

Evaluating Dairy Cattle Using Lifetime Production

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Introduction

The purpose of this publication is to describe production and genetic information found in the DHI Cow Page (DHI-203) and to provide general guidance on how to evaluate this information.

In addition to describing the DHI Cow Page and the genetic and production data it contains, this guide presents an example class of four DHI Cow Pages, a description of the scoring process, an evaluation of the sample class, a glossary of important terms, and a list of publications for further reading.

This guide has been prepared as a resource for dairy cattle judging team coaches and their students. However, the information about the DHI Cow Page and interpretation of dairy production records and genetic information also should be helpful to dairy producers and dairy professionals.

Background

Traditionally, judging dairy cattle in the showing and in judging contests for youth emphasized conformation or type. Most often, cattle are placed according to visual assessment alone, as judges attempt to predict the production capacity and durability of dairy heifers and cows. Evaluating dairy cattle for type traits, especially the more important functional traits such as udder depth, fore-udder attachment, front teat placement, and feet and legs, will continue to be important. Most dairy producers place some emphasis on these functional type traits when making purchasing, breeding, culling, and other management decisions.

Production records and genetic information are also important in the decision making process. Profitable cows and heifers with great genetic potential are desired by most dairy producers. The judging process presented in this publication is directed toward properly ranking cows of similar age according to their genetic ability and lifetime performance. The relative importance of production and type in purchasing, breeding, and culling decisions is an issue frequently debated in the dairy industry and largely based upon the opinion and individual goals of dairy producers. No attempt will be made here to combine the evaluation of production records and genetic merit with type.

Highlighted Items on a Cow Page

1. Pedigree and genetic information. The DHI Cow Page (Figure 4) provides the dam and sire of the cow, if they are known and reported to DHI. A Predicted Transmitting Ability (PTA) is given for the cow and her parents. The PTA is defined as the amount by which an average daughter of a cow or bull is expected to out-perform its herdmates that are breed average. In a given herd, the exact PTA is not as important as the rank among the PTAs of different animals. PTAs are the best estimate of an animal's genetic ability and are calculated periodically by USDA. Because the PTA of a cow is generally based on a relatively small number of offspring, her PTA is largely influenced by the PTAs of her parents. It is important that the PTAs to be compared across cow pages are from the same USDA-DHI genetic evaluation so that common sires and dams have the same PTA for each trait.

A PTA is reported for milk, fat percentage, pounds of fat and protein, and Net Merit. Net Merit is an economic index that



Figure 1. Records play an important role in evaluating dairy cattle.

Figure 2. Description of a Cow Page

A cow page is a cow's individual lifetime record that provides cow, sire, and dam identification; summarizes lactation production; and provides a calving and breeding record. Normally, it is printed under the following circumstances: 1) when the cow completes a lactation, 2) when the cow is coded as "left herd" for any reason, or 3) when cow identification or previous production is corrected or changed. Also, DHI members have an option of receiving a cow page for each new cow in their herd during the first month she is on test. This option provides the dairy farmer with a complete herd book that includes all animals in the milking herd and helps to ensure that all cows' identity and status are reported correctly.

Updated cow pages give production-to-date information for the current lactation, last-test-day production information, and most recent USDA-DHIA genetic evaluation information. The cow page is useful to and should be provided to the purchaser of a cow at dispersals and other sales, to aid in the proper transfer of production credits and identity information. The cow page should be provided to the DHI supervisor at the first test day after the cow enters the new herd.

Description of sections of the Cow Page (DHI-203, see Figure 3):

- A. Heading information includes the herd code, the date the cow page was mailed from the processing center, farm name and address, and the cow's barn name and index number. All known sire and dam identification information stored in the DHI computer file is also included. The latest USDA-DHIA Predicted Transmitting Ability (PTA) for milk, fat, and protein along with Net Merit Dollars (see Glossary) are also included for the cow and her sire and dam. Cows whose sires are unknown or whose records are excluded from genetic evaluation procedures will not have a USDA-DHIA PTA reported. In the latter case, the sire's PTA would be available if he has other daughters with records included in evaluation procedures.
- B. Lactation production summary provides all production information on the cow since she entered the milking herd, including each calving date, the cow's age at the time of calving, number of days dry, rating for that lactation, and conditions affecting the record of that lactation, or number of days the cow was milked three times per day. Production data for both the 305-day and complete record are presented. If the record is more than 365 days, the 365 day record will be over-printed in the complete lactation section.
- C. Updated lifetime summary lists the information for the cow at the time the page is printed, including the status change and the date it occurred. The summary provides production information for the cow's last test day, lifetime actual production, pounds of milk the cow has produced since she turned 2-years old (a value which will penalize the older first-calvers and cows that are dry for longer than normal between lactations), herdmate deviation, and estimated relative producing ability (ERPA).
- D. Calf and breeding record section lists reproduction and standardized production information for each lactation. Calving dates, body weight, days open, number of breedings, breeding dates, and sire and calf identity are listed. Also, persistency of the lactation curve, which may be an indicator of management during the lactation, and average somatic cell score (SCS) for the lactation, which serves as an indicator of mastitis during the lactation, are presented. The standardized Mature Equivalent (ME) record is a lactation record standardized to 305 days, and adjusted for the number of times the cow is milked per day, age at calving for the lactation, month of calving, and number of days open in the preceding lactation. Herd mate deviation compares the cow's ME lactation record with the average ME lactation records of her herdmates.
- E. Test day data is an option that includes milk weights (rounded to the nearest full pound), somatic cell scores, and fat and protein percentages. Only the first 11 tests of a lactation are presented on the cow page.

Adapted from DHI Reference Manual
Dairy Records Management Service, Raleigh, NC

Figure 3. DHI Cow Page (DHI-203)

COW PAGE DHI-203

HERD CODE NO.			DATE MAILED			BARN NAME		INDEX NO.	
ST	CO	HERD	MO	DAY	YR				
64	43	0108	7	21	90	450		450	

HENRY SMITH SMITH DAIRY FARMS RFD 3 AUBURN ALA. 36830	
--	--

COW	INDEX NO.	450	BREED	H
	BARN NAME	450		
	REGISTRATION OR EARTAG	64WAD3785	SIRE	7H1400
	DATE OF BIRTH	07-04-84	DAM	371
	PTA MILK	+590	PTA \$	+40
	PTA % FAT	+05	REL.	28
PTA FAT	+27	PCTILE (NM)	48	
PTA PROT	+30			

REGISTRATION OR E.T.	1842387	PTA MILK	+1573
NAME OR NO		PTA % FAT	-.17
		PTA FAT	+25
		PTA PROT	+38
BREED	H	PTA \$	+126
		REL.	72
		PCTILE (NM)	74

REGISTRATION OR E.T.	64WAC8754	PTA MILK	+210
NAME OR NO		PTA % FAT	+02
		PTA FAT	+10
		PTA PROT	+15
BREED	H	PTA \$	+42
		REL.	36
		PCTILE (NM)	60

LACTATION PRODUCTION SUMMARY

CALVING DATE	AGE AT CALVING YR-MO	DAYS DRY BEFORE CALVING	R A T I N G	DAYS 3X CON. AFF. RECORD	305 DAY LACTATION					COMPLETE LACTATION					TYPE OF RECORD	
					MILK	% FAT	FAT	% PROT.	PROTEIN	DAY IN MILK	MILK	FAT	PROTEIN	VALUE PRODUCT		INCOME OVER FEED COST
8 01 86	2-01		C		12260	35	426	30	368	305	12260	426	368	631	316	DHIA
8 07 87	3-01	67	C		13830	34	472	32	443	323	14070	482	450	922	473	DHIA
8 24 88	4-01	59	B		16240	36	585	34	552	278	16240	585	552	1212	621	DHIA
7 28 89	5-00	60	B		16940	37	627	31	525	365 371	19120 19370	681 687	572 578	1668	1021	DHIA

STATUS CHANGE	MO	DAY	YR	LAST TEST	% PROT.	LIFETIME PRODUCTION			MILK/DAY SINCE 24 MO. OF AGE	YIELD DEV.		ESTIMATED RELATIVE PRODUCING ABILITY		
						MILK WTS.	% FAT	PROTEIN		MILK	PROTEIN	MILK	FAT	PROTEIN
TURNED DRY	8	22	90	26.8	3.2 3.9	59,940	2,130	1,908	42.2	+1236	+35 +42	+680	+13	+8

CALF AND BREEDING RECORD

CALVING DATE	BODY WT. (100 LB)	DAYS OPEN	NO. BR.	SUCCESSFUL BREEDING DATE	SIRE IDENTITY		CALF IDENTITY		PERSIST. OF LACT. CURVE	AVG. SCCS FOR LACT.	ME LACTATION			HERDMATE DEVIATION		
					REG. EARTAG OR OTHER NUMBER	B R	CALF NAME	CODE			MILK	FAT	PROTEIN	MILK	FAT	PROTEIN
8 86	09	90			40H96			DIED	96	3	15570	528	456	+360	-17	-13
8 87	11	101	1	10 30 86	1244009			NEK-CH-60	101	4	16040	533	501	+588	-23	-18
8 88	12	62	2	11 22 87	29H1879			BULL	88	5	17380	614	580	+1774	+52	+32
7 89	13	103	1	10 25 88	29H1842			TATTOO-87	97	4	17180	623	525	+1358	+54	+41

TEST DAY DATA

LACT NO.	CALVING DATE	1ST TEST DAY		2ND TEST DAY		3RD TEST DAY		4TH TEST DAY		5TH TEST DAY		6TH TEST DAY		7TH TEST DAY		8TH TEST DAY		9TH TEST DAY		10TH TEST DAY		11TH TEST DAY	
		SCCS	% PROT	SCCS	% PROT	SCCS	% PROT	SCCS	% PROT	SCCS	% PROT	SCCS	% PROT	SCCS	% PROT	SCCS	% PROT	SCCS	% PROT	SCCS	% PROT	SCCS	% PROT
1	8 86	3	28	3	31	1	27	2	29	4	42	3	32	4	27	1	32	5	35	4	38	5	36
		40	39	42	32	36	34	39	28	34	41	35	36	28	32	33	38	30	41	29	37	24	42
2	8 87	5	36	4	34	4	39	3	27	1	32	4	36	5	31	4	35	3	37	3	34	5	32
		48	38	49	30	38	39	34	36	30	38	28	24	26	37	25	39	24	36	22	38	27	45
3	8 88	5	39	5	31	6	26	4	38	3	42	4	44	7	36	7	26	7	25	6	62	5	33
		50	34	56	33	42	41	49	29	46	36	47	42	40	33	36	37	22	42	38	38	36	41
4	7 89	4	26	3	32	5	34	4	30	3	27	5	29	4	38	5	37	4	38	0	34	4	37
		53	36	55	33	51	38	47	41	43	27	40	39	38	37	35	35	33	36	29	39	28	38

combines genetic evaluations of milk, fat, and protein production; length of productive life; and somatic cell scores in a ratio of 10:4:-1 for production, longevity, and somatic cell score, respectively. The -1 weight for somatic cell score indicates that selection should be for fewer somatic cells.

Reliability is the degree of confidence that the PTA represents the true genetic merit of the animal. The more information included in the PTA, the greater reliability, and the higher the confidence that the PTA is close to the cow's true genetic value. The percentile ranking is how well the cow ranks within her breed for the Net Merit index. Numbers closest to 100 correspond to the best PTA.

PTAs are presented on the cow page only when the cow's records are used in the USDA-DHI genetic evaluation procedures. PTA for sires are available for any bulls with daughters in the genetic evaluation system, including bulls used through artificial insemination, and herd bulls with daughters in the USDA-DHI system.

2. Age at calving is the age in days and months at which the cow gave birth. The age at first calving may reflect differences in management or in the heifer's ability to conceive. The desired number of months between calving dates will vary from herd to herd, but one should be concerned if cows have calving intervals of longer than 15 months. If cows being compared are from the same herd, one would normally prefer the cow with the shortest calving interval, which is usually the cow that returns to estrus sooner after calving and requires fewer inseminations to conceive.

3. Rating is used to categorize cows into five groups or letter rankings based on their current lactation. The rating is determined by adjusting the ME lactation records of all cows in the herd to a 3.5% fat and 3.2% protein basis, called energy corrected milk (ECM). The formula for ECM is: $ECM = 0.3246 \times \text{milk} + 12.86 \times \text{fat} + 7.04 \times \text{protein}$. The ECM record for each cow is divided by the ECM lactation average of the herd and the following values are assigned:

- A = >110 % of herd average
- B = 100 to 110 % of herd average
- C = 90 to 100 % of herd average
- D = 80 to 90 % of herd average
- E = <80 % of herd average

4. 305 day lactation records for milk, fat, and protein percentages, and fat and protein pounds are presented. The values are the production in the first 305 days of lactation. If the lactation lasts less than 305 days, only the amount of milk, fat, and protein actually produced in the shorter lactation is reported. Short lactations may result from culling the cow, drying off the cow early because she bred back quickly, or, alternatively, drying the cow off early because her production tailed off too quickly. The latter case should be evident from the persistency information, which will be detailed later.

5. Complete lactation information is provided for days in milk, and pounds of milk, fat, and protein. Value of product is the

accumulated value of the milk shipped for the lactation. It is based on the milk price and fat and protein differentials reported by the producer on each test day. Therefore, milk, fat, and protein are combined according to the actual market value of each. Numbers should be compared only within a herd, because different test day milk prices could have a tremendous impact on the value of product for two cows with the same production.

Income over feed cost is the approximate net return of a cow since the beginning of the previous dry period. Feed costs are reported by the dairy producer each test day and assigned to the cow according to a level of intake estimated from weight. Again, use caution when comparing cow pages across herds.

6. Lifetime production is the accumulated sum of production from all of the cow's lactations and is reported for milk, fat, and protein. This value includes production for the current lactation, even if it is not complete.

7. Milk per day since 24 months of age is the total lifetime production divided by the number of days of age of the cow minus 24 months. This number discredits cows that calve for the first time after they are 24 months old. This may result from late maturity, late onset of puberty, small stature when breeding is determined by size, difficulty conceiving, or simply a management decision. A drawback of this statistic is that it may discriminate against cows that breed back quickly and, therefore, have more dry periods in a given number of years.

8. Estimated relative producing ability (ERPA) is calculated only in April of each year. As an option, it can also be obtained in November. The ERPA is an estimate of a cow's genetic and permanent environmental effects on her production, expressed as a deviation from her herdmates. A permanent environmental effect is one that is common to all lactation records of a cow and that influences her records differently than those of herdmates. Having pneumonia as a calf is an example of such an effect, which could affect her future milk production.

ERPA is calculated as: $ERPA = \text{Lact. Wt.} \times \text{RIP factor} \times \text{Herdmate Deviation}$, where Lact. Wt. is $N/(N+1)$ with N being the number of lactations including records in progress. RIP factors are:

<u>Days in Milk</u>	<u>1st Lactation</u>	<u>2nd + Lactation</u>
001-045	0.72	0.60
046-075	0.83	0.74
076-105	0.88	0.82
106-135	0.92	0.86
136-165	0.94	0.91
166-195	0.96	0.93
196-225	0.97	0.96
226-255	0.98	0.98
256-285	0.99	0.99
286-305	1.00	1.00

Herdmate deviations are described later.

Figure 4. DHI Cow Page (DHI-203)

COW PAGE DHI-203

HERD CODE NO. ST CO HERD 64 43 0108			DATE MAILED MO DAY YR 7 21 90			BARN NAME 450			INDEX NO. 450		
HENRY SMITH SMITH DAIRY FARMS RFD 3 AUBURN ALA. 36830						COW	INDEX NO. 450	BREED H	REGISTRATION OR E.T. 1842387	PTA MILK +1573	
							REGISTRATION OR EARTAG 64WAD3785		NAME OR NO 7H1400	PTA % FAT -.17	
							DATE OF BIRTH 07-04-84		BREED H	PTA FAT +25	
							PTA MILK +590	PTA \$ +40		PTA PROT +38	
							PTA % FAT +.05	REL 28		PTA \$ +126	
							PTA FAT +27	PCTILE (NM) 48		REL 72	
							PTA PROT +30			PCTILE (NM) 74	
								DAM	REGISTRATION OR E.T. 64WAC8754	PTA MILK +210	
									NAME OR NO 371	PTA % FAT +.02	
									BREED H	PTA FAT +10	
										PTA PROT +15	
										PTA \$ +42	
										REL 36	
										PCTILE (NM) 60	

CALVING DATE	AGE AT CALVING YR-MO	DAYS DRY BEFORE CALVING	R A T I N G	DAYS 3X CON. AFF. RECORD	305 DAY LACTATION					COMPLETE LACTATION					TYPE OF RECORD	
					MILK	% FAT	FAT	% PROT.	PROTEIN	DAY IN MILK	MILK	FAT	PROTEIN	VALUE PRODUCT		INCOME OVER FEED COST
8 01 86	2-01		C		12260	35	426	30	368	305	12260	426	368	631	316	DHIA
8 07 87	3-01	67	C		13830	34	472	32	443	323	14070	482	450	922	473	DHIA
8 24 88	4-01	59	B		16240	36	585	34	552	278	16240	585	552	1212	621	DHIA
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STATUS CHANGE	MO DAY YR	LAST TEST	% PROT.	LIFETIME PRODUCTION			MILK/DAY SINCE 24 MO. OF AGE	YIELD DEV.		ESTIMATED RELATIVE PRODUCING ABILITY		
				MILK WTS.	% FAT	MILK		FAT	PROTEIN	MILK	FAT	MILK
TURNED DRY	8 22 90	26.8	3.2 3.9	59,940	2,130	1,206	42.2	+1236	+35 +42	+680	+13	+8

CALVING DATE	BODY WT. (100 LB)	DAYS OPEN	NO. BR.	SUCCESSFUL BREEDING DATE	SIRE IDENTITY		CALF IDENTITY		PERSIST. OF LACT. CURVE	AVG. SCCS FOR LACT.	LACTATION			INBREEDING DEVIATION		
					REG. EARTAG OR OTHER NUMBER	B R	CALF NAME	CODE			MILK	FAT	PROTEIN	MILK	FAT	PROTEIN
8 86	09	90			40H96		DIED	96	3	15570	528	456	+360	-17	-13	
8 87	11	101	1	10 30 86	1244009		NEK-CH-60	101	4	16040	533	501	+588	-23	-18	
8 88	12	62	2	11 22 87	29H1879		BULL	88	5	17380	614	580	+1774	+52	+32	
7 89	13	103	1	10 25 88	29H1842		TATTOO-87	97	4	17180	623	525	+1358	+54	+41	

LACT NO.	CALVING DATE	1ST TEST DAY		2ND TEST DAY		3RD TEST DAY		4TH TEST DAY		5TH TEST DAY		6TH TEST DAY		7TH TEST DAY		8TH TEST DAY		9TH TEST DAY		10TH TEST DAY		11TH TEST DAY	
		SCCS MILK	% PROT FAT	SCCS MILK	% PROT FAT	SCCS MILK	% PROT FAT	SCCS MILK	% PROT FAT	SCCS MILK	% PROT FAT	SCCS MILK	% PROT FAT	SCCS MILK	% PROT FAT	SCCS MILK	% PROT FAT	SCCS MILK	% PROT FAT	SCCS MILK	% PROT FAT	SCCS MILK	% PROT FAT
1	8 86	3	28	3	31	1	27	2	29	4	42	3	32	4	27	1	32	5	35	4	38	5	36
		40	39	42	32	36	34	39	28	34	41	35	36	28	32	33	38	30	41	29	37	24	42
2	8 87	5	36	4	34	4	39	3	27	1	32	4	36	5	31	4	35	3	37	3	34	5	32
		48	38	49	30	38	39	34	36	30	38	28	24	26	37	25	39	24	36	22	38	27	45
3	8 88	5	39	5	31	6	26	4	38	3	42	4	44	7	36	7	26	7	25	6	62	5	33
		50	34	56	33	42	41	49	29	46	36	47	42	40	33	36	37	22	42	38	38	36	41
4	7 89	4	26	3	32	5	34	4	30	3	27	5	29	4	38	5	37	4	38	0	34	4	37
		53	36	55	33	51	38	47	41	43	27	40	39	38	37	35	35	33	36	29	39	28	38

ERPA can be used to compare the producing abilities of cows for future lactations and to predict which cows should produce the best replacements if USDA-DHI PTAs are not available.

9. Days open, number of breedings, and successful breeding date are reproductive statistics that can be useful in evaluating cows. Days open are the number of days the cow is not pregnant between calving and a successful breeding in the current lactation. Successful breeding dates are verified according to the subsequent calving date. For the most recent lactation, the number of days open is calculated using a reported breeding date. Number of breedings is the number of times a cow was bred between calving and the successful breeding. Number of breedings and the successful breeding dates often are not known for first lactation heifers.

10. Persistency of the lactation curve is an index of how well the cow maintained production throughout the first 305 days of lactation. Persistency is calculated as a ratio of the 305 day ME milk yield, predicted or "projected" from the first test after 80 days in milk to the latest projected or actual 305 day milk yield. Values close to 100 are expected under normal management conditions. A value of more than 100 means the cow was better able to maintain milk yield throughout the lactation than the average cow.

11. Average somatic cell score (SCS) for the lactation is an indicator of mastitis. Under normal conditions, a cow's SCS should not be elevated unless there is a mastitis infection. The infection can be clinical (visible) or subclinical (unnoticed). SCS can generally be expected to increase with age, because the number of mastitis cases also increase with age. Under normal circumstances, lactation average SCS should be four or less. Each one unit increase in SCS represents a doubling in the number of somatic cells, which is important to keep in mind when comparing cows.

12. ME lactation information is a lactation record standardized to 305 days, and adjusted for the number of times the cow is milked per day, the cow's age at calving for the lactation, the month of calving, and the number of days the cow remains open in the preceding lactation. Factors used to calculate ME records are separate by breed and region of the country. ME records are the best available way to compare cows that calve at different ages or during different times of the year.

13. Herdmate deviation is the difference between the ME production of a cow and the average ME production of her herdmates. Herdmates are cows of the same breed that calved during the same season of the year.

Evaluation Procedure

The objective of the cow page judging exercise is to properly rank four cows based solely on the information available from their lifetime production records. Format and scoring are similar to the system long used for dairy judging contests. Contestants are asked

to rank the cows from best to worst. Scores are then determined by comparing the contestants placing with the ranking determined by a preassigned official. In assigning the official rankings (placings), the official also assigns cuts according to the difficulty in deciding between consecutive pairs of animals. Total cuts assigned by the official should not exceed 15, which would result in a score of zero if the contestant placed the class backwards. Easiest decisions should have the largest cuts. The number of possible points is 50 for the cow page class. For further information on scoring, please see *Dairy Cattle Judging Techniques*, (Fourth Edition), by Trimberger, Etgen, and Galton.

In general, the information on the cow page falls into four categories:

1. Production (milk, fat, and protein)
2. Reproduction
3. Mastitis
4. Genetics

The amount of emphasis to place on each category is approximately 40% on production, 30% on reproduction, 20% on mastitis, and 10% on genetics.

Production should receive the most emphasis, but the other three categories must be considered when placing the cows. For example, poor reproduction, low production, and mastitis are the three most common reasons for culling dairy cows. Nevertheless, milk, fat, and protein production pay the bills on most dairy farms. In general, on any farm, cows that give the most pounds of milk, fat, and protein tend to be the most profitable cows.

Reproduction is important for numerous reasons. Cows that do not breed back quickly after calving may not produce enough milk late in lactation to remain profitable. This is because peak milk production is reached shortly after calving and then production gradually declines until the cow is dried off, usually 60 days before her next calving. Cows that are very difficult to breed may need to be sold, which is expensive in terms of lost milk production and the cost of raising additional replacement heifers.

Mastitis is the most costly disease of dairy cattle. The cost of mastitis results from veterinary and antibiotic treatments, discarding milk from treated cows, and decreased milk production by infected cows. The only measure of mastitis available on the cow page is the average somatic cell score for the lactation. Somatic cells reduce the shelf life of milk and the yield of some kinds of cheese; therefore, most dairy producers are paid a premium for milk that is low in somatic cells.

Genetics represent the potential of a cow to produce milk. Through genetic selection, dairy cattle are improving at a rate of about 250 pounds per year of increased genetic potential for milk production. The PTA's are our best measure of the genetic potential a cow will pass along to its calves.

Specifically, the highlighted items from the DHI Cow page fall into the following categories:

Production (milk, fat, and protein)

1. Rating

- 305 Day Lactation
- Complete Lactation
- Lifetime Production
- Milk per Day Since 24 Months of Age
- Estimated Relative Producing Ability
- Mature Equivalent Lactation Yields
- Herdmate Deviation

2. Reproduction

- Age at Calving
- Days Dry Before Calving
- Days Open
- Number of Breedings

3. Mastitis

- Average SCS for Lactation

4. Genetics

- Pedigree
- Predicted Transmitting Ability (PTA)
- Net Merit Percentile
- Herdmate Deviation

Notice that some of the highlighted items occur in more than one category. For example, Herdmate Deviation is both a measure of production and genetics. Herdmate deviation helps to rank cattle for their producing ability within a group of cows that calved at similar times and were managed similarly. Much of the Herdmate Deviation is due to the differing genetic ability of the cows.

As previously mentioned, the most emphasis should be placed on production (40%), the next most emphasis should be placed on reproduction (30%), and somewhat less emphasis placed on mastitis (20%) and genetics (10%).

In placing the class, contestants may find it beneficial to rank the four cows for each category, then relative rankings of the cows can be used to formulate an overall placing for the cow pages that are being judged. For example, if four cows were ranked as:

Production	Reproduction	Mastitis	Genetics
3	3	3	3
2	2	2	2
4	4	4	4
1	1	1	1

the placing of 3-2-4-1 is quite obvious. But, if the rankings are:

Production	Reproduction	Mastitis	Genetics
3	3	1	1
2	2	4	4
4	4	2	2
1	1	3	3

the appropriate placing is less obvious. If one were to use only the rankings and because production and reproduction were given the most weight, a ranking of 3-2-4-1 may still be appropriate. But,

what if the differences among cows for production and reproduction are small and the differences among cows for genetics and mastitis are large? Then a placing of 1-4-2-3 may be appropriate despite this being opposite of how the cows rank for production and reproduction. This is similar to what can happen when using the uniform score card for judging conformation traits using visual appraisal.

Official Placings and Reasons for Example Class

Let's evaluate the example class on the pages 8 and 9 with regard to each of the major categories:

Production: According to rating, 4 was best with a rating of "C" in each lactation. Cows 3 and 2 were next, while Cow 1 clearly had the lowest rating. Cow 4 appeared to top the class for 305 day milk, fat, and protein production, although Cow 3 beat her in 305 day fat yield in second lactation. Cow 3 and Cow 4 produced more milk than Cow 2 in the complete lactation, but it is important to note that Cow 2 produced this milk in only 267 and 274 days, compared to 313 and 297 (Cow 4) or 326 and 359 (Cow 3). This also explains, in part, why Cow 3 had the highest lifetime production. Thus, it is important to consider the standardized measures of milk per day and ME lactation yields. For milk per day, the obvious ranking is 4, 2, 3, 1. Cow 4 appears to have a slight advantage for ME yields (except 3 has an advantage for fat in second lactation). Cow 3 has an advantage over Cow 2 for all MEs except first lactation milk. Similarly, Cow 2 has an advantage over Cow 1 for all MEs except first lactation fat. While some differences are noticeable over both lactations, the cows rank 4,3,2,1 for herdmate deviation too. According to estimated relative producing ability, the cows easily rank 4,3,2,1 for milk and protein and 4,3,1,2 for fat. Thus, ranking the cows for production only, they would rank 4-3-2-1.

Reproduction: Considering age at calving, all cows calved for the first time by 2 years of age and all cows except Cow 1 calved again within 12 months, which is very good. Cows 2, 3, and 4 had from 55 to 62 days dry before calving, which is near the 60 days usually recommended. However, Cow 1 was dry 89 days. To maintain a 13 month calving interval, cows must have no more than 120 days open. Cow 1 was open 118 days in first lactation, but she settled on the first breeding. Cow 3 was open 141 days in second lactation. Cow 1 and Cow 2 settled on the smallest number of breedings (1 in each lactation), while Cows 3 and 4 required 2 breedings in second lactation. The ranking for reproduction is 2-1-4-3. The decision is difficult among the first three cows, but Cow 3 had a high number of days open in second lactation.

Mastitis: Unfortunately, there is only one measure of mastitis on the cow page. Across both lactations, Cow 1 had the lowest average SCC scores. Cows 2, 3, and 4 had the same total score across the two lactations, but Cow 4 had a higher score for the most recent lactation. For mastitis, Cow 1 is best, Cow 4 is worst, and Cow 2 and 3 are in the middle and are equal. Notice that these differences are quite small and should have little effect on the overall placing in this particular class.

COW PAGE DHI-203

DATE MAILED
MO DAY YR
08 1 97

HERD CODE NO.
ST CO HERD
32 94 9650

BARN NAME
INDEX NO.
2695

INDEX NO.
2695

DATE MAILED
MO DAY YR
8 1 97

INDEX NO.
2719

PURDUE DAIRY RESEARCH CENTER
6010 W 600 N
WEST LAFAYETTE IN 47906-9282

PURDUE DAIRY RESEARCH CENTER
6010 W 600 N
WEST LAFAYETTE IN 47906-9282

COW
REGISTRATION OR I.T. # 2695
BARN NAME SIRE
REGISTRATION OR I.T. # 2719
BARN NAME SIRE
REGISTRATION OR I.T. # 15303771
BARN NAME SIRE
DATE OF BIRTH 08-24-93
PFA % FAT -92
PFA % PROT -33
PFA % FAT -02
PFA % PROT 9
PFA % FAT -7
PFA % PROT -13
REL. PFA 99
REL. PROT 15
PFA % FAT +1494
PFA % PROT -10
PFA % FAT +33
PFA % PROT +29
PFA % FAT +131
PFA % PROT 99
PFA % FAT 15
PFA % FAT +1007
PFA % PROT -05
PFA % FAT -27
PFA % PROT -32
PFA % FAT -116
PFA % PROT 51
PFA % FAT 0

LACTATION PRODUCTION SUMMARY

CALVING DATE	MO	DAY	YR	AGE AT CALVING	DAYS BEFORE SALVING	DAYS AFTER SALVING	DAYS TO RECORD	30-DAY LACTATION					COMPLETE LACTATION				TYPE OF RECORD						
								NO	% FAT	% PROT	MEK	MEK	MEK	MEK	MEK	MEK		MEK	MEK	MEK	MEK	MEK	
7 14 95				1-10	E		E	12523	40	505	27	333	313	12783	517	343	1677					DHI	
8 19 96				2-11	E		E	15051	40	608	30	447	312	15349	617	456	2264						DHI-APCS

LACTATION PRODUCTION SUMMARY

CALVING DATE	MO	DAY	YR	AGE AT CALVING	DAYS BEFORE SALVING	DAYS AFTER SALVING	DAYS TO RECORD	30-DAY LACTATION					COMPLETE LACTATION				TYPE OF RECORD						
								NO	% FAT	% PROT	MEK	MEK	MEK	MEK	MEK	MEK		MEK	MEK	MEK	MEK		
11 09 95				1-11	E		E	13301	33	443	29	388	267	13301	443	388	1802						DHI
9 26 96				2-10	D		D	17276	39	669	31	539	274	17276	669	539	2522						HDI-APCS

Figure 5a. Practice Judging class.

STATUS CHANGE
TURNED DRY
6 27 97 42.1
3.2
28132 1134 799 41.9 -1507 .52 -2886 -111 -117

STATUS CHANGE
TURNED DRY
6 27 97 32.9
3.5
30577 1112 927 52.4 -312 -106 -2072 -157 -78

CALF AND BREEDING RECORD

CALVING DATE	MO	DAY	YR	NO. OF CALVES	NO. OF DAUGHTERS	NO. OF SONS	NO. OF OTHERS	SIRE IDENTITY				ESTIMATED RELATIVE PRODUKING ABILITY						
								NO.	% FAT	% PROT	MEK							
7 95 11				118	10	13	94	CHOICE	H	-2890	103	3	17282	692	453	-3414	-120	-156
8 96 11				96	11	9	95	RC MATT	H	-7623	113	2	18362	736	528	-5201	-210	-193
								JOHNSON	H	DUE	8-30							

CALF AND BREEDING RECORD

CALVING DATE	MO	DAY	YR	NO. OF CALVES	NO. OF DAUGHTERS	NO. OF SONS	NO. OF OTHERS	SIRE IDENTITY				ESTIMATED RELATIVE PRODUKING ABILITY						
								NO.	% FAT	% PROT	MEK							
11 95 12				49	1	27	95	CHOICE	H	-7543	98	4	18237	600	529	-4451	-344	-176
9 96 13				51	12	28	95	EMPEROR	H	-2990	94	2	21746	818	660	-1735	-125	-58
								DUSTER	H	-8-23								

TEST DAY DATA

CALVING DATE	MO	DAY	YR	LACT NO.	1ST TEST DAY			2ND TEST DAY			3RD TEST DAY			4TH TEST DAY			5TH TEST DAY			6TH TEST DAY			7TH TEST DAY			8TH TEST DAY			9TH TEST DAY			10TH TEST DAY			11TH TEST DAY		
					SOCS	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT
7 95 11				39	51	44	53	44	53	44	53	44	53	44	53	44	53	44	53	44	53	44	53	44	53	44	53	44	53	44	53	44	53	44	53		
8 96 11				19	44	41	44	46	28	62	28	65	55	60	55	60	55	60	55	60	55	60	55	60	55	60	55	60	55	60	55	60	55	60	55	60	

TEST DAY DATA

CALVING DATE	MO	DAY	YR	LACT NO.	1ST TEST DAY			2ND TEST DAY			3RD TEST DAY			4TH TEST DAY			5TH TEST DAY			6TH TEST DAY			7TH TEST DAY			8TH TEST DAY			9TH TEST DAY			10TH TEST DAY			11TH TEST DAY		
					SOCS	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT	MEK	% FAT	% PROT
1 11 95				95	52	1	30	55	38	56	38	53	27	55	27	50	36	47	36	44	32	34	32	36	3	32	36	4	35	32	3	32	36	4	35		
2 9 96				96	FRSH	80	43	74	43	65	37	60	37	69	34	60	34	60	34	60	34	60	34	60	34	60	34	60	34	60	34	60	34	60	34	60	



Figure 5a. Practice Judging class (continued).

COW PAGE DHI-203

HERD CODE NO. ST CO I HERD 32 94 19650	DATE MAILED MO DAY YR 5 2 97	BARN NAME 2683	INDEX NO. 2683
COW REGISTRATION NO. 15204819 DATE OF BIRTH 07-12-93 PFA MILK -55 PFA % FAT -22 PFA % FAT +05 REL -50 PFA PROT -11 PFA % PROT 24 PFA PROT -6		SIRE REGISTRATION NO. 2046914 NAME OR NO. TOPSECRET BREED H PFA MILK +979 PFA % FAT -07 PFA % FAT +21 PFA PROT +27 PFA % PROT +101 REL 99 PFA PROT 23	
PURDUE DAIRY RESEARCH CENTER 6010 W 600 N WEST LAFAYETTE IN 47906-9282		DAM REGISTRATION NO. 12239726 NAME OR NO. DAM 1853 BREED H PFA MILK -773 PFA % FAT -01 PFA % FAT -31 PFA PROT -28 PFA % PROT -104 REL 60 PFA PROT 3	

CALVING DATE	MO	DAY	YR	AGE AT CALVING	MO	DAY	YR	DAYS BEFORE CALVING	DAYS AFTER CALVING	LACT TEST	MO	DAY	YR	MILK WTS	% FAT	% PROT	MILK	COMPLETE LACTATION			TYPE OF RECORD
																		VALUE	PROFIT	INCOME	
6-14-95	6	14	95	1-11	6	14	95	C	16081	39	629	31	504	313	16376	641	516	2182		DHI	
6-23-96	6	23	96	2-11	6	23	96	C	19211	41	792	31	598	297	19211	792	598	2958		DHI-APCS	

STATUS	CHANGE	MO	DAY	YR	LACT TEST	MO	DAY	YR	MILK WTS	% FAT	% PROT	MILK	ESTIMATED RELATIVE PRODUCING ABILITY		
													VALUE	PROFIT	INCOME
TURNED DRY	4	16	97	25.9	4.2	3.6	1114	1433	55.3	-825	-53	+120	+13	+8	

CALVING DATE	MO	DAY	YR	AGE AT CALVING	MO	DAY	YR	DAYS BEFORE CALVING	DAYS AFTER CALVING	LACT TEST	MO	DAY	YR	MILK WTS	% FAT	% PROT	MILK	COMPLETE LACTATION			TYPE OF RECORD
																		VALUE	PROFIT	INCOME	
6-95	6	95	11	91	1	9	13	94	MERRILL	H	21388	837	651	+774	-28	+46					
6-96	6	96	14	103	2	9	13	95	MERRILL	H	23054	951	696	-417	-10	-22					

CALVING DATE	MO	DAY	YR	AGE AT CALVING	MO	DAY	YR	DAYS BEFORE CALVING	DAYS AFTER CALVING	LACT TEST	MO	DAY	YR	MILK WTS	% FAT	% PROT	MILK	COMPLETE LACTATION			TYPE OF RECORD
																		VALUE	PROFIT	INCOME	
6-95	6	95	11	91	1	9	13	94	MERRILL	H	21388	837	651	+774	-28	+46					
6-96	6	96	14	103	2	9	13	95	MERRILL	H	23054	951	696	-417	-10	-22					

COW PAGE DHI-203

HERD CODE NO. ST CO I HERD 32 94 19650	DATE MAILED MO DAY YR 12 9 97	BARN NAME 2714	INDEX NO. 2714
COW REGISTRATION NO. 15303760 DATE OF BIRTH 11-07-93 PFA MILK +198 PFA % FAT +04 PFA % FAT +16 REL 54 PFA PROT +27 PFA % PROT 34 PFA PROT +6		SIRE REGISTRATION NO. 2016536 NAME OR NO. MALCOLM BREED H PFA MILK +90 PFA % FAT +12 PFA % FAT +28 PFA PROT +5 PFA % PROT +35 REL 98 PFA PROT 1	
PURDUE DAIRY RESEARCH CENTER 6010 W 600 N WEST LAFAYETTE IN 47906-9282		DAM REGISTRATION NO. 13963073 NAME OR NO. DAM 2336 BREED H PFA MILK +322 PFA % FAT -10 PFA % FAT -9 PFA PROT +12 PFA % PROT +27 REL 59 PFA PROT 43	

CALVING DATE	MO	DAY	YR	AGE AT CALVING	MO	DAY	YR	DAYS BEFORE CALVING	DAYS AFTER CALVING	LACT TEST	MO	DAY	YR	MILK WTS	% FAT	% PROT	MILK	COMPLETE LACTATION			TYPE OF RECORD
																		VALUE	PROFIT	INCOME	
11-10-95	11	10	95	2-00	11	10	95	E	14026	42	592	31	438	326	14803	629	464	2163		DHI	
11-28-96	11	28	96	3-00	11	28	96	C	19162	46	872	31	599	359	20982	959	669	3026		DHI-APCS	

STATUS	CHANGE	MO	DAY	YR	LACT TEST	MO	DAY	YR	MILK WTS	% FAT	% PROT	MILK	ESTIMATED RELATIVE PRODUCING ABILITY			
													VALUE	PROFIT	INCOME	
TURNED DRY	11	22	97	31.6	5.0	4.1	35785	1588	1133	48.0	+3	+369	+53	-1851	-46	-58

CALVING DATE	MO	DAY	YR	AGE AT CALVING	MO	DAY	YR	DAYS BEFORE CALVING	DAYS AFTER CALVING	LACT TEST	MO	DAY	YR	MILK WTS	% FAT	% PROT	MILK	COMPLETE LACTATION			TYPE OF RECORD
																		VALUE	PROFIT	INCOME	
11-95	11	95	11	97	1	2	2	95	TESK	H	17533	734	539	-5161	-209	-166					
11-96	11	96	12	141	2	2	15	96	EMPEROR	H	22036	985	672	-364	+72	-6					

CALVING DATE	MO	DAY	YR	AGE AT CALVING	MO	DAY	YR	DAYS BEFORE CALVING	DAYS AFTER CALVING	LACT TEST	MO	DAY	YR	MILK WTS	% FAT	% PROT	MILK	COMPLETE LACTATION			TYPE OF RECORD
																		VALUE	PROFIT	INCOME	
11-95	11	95	11	97	1	2	2	95	TESK	H	17533	734	539	-5161	-209	-166					
11-96	11	96	12	141	2	2	15	96	EMPEROR	H	22036	985	672	-364	+72	-6					

4

3

Genetics: Genetic merit in the pedigree is accounted in the Predicted Transmitting Abilities (PTA) of the cows. The rank of the cows for PTA milk is 2-3-1-4. The rank for PTA protein is 2-3-4-1, and for PTA fat is 3-1-4-2. But these PTAs are combined in the net merit index, along with PTA for somatic cell score and productive life. The ranking for net merit percentile and the overall ranking is 2-3-4-1.

<u>Production</u>	<u>Reproduction</u>	<u>Mastitis</u>	<u>Genetics</u>
4	2	1	2
3	1	2	3
2	4	3	4
1	3	4	1

Because production is the most important trait economically, one might be tempted to place the class 4-3-2-1. However, reproduction is important too. Cow 3 had a large number of days open in second lactation, while Cow 2 was sound for reproduction. For this class, the differences in mastitis were not large enough to change the rankings based on production and reproduction. For genetics, Cow 4 ranked lower than Cow 2 or Cow 3, but not enough to account for the clear advantage it had in production, specifically for milk per day since 24 months of age, for ME lactation yields, and for estimated relative producing ability. Thus the official placing is 4-2-3-1 with cuts of 3, 3, and 6. A placing of 4-2-3-1 would result in a score of 50 (Table 1).

Discussion

In placing this class of second lactation cows 4-2-3-1, begin with the cow that produced the most milk per day since 24 years of age and clearly had the best estimated relative producing ability.

Cow 4 places over Cow 2 in the top placing because of her advantage in production. Four out-produced 2 in both 305 day and complete lactations and produced more milk per day of age since 24 months of age. Four also had a definite advantage in ME production and especially in estimated relative producing abilities. I do recognize that two completed her lactations in fewer days, had a higher percentile rank for net merit, and had a slightly lower average somatic cell score in second lactation.

Two places over 3 in the middle placing because of her decided advantage in reproduction. Two calved earlier in first lactation, was open far fewer days in both lactations, and settled after fewer breedings in second lactation. Further, 2 produced more milk per day of age since 24 months and ranked higher for net merit than 3. Yes, 3 did produce more milk in her 305 day and complete lactation and had more lifetime production.

In the final placing, 3 places quite easily over 1 because of her advantages in most production measures. Three produced more milk in 305-day and complete lactations, more lifetime milk, more milk per day of age since 24 months of age, and had much higher estimated relative producing abilities. Moreover, 3 did have a much higher percentile ranking for net merit, was open fewer days

in first lactation, and was dry fewer days between first and second lactation than 1. Granted, 1 did calve earlier as a heifer, required fewer breedings in second lactation, and had a lower average SCC score in first lactation. However, 1 simply did not produce enough lifetime milk or milk per day of age and did not have high enough estimated relative producing abilities to place any higher in this class, which placed 4-2-3-1, with cuts of 3, 3, and 6.

Table 1. Possible placings and scores for the example class.

1-2-3-4=14	2-1-3-4=23	3-1-2-4=17	4-1-2-3=35
1-2-4-3=20	2-1-4-3=29	3-1-4-2=20	4-1-3-2=32
1-3-2-4=11	2-3-1-4=29	3-2-1-4=36	4-2-1-3=44
1-3-4-2=14	2-3-4-1=41	3-2-4-1=38	4-2-3-1=50
1-4-2-3=23	2-4-1-3=41	3-4-1-2=32	4-3-1-2=38
1-4-3-2=20	2-4-3-1=47	3-4-2-1=41	4-3-2-1=47

Table 2. Indiana state breed averages for milk fat and protein production in 1997 (source: Indiana State Dairy Association).

<i>Breed</i>	<i>Milk (lbs.)</i>	<i>Fat (lbs.)</i>	<i>Protein (lbs.)</i>
Ayrshire	14,429	563	484
Brown Swiss	17,717	722	650
Guernsey	13,631	613	489
Holstein	19,559	709	630
Jersey	13,994	646	526

Glossary of Terms Associated With DHI Cow Pages

Age: Age is usually considered the number of months from birth to the latest calving date, rounded to the nearest month.

Bred date: Date an animal is mated to a bull or bred by artificial insemination.

Breed: One of the nine recognized breeds of dairy cattle. If the sire and dam are of different breeds, the offspring is considered to be a crossbred.

Bull: Male animal in dairy cattle.

Calf: Young of cattle, either sex.

Calving date: Date the cow gave birth to a calf, also known as "Fresh Date"

Calving interval: Period of time (in months) from one calving to the next.

Conception: The time when the cow or heifer became pregnant.

Culling: Removing a cow from the herd.

Daily milk weight: Pounds of milk produced in a 24-hour period of time.

Dam: The mother of an animal.

Days dry: Number of days from dry date to next calving date.

Days carried calf: The number of days the cow was pregnant.

Days in milk: Number of days from calving to dry date or through the date of the most recent test.

Days open: Days the cow is not pregnant during a lactation.

Number of days from calving to a successful breeding date.

DHIA: Dairy Herd Improvement Association

DRMS: Dairy Records Management Service, Raleigh, NC and Ames, IA.

Dry date: First whole day a cow is not milked after a lactation.

Dry off: Stop milking a cow to allow a "dry period" of preparation for the subsequent calving and lactation.

Due date: The date a heifer or cow is due to give birth or "freshen".

Eartag number: A uniform series eartag number consisting of a unique combination of two numbers, three letters, and four numbers (For example, 64WAX1786) used to identify non-registered animals.

Energy corrected milk (ECM): Milk expressed on a 3.5% fat and 3.2% protein basis. The formula for ECM is: $ECM = 0.3246 \times \text{milk} + 12.86 \times \text{fat} + 7.04 \times \text{protein}$.

Estimated relative producing ability (ERPA): An estimate of a cow's genetic and permanent environmental effects on her production, expressed as a deviation from her herdmates.

First calf heifer: A young cow that has calved once.

Fresh date: Date a cow gave birth to a calf.

Gestation period: Number of days from successful breeding date to fresh date.

Grade animal: An animal that is not registered with a breed association.

Heifer: A female that has never calved.

Herd code: An eight digit number used to identify each dairy herd (for example, 55-27-0034).

Herdmate deviation: The difference between the Mature Equivalent (ME) production of a cow and the average ME production of her herdmates.

Income over feed cost: The approximate net return of a cow since the beginning of the previous dry period, after considering the cost of feed consumed.

Index number: A unique five digit number used by DHIA to identify each cow within a herd.

Lactation record: Yield of milk, fat, or protein from calving to a dry date or date the cow was sold.

Lifetime actual production: The number of pounds of milk, fat, or protein a cow actually produces in her lifetime.

Mature Equivalent (ME) record: A lactation record standardized for age, season of calving, region of the country, and number of days open in the previous lactation.

Net merit dollars: A genetic index that combines Predicted Transmitting Abilities for production, length of productive life, and mastitis resistance in a 10:4:1 ratio.

Open: Not pregnant.

Pedigree: A list of an animal's ancestors, ideally including complete genetic information.

Permanent environmental effect: An effect that is common to all lactation records of a cow and influences her records differently than those of her herdmates.

Persistency of the lactation curve: An index of how well the cow maintained production throughout the first 305 days of lactation.

Persistency is calculated as a ratio of the 305 day ME milk yield predicted from the first test after 80 days in milk to the latest projected or actual 305 day milk yield.

Predicted Transmitting Ability (PTA): A measure of the genetic ability an animal is expected to transmit to its offspring.

Rating: A score of A, B, C, D, or E that categorizes cows in a herd into five groups based on their current lactation energy corrected milk.

Registered animal: An animal that is registered in a national breed registry or herdbook.

Reliability: The degree of confidence that the Predicted Transmitting Ability represents the true genetic ability of the animal.

Service sire: Bull to which a cow or heifer was bred.

Somatic Cell Count (SCC): The number of white blood cells per milliliter of milk, used as an indicator of mastitis.

Somatic Cell Score (SCS): A linear scale used to report SCC on a 0 to 10 scale.

Test Date: Date the herd test was completed. It is the date on which the last milk weight and sample were taken.

Further Reading

Dairy Records Processing Center. 1995. *DHI Reference Manual*. DRMS. Box 7623, Raleigh, NC. 27695-7623.

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Washington State University Cooperative Extension Service. 1987. *Teaching 4-H Oral Reasons*. Leaders Guide (EM-4789). Dept. of Information, 401 Hulbert Hall, Washington State University, Pullman, WA 99164-6244.

Trimberger, G. W., W. M. Etgen, and D. M. Galton. 1987. *Dairy Cattle Judging Techniques (4th ed.)*. Prentice Hall Inc. Englewood Cliffs, N.J.

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