Recent Developments in the Progeny Testing of Dairy Bulls in Japan

Contents

RECENT DEVELOPMENTS IN THE PROGENY TESTING OF DAIRY BULLS IN JAPAN

Takeo Abe

The Livestock Improvement Association of Japan, Inc.

1. INTRODUCTION (DAIRY FARMING IN JAPAN)

As of February 1, 1993, a total of 51 thousand farmers keep 2.1 million dairy cows in Japan. Those over two years of age are 1.4 million, and the cows in milk 1.1 million. The average herd size is 40.6, including all age classes, and 27.8 with only those over two years. Ninety-nine percent of the dairy cattle in this country are Holsteins with a tiny minority of Jersey cattle. Annual milk production per cow is about 6,700 kgs.

Almost all of the dairy cows and heifers are bred artificially with frozen semen. The total number of units of dairy bull semen in 1992 is estimated roughly at two million. The leading semen suppliers of dairy bull semen are the Livestock Improvement Association of Japan (LIAJ) and Hokkaido Livestock Improvement Association (HLIA), taking up altogether about two thirds of the national sales.

Importation of livestock semen from overseas began in 1984. Annual import of dairy bull semen has been gradually increasing from about 20,000 units in 1984 to 166,000 in 1992. All of the imported semen has been from USA and Canada. Export of semen is quite limited in quantity (about 20 thousand units of dairy bull semen).

The official milk recording program came into existence in 1974. It has shown a rather rapid expansion since then. In 1993, about 44 percent of the cows are enrolled in the milk recording program (Table 1).

2. REORGANIZATION OF DAIRY BULL PROGENY TESTING PROGRAM

Up until 1988, proven sires came from two official dairy bull progeny

testing programs. One was carried out by the National Livestock Breeding Stations (NLBS) for the young bulls produced in these governmental establishments. The other was undertaken by the Livestock Improvement Association of Japan (LIAJ) under the sponsorship of the National Government. Such young bulls as produced by the private breeders and farmers through contract mating and purchased by the Government were progeny-tested in this latter program. The NLBS program was initiated in 1969 and the LIAJ program in 1971. These two programs were separate ones, but the method of progeny testing and data analysis were much the same for both.

The system of progeny testing dairy bulls in these programs was very different from that in other countries where this kind of work was run to the extent that all the daughters of the test bulls were milk recorded in special stations. Part of the barns of two National Livestock Breeding Stations and many prefectural government institutions were utilized for this purpose. The station system was the only choice available at the time when these programs were started, because no nationwide milk recording program existed yet in Japan.

By the end of 1988, about 180 Holstein proven sires were selected and stationed for service in the four bull centers and one depot of the LIAJ located in different regions of the country. The LIAJ bull centers kept 51 proven Holstein sires active in 1988. Almost all of the Holstein bull semen produced for sale by the LIAJ centers was from the proven sires.

Meanwhile, with progress of the progeny testing programs for dairy bulls, the following limitations and problems came to be felt increasingly:

i) While there is growing interest among farmers in the use of proven sires, the stations' total capacity for accomodating the daughters of the test bulls is limited, barring further expansion of the program.

ii) Only the Government-owned bulls can be progeny-tested and selected as official proven sires. In some regions, efforts are made by private breeders to prove sires within such regions on the basis of the data available from the milk recording program which is developing rapidly. The dairy farmers as users of the semen are claiming for a nationally unified system of sire

evaluation, instead of the "official" and "private", or "national" and "local", proof figures which are not convertible mutually.

The Government decided in 1984 on establishment of a new national progeny testing program by reorganizing the existing ones such that:

i) The NLBS program and LIAJ program be taken over by the new program;

ii) The new program include progeny testing of private-owned young bulls meeting certain requirements, in addition to the Government-owned young bulls; and

iii) Sire evaluation by a unified method, based on the milk recording as well as station data, be made not only for the bulls progeny-tested under the new system, which requires "waiting", but also for any other bulls that have data enough for evaluation.

It was expected that more young bulls would be progeny-tested in the new program than in the old ones so that a larger number of selected proven sires might be available for use and/or higher genetic quality of proven sires might be secured than ever through intensified selection.

The batch of the young bulls test-mated in 1983 was the last one involved in the old programs, being proved in 1988. The test bulls mated in 1984, the first group in the new program, had their first evaluation in May 1989, along with a large number of other sires used in the past and outside this program. We have now the eighth sire evaluation (April 1993) in the new program. The routine practice is two evaluations a year so far.

In what follows, description will be focused on the new program.

3. TEST BULLS

The young bulls to be progeny-tested (referred to as "test bulls"), may be divided by ownership into:

i) Those owned by the National Government (Government-owned bulls), which are further classified into:

a. The bulls purchased by the Government from among the bull calves produced by planned mating under the contract between the Government and farmers; and

b. The bulls produced by the National Livestock Breeding Stations (NLBS); and

ii) Those owned by private organizations or individuals (private bulls).

Production of Test Bulls Through Planned Mating

(1) Selection of bull sires and bull dams

Selection of individual bull sires and establishment of the general selection criteria for bull dams are made every year by a committee of the Livestock Improvement Association of Japan (LIAJ), consisting of university professors and researchers in animal breeding, dairy cattle specialists and representatives of dairy organizations, and so forth.

The number of the bull sires selected for the planned mating each year is around 30. Those selected include both domestic and foreign bulls, the latter being used in the form of imported semen. A large portion of the foreign sires are US ones and the remaining are Canadians.

The general criteria for cows to be selected as bull dams, decided by the committee for the 1992 season are essentially the same as the conditions required for the domestic dam of a private test bull, which will be presented later.

(2) Contract

When the owner of a bull dam thus selected agrees to use the semen of the bull sire specified by the Government on his cow concerned, a contract will be concluded to the effect that, if such mating results in a bull calf which is apparently normal, the Government purchases it at a predetermined price. The semen for the planned mating is provided to the herd owner free of charge. If the calf born is female, it belongs to the herd owner.

(3) Collective raising of bull calves and preliminary selection

The bull calves produced by the planned mating and bought by the Government are all moved into one of the Livestock Breeding Stations for collective raising. A preliminary selection is made on them at around 12 months of age mainly on the basis of the growth, conformation and semen conditions. Half of them will be culled. The other half saved are still to be

kept there for semen collection and "waiting".

Requirements to be Met by Private Bulls

For a private bull to be accepted as test bull, it must satisfy the criteria regarding its sire and dam. These criteria are set out each year by a committee of LIAJ, composed of learned persons and representatives of organizations relative to dairy cattle breeding. The criteria applicable to each case will be the ones effective at the time when the action for acquisition of the bull (mating, purchase, etc.) is taken.

The criteria set out at the 1992 committee meeting follow:

(1) Sire

i) As for a domestic sire, the following conditions should, in principle, be satisfied:

	Proof*
Production:	
BVF + BVP	≧ 99 kg
or	
BVF + BVSNF	≧ 187 kg
Repeatability	≧ 65 %
Conformation:	
STA (final score)	+
STA (mammary system)	+

* Dairy Sire Evaluations (1992-I)

ii) As for a foreign sire, the conditions below should, in principle, be satisfied:

USA*		CANADA**	
Production: PTAF+PTAP	≧115 lb	ETAF+ETAP	≧27
Rel.	≧ 65 %	R	≧65 %
Conformation: PTAT	+	FC	+
UDDER COMP.	+	UDDER	+

* Holstein Association, Sire Summaries, 1991 Vol. 1

** Agriculture CANADA, Dairy Sire Appraisal (1991, I)

A sire of any other country than USA and Canada is required to have proofs considered comparable enough to the above.

(2) Dam

i) As for a domestic dam, it should have undergone the type classification of the Holstein Cattle Association of Japan and milk recording with the results satisfying, in principle, the following conditions:

		Proof* and result of type classification
Production:		
CBVF + CBVP		≧ +64 kg
or		
CBVF + CBVSNF		≧ +126 kg
Conformation:		
Final score	Post-2nd calving or later	≧ 85 pts
	Post-1st calving	≧ 82 pts
Score % for mammary system	Post-2nd calving or later (83% if production proof is outstanding)	≧ 85 %
	Post-1st calving	≧ 82 %

* Cow Evaluations for Selection of Dams to Produce Domestic Test Bulls (June, 1992)

ii) As for a foreign dam (including a donor cow), the conditions below should, in principle, be satisfied.

	USA*	CANADA**
Production:	PTAF+PTAP ≧ 86 lb	ETAF+ETAP ≧ +18
Conformation:		
Final score	VG or higher	VG or higher
Mammary system	VG or higher	VG or higher

* USDA-DHIA, Elite Cow Index (1992, 1)

** Agriculture CANADA, Cow Indices (1992, spring)

A dam of any other country than USA and Canada is required to have proofs and classification results considered comparable enough to the above.

iii) As for an imported dam, either of the conditions presented in i) or ii) above should be satisfied.

Test Bulls Selected in 1992

The number of young bulls selected as test bulls in 1992 is given in the table below, as classified by ownership and sources.

Ownership	Sources		Total
	Domestic	Imported	
Government:			
NLBS	5	0	5
Planned mating	30	0	30
Private	4	145	149
Total	39	145	184

The private bulls come largely from the two leading AI organizations, i.e., the Livestock Improvement Association of Japan (LIAJ) and the Hokkaido Livestock Improvement Association (HLIA). Many of the domestic test bulls have been produced with imported semen. Most of the imported young bulls are from the United States, the remaining small part being from Canada.

4. TEST MATING

The semen of the test bulls is distributed to many different herds nationwide for test mating.

General Planning for Test Mating

The Livestock Improvement Association of Japan (LIAJ) is responsible for making a general test mating plan each year. For 1992, the number of necessary test matings was figured out as follows:

No. of test bulls	No. of milk recorded daughters needed		No. of necessary matings
	Per test bull	Total	
184	36	6,624	52,992

For the above calculation of the number of necessary matings, the heritability value for milk yield is assumed to be 0.25. It is also assumed that 8 test matings are necessary to obtain one lactation record of daughter usable for sire evaluation.

Distribution of Semen for Test Mating

The test bull's semen is distributed nationwide to herds participating in the milk recording program for production of sample daughters. All of the prefectures cooperate in the test mating.

Allotment of test matings to different prefectures is based mainly on the cow population of each prefecture but some consideration is given also to the number of dairy farmers.

The owners of the test bulls are requested to provide about 800 units of semen from each bull. The part of such semen for use in all the prefectures except in Hokkaido region is sent firstly to the stock point in the Maebashi Bull Center of the LIAJ, and the part to be used in Hokkaido to the stock point in the Main AI Center of the HLIA. In turn, according to the semen distribution plan set out by the LIAJ, as classified in two ways by test bull and prefecture, the Maebashi Center sends out the semen of different bulls to the semen handling organization of each prefecture except for Hokkaido, where the Main AI Center ships semen to sub-centers in the region.

The LIAJ has concluded a contract for implementation of test mating with an appropriate organization in each prefecture which represents the milk recording associations at prefectural level.

5. MILK-RECORDING OF DAUGHTERS

The daughters of the test bulls are expected normally to be milk recorded in the herds where they were born. The herd owners are requested to make best efforts to keep them at least until they complete their first lactation.

In the milk recording program, 305 day milk yield is based normally on 10 recording day measurements. As for milk composition such as fat %, protein %, and SNF %, measurement is made once a month with the sample taken on the recording day.

For some years following reorganization of the progeny testing program, the daughters of the test bulls were milk recorded in both farmers' herds and special stations which had been used under the old system. Use of the special stations, however, was dropped for the daughters of 1990 and later groups of test bulls. This complete change to field system was decided after a few year experience of using field data for sire evaluation.

6. SIRE EVALUATION

The traits that sire evaluation, whether a formal genetic evaluation or else, concerns include milk production traits, conformation characters, management characters and beef production characters.

In sire evaluation for milk production and conformation characters, BLUP (best linear unbiased prediction) with a sire-maternal grandsire model was used from 1989 to 1992 (1st to 7th run of evaluation in the new program). But, it was replaced by the animal model BLUP from 1992 autumn run to enable simultaneous evaluation of bulls and cows.

Milk Production characters

(1) Traits included

Milk yield, fat % and yield, protein % and yield, and SNF % and yield.

(2) Sources of data

i) Data from the milk recording program accumulated to a recent date. Only the data satisfying the following conditions are used:

a. The 1st to 5th lactation records of a duly registered Holstein or grade cow, having calved first between 22 and 36 months of age;

b. Two milkings a day;

c. Officially approved record based on supervised recording day measurements; and

d. Record of a complete lactation of 240 days or longer, or incomplete lactation record based on at least five supervised recording day measurements.

Note: In case where the first lactation record fails to be usable for a

reason or another, any subsequent records will also be ommitted. When a lactating cow moves from one herd to another, the part of lactation measured in the new herd will be neglected.

ii) Data from the station testing, accumulated in the old and new progeny testing programs. Only the records meeting the following conditions are used:

a. Complete 240-day record based on everyday measurement of milk production; and

b. At least five measurements of milk composition at appropriate intervals during the test period.

(3) Cutting or extension of record

A record of lactation longer than 305 days is cut on the 305th day.

A record of lactation terminating between the 240th and 305th days, inclusive, is used as it is.

A record of lactation in progress is used after extension to the 305-day basis if five or more supervised recordings in the field testing or five or more measurements of milk composition in station testing have been made.

All the 240-day records from station testing are also extended.

Extension of record is made for milk yield, fat yield, protein yield and SNF yield, using the following formula:

$$Y = Y_t + (B_0 + B_1 X)\,(305 - t),$$

where Y: Estimated 305-day yield.

Y_t: Amount produced from the calving day to the preceding day of the latest supervised recording.

X: Measurement on the last supervised recording day.

t: Number of days from calving to the last supervised recording.

B_0,B_1: Coefficients in correspondence to region, calving month, and the number of days from calving. These coefficients have been determined by application of the fifth power regression curves to data from the milk recording program.

(4) Total number (rounded) of records used in 1993 spring run of sire evaluation:

1,137,000 for milk yield and fat % and yield,

617,000 for protein % and yield, and

969,000 for SNF % and yield.

(5) Method of sire evaluation

The single-trait, multi-record BLUP with an animal model is employed for evaluation of sires and cows.

i) Statistical model

$$y_{ijklm} = H_i + c_{ij} + M_k + A_l + u_m + p_m + e_{ijklm}$$

where y_{ijklm}: Observed value

H_i: Effect of the i^{th} herd-year (fixed)

c_{ij}: Effect of interaction between the i^{th} herd-year and j^{th} sire's semen producing country-cow's parity (random)

M_k: Effect of the k^{th} region-calving month (fixed)

A_l: Effect of the l^{th} calving age (fixed)

u_m: Breeding value of the m^{th} cow (random)

p_m: Permanent effect of environment common among records of the m^{th} cow (random)

e_{ijklm}: Effect particular to each observation (random)

ii) The numerator relationship matrix with all the males and females included in the analysis is used.

(6) Genetic base

The genetic base for the two 1993 evaluations is defined as the average breeding value of the cows born in 1985. For evaluation thereafter, the genetic base is to be shifted by one year in the spring run every year.

Conformation characters

(1) Traits included

Scores for general appearance, dairy characters, body capacity, mammary system, as well as final score, and also fifteen linear characters.

(2) Sources of data

The records of the type classification plan designed specifically for part of the daughters of test bulls, as well as the records of herd classification

service conducted as routine by the Holstein Cattle Association of Japan are the main sources of data. Only the records satisfying the following conditions are eligible for use:

i) Record of a Holstein or Holstein grade duly registered in herdbook;

ii) Record of first calver which calved not earlier than 22 months nor later than 36 months of age; and

iii) Record of classification made within ten months after calving.

(3) Method of sire evaluation

The single-trait BLUP with the following animal model and numerator relationship matrix is applied:

$$y_{ijkl} = H_i + A_j + L_k + u_l + e_{ijkl},$$

where y_{ijkl}: Observed value

H_i: Effect of the i^{th} classification group (classifier-herd-year) (fixed)

A_j: Effect of the j^{th} classification age (fixed)

L_k: Effect of the k^{th} lactation stage (fixed)

u_l: Breeding value of the l^{th} animal (random)

e_{ijkl}: Effect particular to each observation (random)

Management characters

(1) Traits included

Milking rate, fore-rear udder ratio of milk secretion, calving ease, and milking ease.

(2) Sources of data

For management traits, data come from different sources. Information about calving ease comes from the mates of test bulls and/or their daughters. Hearing from herd owners who keep the test bulls' daughters is done for temperament and milking ease. The station testing of daughters can provide data on milking rate and other milkability traits. In general, however, the system of data collection on these management characters has not been developed well enough to allow a formal genetic evaluation of sires. So, efforts are being made, for the time being, to analyze data in one way or another and furnish farmers with information just indicative of

sire's effect.

(3) Method of analysis

The Harvey's least squares analysis is applied to the station data to estimate sire effect for milking rate and fore-rear udder ratio with the following model:

$$y_{ijk} = M + H_i + S_j + e_{ijk}$$

where y_{ijk}: Observed value

M: Population mean

H_i: Effect of the i^{th} station

S_j: Effect of the j^{th} sire

e_{ijk}: Effect particular to each record

As for calving ease, temperament, and milking ease, records are classified into a number of classes, i.e., "easy, no assistance", "slight assistance", "two- or three-men assistance", "difficult, several-men assistance", and "very difficult, surgery needed or death of cow" for calving ease, "gentle", "nervous", and "rough" for temperament, and "fast", "medium", and "slow" for milking ease. Then the standardized relative frequency (SRF) is computed for each of the traits of each sire as follows:

$$SRF = (P_i - \bar{P}) / \sqrt{\bar{P}(1 - \bar{P})N_i}$$

where P_i: Relative frequency of the i^{th} sire's records classified into the specified class(es): "easy, no assistance" and "slight assistance" for calving ease, "gentle" for temperament, and "fast" for milking ease

$\bar{P}$: Average P over all the sires

N_i: Number of i^{th} sire's records

Beef production characters

For beef production, only daily weight gain from 7 to 17 months of age is measured on a certain number of sons from each Government-owned test bull.

Analysis of data is made using the method of least squares with the same type of model as for the milking rate and fore-rear udder ratio mentioned above.

7. PUBLICATION OF SIRE EVALUATIONS

Until the spring of 1992, all of the computation work for sire evaluation in the new program was done regularly (twice a year) at the Computing Center of the Livestock Improvement Association of Japan (LIAJ) for publication of the results in the "Dairy Sire Evaluations" by LIAJ under the supervision of the Livestock Bureau, Ministry of Agriculture, Forestry and Fisheries.

With the change of sire evaluation method for milk production and conformation traits to an animal model BLUP in the autumn of 1992, the job of sire evaluation for these characters was taken over by the Livestock Breeding Center, Ministry of Agriculture, Forestry and Fisheries.

Publication of all the sire evaluation results, however, still remains in the responsibility of LIAJ.

The sire evaluation is to be published only if the sire has at least 15 daughters, distributed over 5 or more different herds, with lactation records usable for sire evaluation.

Information items for each sire follow:

(1) Identification of bull

Name, registration number, date of birth, final type score, and names of sire and maternal grandsire, and "BL" in case he is known as a BLAD gene carrier.

(2) Milk production and conformation characters

ETA (estimated transmitting ability) for seven milk production traits (milk yield, fat yield, fat %, solid-not-fat yield, solid-not fat %, protein yield and protein %) and five conformation traits (final score, general appearance, dairy character, capacity and mammary system).

CR (confidence range) for ETA

Reliability of ETA for milk yield and final score

Numbers of daughters and herds

Percentage of records in progress defined as the percentage of daughters the first lactation record of which was used after extension to the 305-day basis against the total number of daughters that contributed to evaluation

of the bull.

Economic merit of using the bull, in terms of increase or decrease of income expected from milk production of his average daughter. To calculate, the following formula is used:

Economic merit = ETAM × A + ETAF × B + ETASNF × C,

where

A: Average raw milk price - (average fat % × 1/0.1 × extra payment per 0.1 fat % + average SNF % × 1/0.1 × extra payment per 0.1 SNF %),

B: Price per kg fat, and

C: Price per kg SNF.

(3) Management characters

Rate of milk flow and fore-rear udder ratio of milk secretion, the former being presented in terms of the least squares sire effect, while the latter in terms of the least squares sire mean.

Calving ease, temperament and milking ease, presented graphically on the basis of the standardized relative frequency (SRF) calculated for each of these traits. Asterisk (*) is used for zero SRF to distinguish from no-data case.

(4) Beef production character

DG (daily gain in live weight), presented in terms of least squares sire effect and sire mean.

(5) Owner of the bull and availability of semen.

(6) Graphical presentation of STA (standardized transmitting ability) for different traits

Different traits have different genetic variations, and it is rather difficult only with ETA value to see at once the relative position of the bull in the bull population at large. For supplementation in this respect, STA is calculated for each important trait in the following manner:

$$STA = \frac{\text{ETA for the bull - Average ETA for all the bulls}}{\text{Standard deviation of ETA for all the bulls}}$$

The STAs are computed for 4 milk characters, 15 linear conformation traits as well as 5 scored type traits, including the final score, and arranged on a compact diagram, where the relative position of the bull regarding the trait concerned is indicated by the length and direction (to the right or left of the middle point) of a horizontal bar.

Table 1. MILK RECORDING PROGRAM IN JAPAN

Present status of milk recording program (31 March 1993)

No. of prefectures involved	46
No. of milk recording associations	352
No. of milk-recorded herds	16,068
No. of cows enrolled	563,591
No. of all cows (Feb. 1)	1,281,000
Percentage of cows enrolled	44.1

Yearly average for 305-day 2X production

Year	Cow No.	Milk kg	Fat %	Fat kg
1975	6,271	5,826	3.6	208
1980	98,266	6,339	3.7	232
1981	121,832	6,330	3.7	232
1982	149,782	6,372	3.7	233
1983	178,187	6,704	3.6	244
1984	193,560	6,821	3.6	247
1985	210,840	7,008	3.65	256
1986	206,203	7,171	3.65	262
1987	211,786	7,346	3.66	269
1988	233,183	7,507	3.67	276
1989	242,754	7,705	3.69	284
1990	261,670	7,798	3.69	288
1991	281,533	7,781	3.70	288

HEAD OFFICE
1-28-6 Kameido, Koto-ku, Tokyo 〒136
Tel 03-3682-6981 Fax 03-3682-7369

COMPUTING CENTER
1-28-6 Kameido, Koto-ku, Tokyo 〒136
Tel 03-3682-6811 Fax 03-5626-8376

HOKKAIDO OFFICE
1-12 Higashi 2, 13-chome, Tsukisamu,
Toyohira-ku, Sapporo-shi 〒004
Tel 011-856-0262 Fax 011-856-0262

TOKACHI AI CENTER
Minami Shimizu, Shimizu-cho, Kamikawa-gun,
Hokkaido 〒089-01
Tel 01566-2-2158 Fax 01566-2-2150

MORIOKA AI CENTER
301-5 Shimoda, Tamayama-mura, Iwate-gun,
Iwate-ken 〒028-41
Tel 0196-83-2760 Fax 0196-83-1334

MAEBASHI AI CENTER
312 Kanamaru-cho, Maebashi-shi,
Gunma-ken 〒371-01
Tel 0272-69-3311 Fax 0272-69-5426

OKAYAMA AI CENTER
415 Miyabeshimo, Kume-cho, Kume-gun,
Okayama-ken 〒709-46
Tel 0868-57-2475 Fax 0868-57-2476

KUMAMOTO AI CENTER
4332-16 Kawahara, Nishihara-mura, Aso-gun,
Kumamoto-ken 〒861-24
Tel 096-279-2647 Fax 096-279-3496

LIVESTOCK IMPROVEMENT RESEARCH CENTER
PO Box 3, Fujimi Post Office,
Gunma-ken 〒371-01
BLOOD TYPING SECTION
Tel 0272-69-2441 Fax 0272-69-9526
AI RESEARCH SECTION
Tel 0272-69-2440 Fax 0272-69-9526

ANIMAL BIOTECHNOLOGY CENTER
Yada-Bld. 3-21-10 Higashi Shinagawa,
Shinagawa-ku, Tokyo 〒140
Tel 03-3740-2709 Fax 03-3740-2719

BEEF CATTLE PROGENY TESTING CENTER
2138-1 Higashiyama, Nyuno, Kouchi-cho,
Kamo-gun, Hiroshima-ken 〒729-15
Tel 08243-7-0327 Fax 08243-7-0327