAM.

When available, abstracts in English are included on the disks. Many of the reports from Eastern European countries did not have English abstracts, but article titles, authors and where published are included in order that users can gain a broader appreciation of the use of Jerseys in the animal programs of these countries. Scientists from Poland and Hungary were generous and responded to inquiries but did not receive response from the USSR. Papers from Poland and Hungary seldom had English summaries, therefore did not render full use.

There is merit in periodic up-date of the bibliography. Hopefully the Jersey Cattle Club can be supportive. If not through DIALOG database due to cost, AJCC should at least include reports it can glean through networking with researchers in various countries.

TABLE 1. DATA FILES SEARCHED

Agribusiness U.S.A. Database. Sub.: Agricultural Industry. Producer: Pioneer Hi-Bred International, Inc.

Agricola. Sub: Agriculture, Food, Nutrition. Producer: U.S. Dept. Agriculture, National Agriculture Library, Belstville, Maryland.

AGRINDEX: AGRIS (International Info System for Agricultural Sciences and Technology). Sub: Agriculture. Producer: FAO (1.3 million citations, some abstracts, worldwide on all aspects of agriculture; accumulates 10,000 records per month).

BIOSIS (Biosciences Information Services). Sub: Worldwide literature on research in life sciences (plant and animal) from approximately 9,000 periodicals and books.

CAB Abstract (Commonwealth Bureau of Animal Breeding). Sub: Agriculture, Food Sciences, Nutrition, Veterinary Services. Two million citations with abstracts from worldwide literature in agricultural sciences and related areas of applied biology. Contains 12 subsets; adds 12,000 references per month.

CRIS (CRIS/USDA) Current Research Information System. Sub: Agriculture research in progress. Producer: U.S. Dept. of Agriculture, Washington.

DISSERTATION ABSTRACTS INTERNATIONAL. Sub: Thesis Dissertation. Producer: University Microfilms Internationa. Contains citations with abstract. Coverage: International since 1961; adds 2,500 records per month.

ILCA (International Livestock Centre for Africa). Sub: Africa livestock, forage agronomy, milk and meat processing. Producer: ILCA, Addis Ababa, Ethiopia. Started 1974 from microfiche of animal research data collected from 17 countries; adds about 300 records per month; will soon be available through USDA National Agriculture Library.

Life Sciences Collection. Sub: Life Science. Producer: Cambridge Scientific Abstract. Citations with abstracts, worldwide plant and animal agriculture. Started 1978; adds 2,000 records per month.

On Line Service: DIALOG Information Services, Inc. Sub: 20,000 citations with abstracts from U.S. literature on the business of agriculture. Coverage: U.S.; started 1985; adds 1,500 records each 2 weeks.

APPENDIX II. GENERAL GUIDELINES FOR USE: COMPUTERIZED BIBLIOGRAPHY AND INDEXES ON JERSEYS

***MUST HAVE ASKSAM SYSTEM SET-UP ON HARD DISK

A. CONTENTS OF EACH FILE

1. JERSEY.ASK - over 900 different abstracts dealing with various topics in some relationship to the Jersey breed.

2. INDEX.ASK - an index of the JERSEY.ASK file by subject/topic.

3. BREEDIND.ASK - an index of the JERSEY.ASK file by breed.

4. COUNTRYI.ASK - an index of the JERSEY.ASK file by country.

B. TRANSFERRING FILES FROM THE BACK-UP DISKS TO THE HARD DISK

* The files will not run directly from the floppy disks; they must be restored to the hard disk before the information can be used.

1. Make a directory

C: MD\ASKSAM

2. Type RESTORE A: C:\ASKSAM

The computer will prompt you to insert a back-up disk into drive A. Make sure that you insert the disks in numerical order if there is more than one. Repeat this step to install each of the files to the hard disk.

3. Change the directory to ASKSAM C: CD\ASKSAM

4. When at C:\ASKSAM type AS to start program.

C. IDENTIFICATION OF EACH ABSTRACT

Each abstract has been assigned a unique code number consisting of a letter, a slash (/), three numbers OR consisting of a letter, /, three numbers, /, one number

For example:

A/127

A/101/2

The letter coincides with the first letter of the last name of the author of the abstract. The numbers are for the specific identification of each abstract. Use the index files (INDEX. ASK, BREEDIND.ASK, COUNTRYI.ASK) to obtain the code number of abstracts for a specific topic you wish to research OR use JERSEY.ASK and create a search of your own.

D. USING THE INDEXES

1. Select the index file you wish to use.

2. Select option Query.

3. a. If you want to view the entire index, type a colon (:) and press return. The entire file can be viewed starting from the beginning. Options at the top of the screen allow movement from one screen to another and allow printing of screens.

b. If you have a specific topic request, type the request on the line that appears after you have selected Query. For example, if you typed ABNORMALITIES on the request line and press return, the following will appear on the screen:

ABNORMALITIES
KYPHOSIS, J/466
LETHAL, L/529
LIMBER LEG, A/123 G/415 H/427 L/530

If the topic requires more than one screen to display it OR if the topic is also listed somewhere else in the file as a subtopic, the word -MORE- will appear at the bottom of the screen. Options at the top of the screen will allow you to move to the next screen or to print.

Pressing ESCape will return you to the request line where you may enter another request or press ESCape again to return to the main menu.

4. Once you have obtained the code numbers of abstracts you wish to view, return to the main menu, select File Change and enter JERSEY.ASK.

E. USING JERSEY.ASK

1. After you have selected JERSEY.ASK from the File Change or File Select options, choose the Query operation.

2. a. If you have the code number of the abstract(s) you wish to view, type the code number exactly as it appeared in the index. Each request must be made separately. For example, if you wished to view abstracts A/124, B/228, and C/271, you would type A/124 on the request line and press return. You would view abstract A/124 and then return to the request line to enter the next abstract you wish to see. If the abstract is longer than one screen it will be indicated by -MORE- at the bottom of the screen.

b. If a topic you wish to research is not listed in any of the index files, you may do a search of your own in the JERSEY.ASK file. On the request line type the word OR the group of words you wish to research EXACTLY as they would appear in the title OR in the body of an abstract. Groups of words should be followed by a closed bracket

For example: AGE AT CALVING]

The computer will display any/all abstracts with age at calving mentioned in the title or body of the abstract. More abstracts will be indicated by –MORE– at the bottom of the screen.

F. ENDING A SESSION

When you are finished using the Jersey and index files for a period of time, always exit the ASKSAM system.

WARNING!!! The information in the Jersey and index files is not protected and may be erased. We suggest that you keep the original back-up disks and occasionally restore the files again as you did in Part A to replace any information that may have been accidentally deleted.