[Part 1]

Report on Experimental Feeding of Dairy Cattle with DDGS (Distiller's Dry Grains with Solubles)*)

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I. Objectives

DDGS (Distiller's Dry Grains with Solubles[1)#]) is highly nutritious and is presently being used as a new feed ingredient in USA, mainly for cattle. Its supply is expected to increase in the future.

In Japan also, basic evaluation tests of this new feed ingredient have been completed and its nutritional values and other characters have been established and published as provisional values (MAFF notification No. 1589, Official Gazette dated August 30, 2004).

The present study was conducted to evaluate the usefulness of DDGS as a feed in existing cattle farms, in the context of the dairy farm in Japan, before its large-scale adoption as a feed in the country.

II. Methods

1. Study period and locations

The study was conducted for 3-4 months during February to June 2004 at 3 farms. These 3 farms were representative dairy farms of the Nasu region of Tochigi prefecture, a leading dairy farming region like Hokkaido. The profiles of these farms are given in Table 1.

Table 1 Profiles of farms where the study was conducted

Farm	Farm A	Farm B	Farm C
No. of animals[1)]	100 heads	70 heads	480 heads
Rearing method	Individual tie stalls	Individual tie stalls	Free stall
Workers	2 generations of a family	2 generations of a family	2 families plus employees

Study period	March 1 – June 8	March 7 – June 7	February 4 – May 30

Note: 1) Breakdown of animals: Lactating cows, dry cows, heifers and some beef cattle.

Note: *) The official Japanese name notified for DDGS was "Toumorokoshi Distillers Grain Soluble" at the time of publishing the provisional values, on August 30, 2004.

Characteristics of each farm

(1) Farm A gives importance to increase the number of calvings in their farm management. The target is an average of 5 calvings per cow. They do not milk the cows fully even at peak lactation and feed them plenty of grass with only a moderate amount of concentrate feed. The farm even had a cow that yielded 9500 kg and more milk in its 7th calving. The majority of the cows had 5 or more calvings. The management is being handed over to the younger generation in its 20's. A consultant veterinarian formulates the feed, which consisted mainly of TMR, hay and concentrate feed.

(2) The Farm B is managed cooperatively by two generations of a family. Their approach is gradually shifting from the earlier emphasis on the increased numbers of calvings to high milk yield. Currently, they are looking for an optimal balance between the two targets. Their cows presently have 3-4 calvings. The farm grows dent corn and produces corn silage every year. The feed formulation is outsourced to a feed company.

(3) The younger generation has taken over the management of farm C. The farm has more than 200 lactating cows and their number is increasing. The cows are divided into a high yield (30 kg or more per day) herd and a low yield herd, and they are milked 3 times and 2 times a day, respectively.

The feed formulation is outsourced to a feed company. The hay produced by the farm is fed to heifers. Lactating cows are fed purchased TMR, concentrate feed and hay.

2. DDGS used in the study

The DDGS used in this study was imported from USA in January 2004 by Nippon Veterinary and Animal Science University. The below-given provisional composition (draft) 2) announced by the Ministry of Agriculture, Forestry and Fisheries (MAFF) were used for formulating the feed.

Table-2 DDGS composition used for planning the DDGS feeds of the study

(Unit: %)

Water	Crude protein	Crude fat	N F E	Crude fiber	Crude ash	T D N
11.4	27.3	12.1	38.2	6.9	4.1	84.0

(Note: 2) The provisional composition of DDGS (Distiller's Dry grains with Solubles) (draft) has since been notified as the provisional composition (Official Gazette dated August 30, 2004) .

3. Planning and feeding of DDGS containing feeds

The actual cases of DDGS use in USA reported in NETWORK No. 30, dairy feed ingredients currently used in Japan, and the extent of silage use and other ingredients were taken into consideration in formulating the feeds. Finally, DDGS was mixed with the TMR that each farm was already using, aiming at a DDGS intake of 1.5 kg per day per head. Taking into account the characteristics of DDGS as feed, we coordinated with the feed formulators of each farm in formulating feeds and feeding to the dairy cattle in such a way that the overall intake of each nutrient, dry matter and others would not differ from the feed being currently used.

The feeding method normally used in each farm was followed. The amounts of hay, concentrate feed and purchased TMR were adjusted in Farm A to incorporate the DDGS and the concentrate feed and pressed corn were substituted with DDGS in Farms B and C.

4. Methods and animals used in the study

No special methods were used in the study because it was undertaken as a part of the routine farm management. After assigning the animals to the study groups, the study was conducted for about 3 months. The first month was the non-DDGS period (Period 1), when no DDGS was added to the feed. The next month was the DDGS period (Period 2), when DDGS was mixed in the feed. The last month (Period 3) was again a non-DDGS period.

The number of animals included in the study were 34, 39 and 87 respectively in farms A, B and C.

5. Observations

The milk yield, milk components (milk fat, milk protein and non-fat solid

contents) were determined in each period. The milk production record maintained at each farm was used for calculating the milk yield and results of fresh milk testing done 4 times a month at diary farmer's cooperatives to which the milk was shipped were used for the milk components.

III. Results

1. Milk yield

The daily milk production is recorded by each farm were used for milk yield. The average daily milk yield per cow during the DDGS period and the non-DDGS periods are compared in Table 3 and Fig 1. The milk yield of Period 2 is that of the DDGS period and the combined means of Period 1 and Period 3, which is also given, is used as the average milk yield of the non-DDGS period. (This method is followed in the rest of the report also).

Day-by-day changes in the milk yield are shown in Figs 2 to 4 and the actual values are given in IV References (Tables 5 to 7).

1-1 Average milk yield at each farm

Table 3 Effect of DDGS feeding on average milk yield

(Milk yield unit: kg/day/head)

Farm	Period	Feed	Test period	No. of days	Average No. of cattle	Average milk yield
A	1	Non-DDGS	3/1– 4/2	33	33.1	28.4
	2	DDGS	4/3 – 5/9	37	33.7	28.6
	3	Non-DDGS	5/10 – 6/8	30	33.8	29.4
	(1+3)/2	Mean of non-DDGS periods				28.9
B	1	Non-DDGS	3/7 – 4/6	31	39.2	27.0
	2	DDGS	4/7 – 5/7	31	39.5	26.5
	3	Non-DDGS	5/8 – 6/7	31	40.1	26.2
	(1+3)/2	Mean of non-DDGS periods				26.6
C	1	Non-DDGS	2/4 – 3/13	39	87	33.8
	2	DDGS	3/14 – 4/12	39	87	33.9
	3	Non-DDGS	4/22 – 5/30	39	87	33.4
	(1+3)/2	Mean of non-DDGS periods				33.6

Fig. 1　Average milk yield in each farm

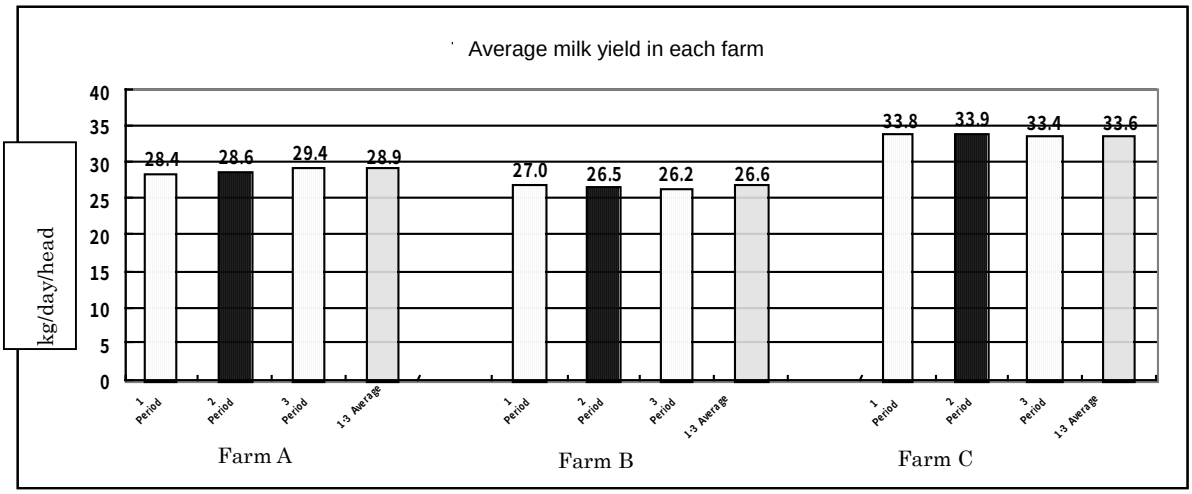


Fig 2　Change in daily milk yield at Farm A

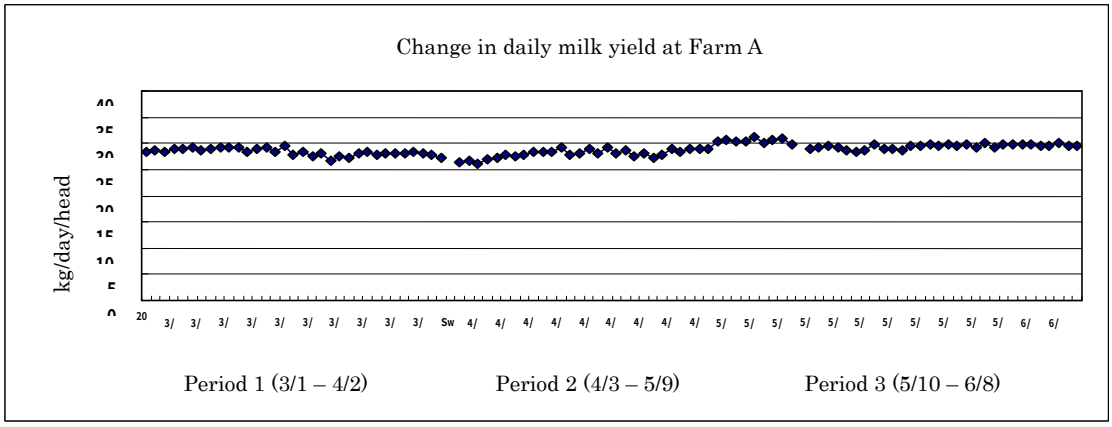


Fig 3　Change in daily milk yield at Farm B

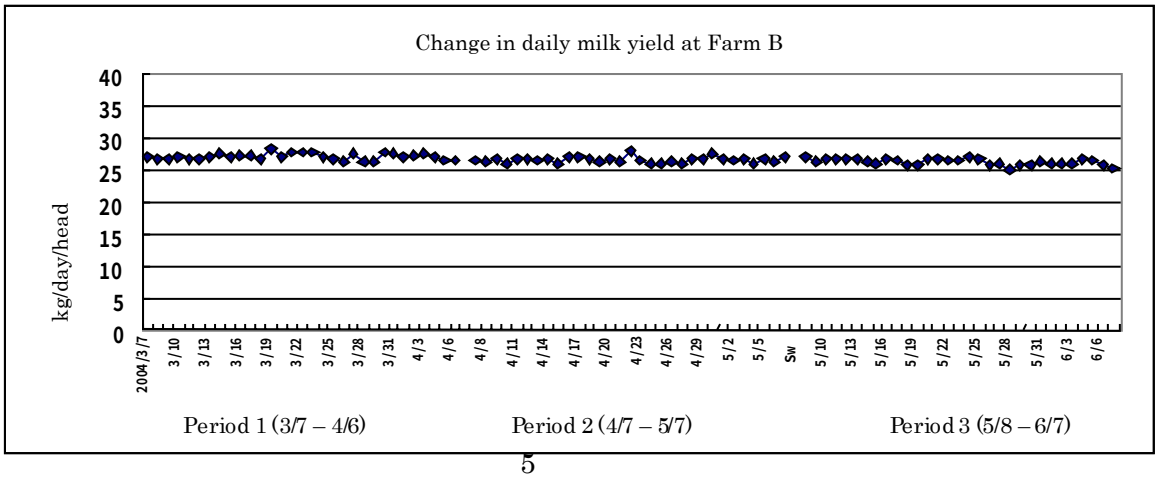
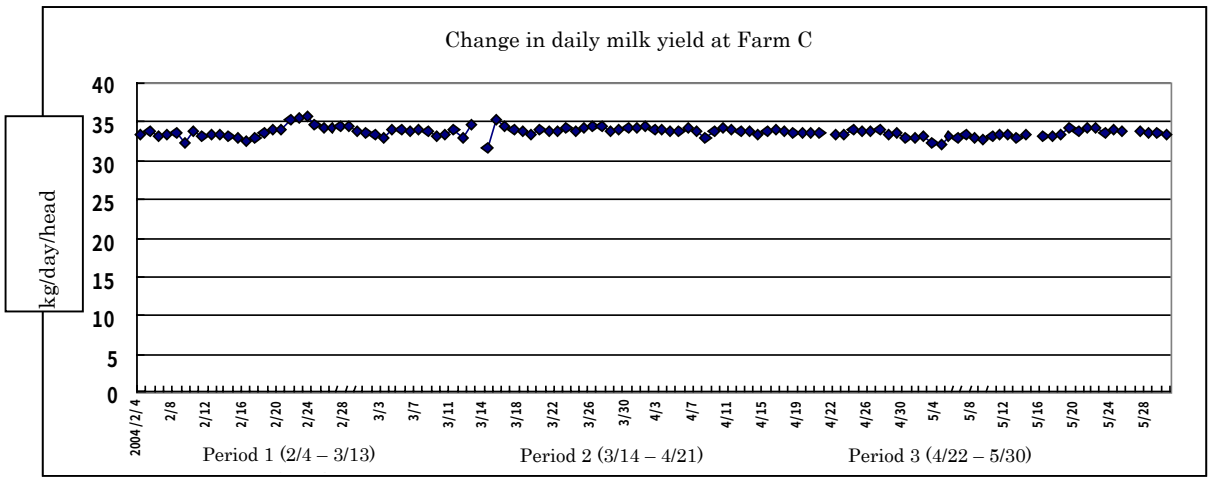


Fig 4　Change in daily milk yield at Farm C



The three farms differed in average milk yield because of differences in management policies and the constitution of the study groups. However, when we compare the DDGS period (Period 2) with the non-DDGS period (Period 1 and Period 3) within each farm, there was no difference.

1-2)　Changes in milk yield at the time of changeover of the feed

Sometimes, the milk yield fluctuated at the time of changeover from one feed to another. So we measured these changes and the results for the three farms are given in Figs 5 to 7. Some decline in milk yield was noticed in Farm C at the time of changeover from non-DDGS (Period 1) to DDGS (Period 2) feed. We therefore requested the farm managers to look for the reasons. They reported that the feed had been switched on the afternoon of the 14th and that any effect of feed changeover would have appeared 2-3 days later. Observations on subsequent days ruled out the possibility of the changeover of feed being the reason for the decrease of milk yields.

Farm A reported that feed intake increased immediately after the changeover from Period 1 to Period 2. However, this did not change the milk yield.

Fig 5 Change in milk yield at the time of changeover of feed at Farm A

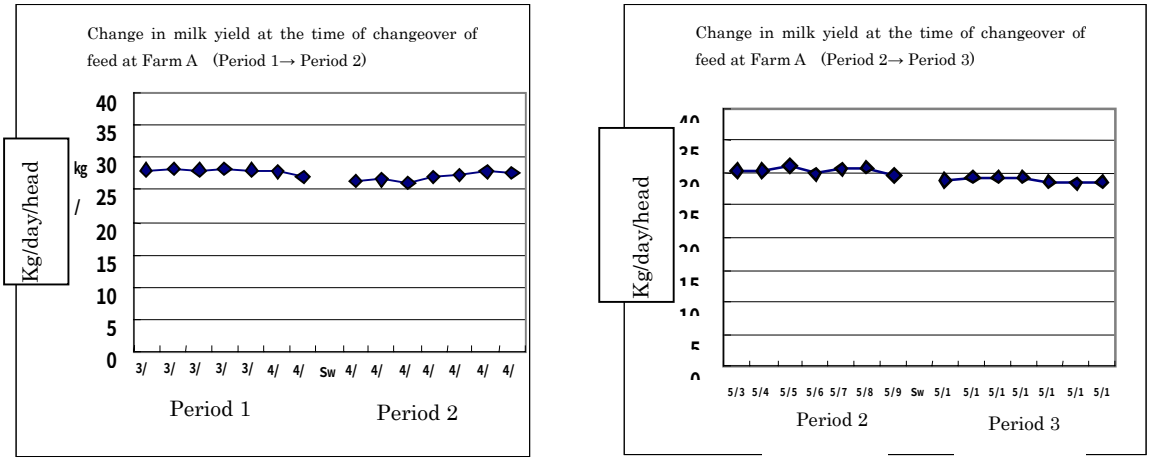


Fig 6 Change in milk yield at the time of changeover of feed at Farm B

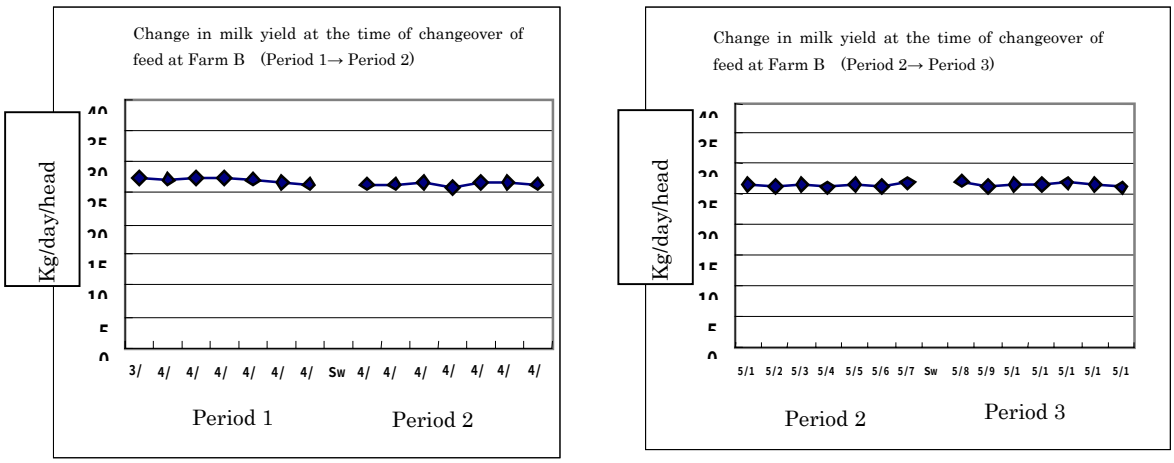
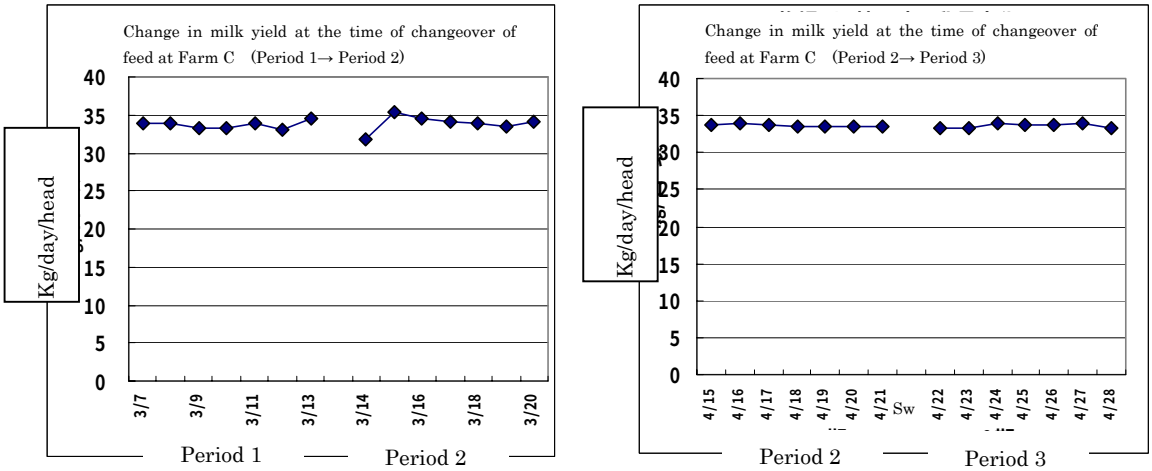


Fig 7 Change in milk yield at the time of changeover of feed at Farm C



2. Milk components

Milk components were calculated from the results of testing fresh milk at dairy farmer's cooperatives to which the milk was shipped.

The milk components, i.e., milk fat, milk protein and non-fat solids are given in Table 4, Table 8 and Figs 8 to 10.

These results show that there was no difference in milk fat, milk protein and non-fat milk solids between the DDGS and the non-DDGS periods at any of the farms.

Table 4 Average milk components in the three periods and the combined means for the two non-DDGS periods

(Unit: %)

Farm	Period	Feed	No. of tests	Milk fat (%)	Milk protein (%)	Non-fat milk solids (%)
A	1	Non-DDGS	3	4.22	3.33	8.70
	2	DDGS	4	4.07	3.30	8.66
	3	Non-DDGS	3	3.98	3.29	8.58
	(1+3)/2	Mean of non-DDGS periods		4.10	3.31	8.64
B	1	Non-DDGS	3	3.84	3.27	8.70
	2	DDGS	3	3.89	3.25	8.70
	3	Non-DDGS	3	3.91	3.20	8.67
	(1+3)/2	Mean of non-DDGS periods		3.88	3.24	8.69
C	1	Non-DDGS	4	3.86	3.20	8.75
	2	DDGS	5	3.72	3.18	8.67
	3	Non-DDGS	4	3.70	3.16	8.67
	(1+3)/2	Mean of non-DDGS periods		3.78	3.18	8.71

Fig. 8 Average milk fat at each farm

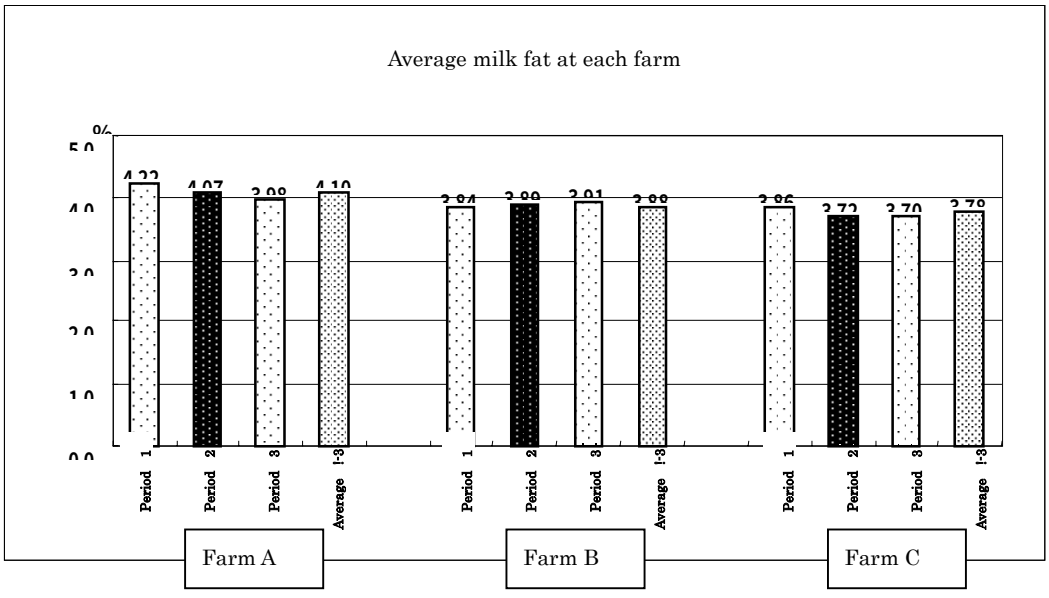


Fig. 9 Average milk protein at each farm

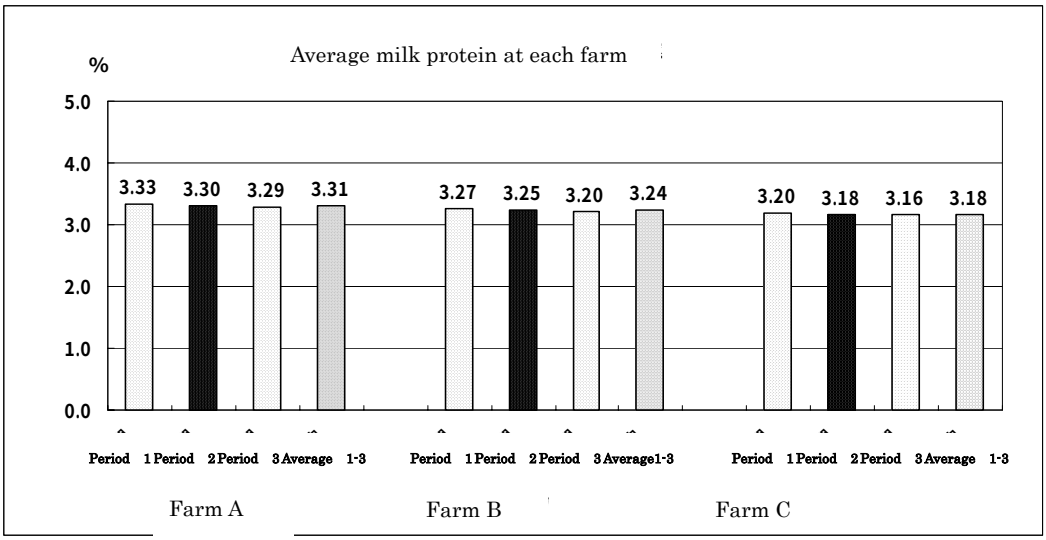
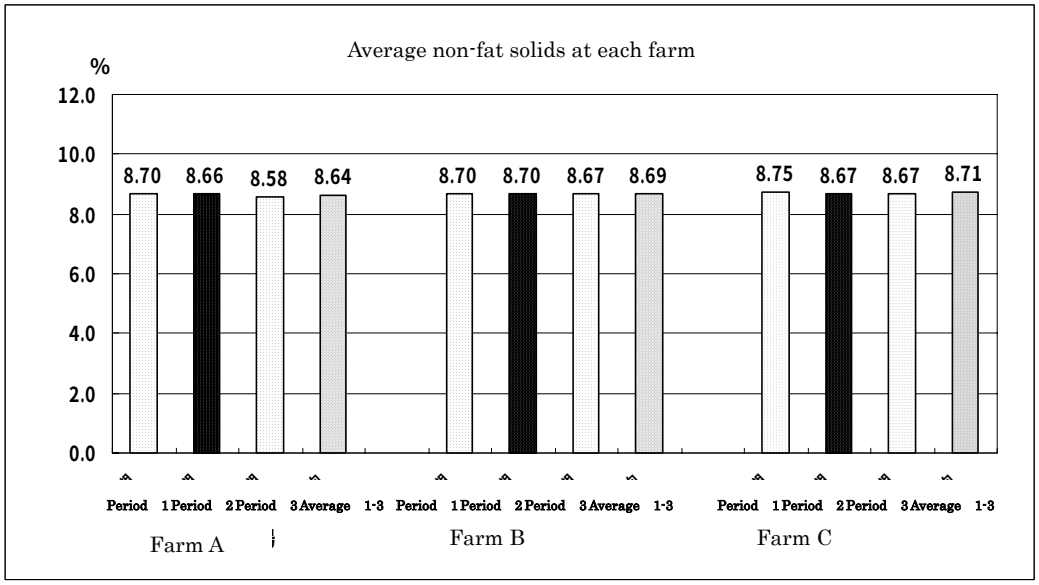


Fig. 10 Average non-fat solids at each farm



IV. Conclusion

1. The study was conducted in 3 dairy farms of the Nasu region of the Tochigi prefecture, a leading dairy farming region of the country.
2. The amount of 1.5 kg of DDGS/day/milking cow was decided to feed based on the background that the actual cases of DDGS use in USA (see NETWORK No. 30 issued by the US Grains Council) and feed ingredients currently fed to dairy cattle in Japan were taken into consideration for evaluating DDGS as a dairy feed.
3. 1.5 kg/day/head of DDGS amounts to 5-7% of the dry matter intake. This meant that when the amount of concentrate feed was 10-12 kg/day, 12-15% of the total feed was DDGS.
4. For formulating feeds with DDGS, the feed characteristics of DDGS were thoroughly discussed with the specialized feed formulators at the farms and the actual conditions at the farm were taken into account.
5. Animals were selected for the study in such a way that the study would not be an undue burden on the management of each farm. The feed normally used by each farm was given during the first month. The animal were then fed with DDGS feed for the next month and returned to non-DDGS feed for the last one month.
6. The changes in milk yield, observations made by the farm managers, etc at the time of switchover from non-DDGS to DDGS feeds and vice a versa were examined and the milk yield and milk composition produced in the DDGS and non-DDGS periods were compared in the analysis of the results.
7. The milk yield and milk components have shown no difference at the time of switchover between non-DDGS and DDGS feeds and did not differ among the different periods. The farm managers also did not observe any difference in the palatability of the two types of feed.
8. The overall evaluation by the farm managers and the feed formulators after completing the study was that they would like to use DDGS as a feed ingredient due to excellent palatability if it is cost effective.

[Reference]

Table 5 Daily milk yields in Farm A

(Unit: kg/day/head)

Day	Period 1		Period 2		Period 3	
	Date	Milk yield	Date	Milk yield	Date	Milk yield
1	2004/3/1	28.5	4/3	26.3	5/10	28.9
2	3/2	28.8	4/4	26.6	5/11	29.3
3	3/3	28.5	4/5	26.2	5/12	29.4
4	3/4	29.0	4/6	27.0	5/13	29.3
5	3/5	29.0	4/7	27.3	5/14	28.5
6	3/6	29.1	4/8	27.7	5/15	28.4
7	3/7	28.7	4/9	27.5	5/16	28.6
8	3/8	29.0	4/10	27.8	5/17	29.8
9	3/9	29.2	4/11	28.3	5/18	29.0
10	3/10	29.3	4/12	28.5	5/19	28.9
11	3/11	29.2	4/13	28.4	5/20	28.7
12	3/12	28.5	4/14	29.1	5/21	29.4
13	3/13	29.0	4/15	27.8	5/22	29.4
14	3/14	29.2	4/16	28.2	5/23	29.7
15	3/15	28.5	4/17	28.9	5/24	29.4
16	3/16	29.6	4/18	28.2	5/25	29.7
17	3/17	27.8	4/19	29.1	5/26	29.5
18	3/18	28.3	4/20	28.2	5/27	29.7
18	3/19	27.5	4/21	28.6	5/28	29.3
20	3/20	28.2	4/22	27.5	5/29	30.0
21	3/21	26.8	4/23	28.2	5/30	29.3
22	3/22	27.6	4/24	27.4	5/31	29.7
23	3/23	27.2	4/25	27.8	6/1	29.7
24	3/24	28.0	4/26	28.8	6/2	29.7
25	3/25	28.4	4/27	28.2	6/3	29.9
26	3/26	27.8	4/28	28.9	6/4	29.4
27	3/27	28.0	4/29	29.0	6/5	29.5
28	3/28	28.2	4/30	29.0	6/6	30.1
29	3/29	28.2	5/1	30.5	6/7	29.4
30	3/30	28.2	5/2	30.7	6/8	29.6
31	3/31	28.2	5/3	30.4	−	−
32	4/1	27.8	5/4	30.4	−	−
33	4/2	27.2	5/5	31.2	−	−
34	−	−	5/6	29.9	−	−
35	−	−	5/7	30.6	−	−
36	−	−	5/8	30.8	−	−
37	−	−	5/9	29.7	−	−
Mean		28.4		28.6		29.4

Table 6 Daily milk yields in Farm B

(Unit: kg/day/head)

Day	Period 1		Period 2		Period 3	
	Date	Milk yield	Date	Milk yield	Date	Milk yield
1	2004/3/7	27.0	4/7	26.4	5/8	27.0
2	3/8	26.6	4/8	26.3	5/9	26.3
3	3/9	26.7	4/9	26.6	5/10	26.6
4	3/10	27.0	4/10	25.9	5/11	26.6
5	3/11	26.7	4/11	26.7	5/12	26.8
6	3/12	26.8	4/12	26.6	5/13	26.6
7	3/13	27.0	4/13	26.3	5/14	26.2
8	3/14	27.3	4/14	26.6	5/15	26.0
9	3/15	27.0	4/15	25.9	5/16	26.6
10	3/16	27.2	4/16	26.8	5/17	26.3
11	3/17	27.1	4/17	27.0	5/18	25.5
12	3/18	26.6	4/18	26.8	5/19	25.8
13	3/19	28.1	4/19	26.1	5/20	26.6
14	3/20	27.0	4/20	26.6	5/21	26.7
15	3/21	27.7	4/21	26.3	5/22	26.4
16	3/22	27.7	4/22	28.0	5/23	26.5
17	3/23	27.6	4/23	26.3	5/24	26.8
18	3/24	27.0	4/24	26.0	5/25	26.7
19	3/25	26.6	4/25	26.0	5/26	25.6
20	3/26	26.3	4/26	26.1	5/27	25.8
21	3/27	27.4	4/27	26.0	5/28	24.9
22	3/28	26.1	4/28	26.7	5/29	25.6
23	3/29	26.3	4/29	26.7	5/30	25.7
24	3/30	27.7	4/30	27.3	5/31	26.2
25	3/31	27.3	5/1	26.7	6/1	26.0
26	4/1	27.0	5/2	26.3	6/2	26.0
27	4/2	27.3	5/3	26.6	6/3	26.0
28	4/3	27.3	5/4	26.0	6/4	26.8
29	4/4	27.0	5/5	26.6	6/5	26.3
30	4/5	26.5	5/6	26.2	6/6	25.6
31	4/6	26.4	5/7	26.9	6/7	25.3
Mean		27.0		26.5		26.2

Table 7 Daily milk yields in Farm C

(Unit: kg/day/head)

Day	Period 1		Period 2		Period 3	
1	2004/2/4	33.3	3/14	31.7	4/22	33.4
2	2/5	33.9	3/15	35.3	4/23	33.3
3	2/6	33.1	3/16	34.5	4/24	34.0
4	2/7	33.4	3/17	34.1	4/25	33.7
5	2/8	33.6	3/18	33.9	4/26	33.8
6	2/9	32.2	3/19	33.4	4/27	34.0
7	2/10	33.8	3/20	34.1	4/28	33.3
8	2/11	33.2	3/21	33.8	4/29	33.6
9	2/12	33.3	3/22	33.8	4/30	33.0
10	2/13	33.4	3/23	34.3	5/1	33.0
11	2/14	33.2	3/24	33.7	5/2	33.2
12	2/15	33.0	3/25	34.3	5/3	32.3
13	2/16	32.6	3/26	34.4	5/4	32.1
14	2/17	32.9	3/27	34.4	5/5	33.1
15	2/18	33.6	3/28	33.8	5/6	33.0
16	2/19	34.0	3/29	34.0	5/7	33.4
17	2/20	34.1	3/30	34.2	5/8	32.9
18	2/21	35.2	3/31	34.3	5/9	32.8
19	2/22	35.6	4/1	34.5	5/10	33.1
20	2/23	35.7	4/2	34.0	5/11	33.4
21	2/24	34.7	4/3	34.1	5/12	33.4
22	2/25	34.3	4/4	33.7	5/13	33.0
23	2/26	34.2	4/5	33.9	5/14	33.4
24	2/27	34.5	4/6	34.3	5/15	−
25	2/28	34.4	4/7	33.8	5/16	33.1
26	2/29	33.8	4/8	33.0	5/17	33.1
27	3/1	33.5	4/9	33.8	5/18	33.4
28	3/2	33.3	4/10	34.3	5/19	34.2
29	3/3	33.0	4/11	34.0	5/20	33.8
30	3/4	34.0	4/12	33.8	5/21	34.2
31	3/5	34.1	4/13	33.7	5/22	34.2
32	3/6	33.9	4/14	33.3	5/23	33.6
33	3/7	34.0	4/15	33.8	5/24	34.1
34	3/8	33.8	4/16	34.0	5/25	33.9
35	3/9	33.2	4/17	33.8	5/26	−
36	3/10	33.3	4/18	33.5	5/27	33.7
37	3/11	34.0	4/19	33.5	5/28	33.5
38	3/12	33.0	4/20	33.6	5/29	33.5
39	3/13	34.6	4/21	33.6	5/30	33.3
Mean		33.8		33.9		33.4

Table 8 Milk components at different farms

(Unit: %)

Farm	Period	Test date	Milk fat	Milk protein	Non-fat milk solids
A	1	3/9	4.23	3.33	8.67
		3/17	4.23	3.29	8.63
		3/25	4.21	3.37	8.79
		Mean	4.22	3.33	8.70
	2	4/12	4.19	3.34	8.68
		4/20	4.03	3.31	8.62
		4/27	3.99	3.29	8.67
		5/6	4.08	3.27	8.67
		Mean	4.07	3.30	8.66
	3	5/19	3.96	3.29	8.58
		5/24	4.03	3.31	8.62
		6/8	3.94	3.26	8.53
		Mean	3.98	3.29	8.58
B	1	3/18	3.91	3.23	8.67
		3/24	3.85	3.28	8.71
		4/1	3.77	3.29	8.73
		Mean	3.84	3.27	8.70
	2	4/22	3.95	3.27	8.70
		4/28	3.89	3.25	8.69
		5/7	3.82	3.23	8.70
		Mean	3.89	3.25	8.70
	3	5/18	3.89	3.20	8.69
		5/25	3.95	3.21	8.65
		6/7	3.90	3.20	8.67
		Mean	3.91	3.20	8.67
C	1	2/9	3.82	3.18	8.73
		2/17	3.94	3.18	8.77
		2/26	3.84	3.18	8.76
		3/8	3.82	3.25	8.73
		Mean	3.86	3.20	8.75
	2	3/22	3.82	3.25	8.76
		3/29	3.74	3.20	8.71
		4/6	3.65	3.15	8.63
		4/13	3.69	3.16	8.62
		4/21	3.72	3.13	8.64
		Mean	3.72	3.18	8.67
	3	5/6	3.72	3.15	8.67
		5/13	3.68	3.16	8.65
		5/20	3.64	3.16	8.67
		5/26	3.76	3.16	8.67
		Mean	3.70	3.16	8.67

[Reference Table] Average milk components in each period and the combined means of the two non-DDGS periods

(Unit: %)

Farm	Period	Feed	No. of tests	Milk fat (%)	Milk protein (%)	Non-fat solids (%)	Milk sugar (%)	Somatic cells (x 10^4)
A	1	Non-DDGS	3	4.22	3.33	8.70	4.37	21
	2	DDGS	4	4.07	3.30	8.66	4.36	18
	3	Non-DDGS	3	3.98	3.29	8.58	4.29	23
	2 (1+3)/2	Mean of non-DDGS periods		4.10	3.31	8.64	4.33	22
B	1	Non-DDGS	3	3.84	3.27	8.70	4.44	34
	2	DDGS	3	3.89	3.25	8.70	4.45	35
	3	Non-DDGS	3	3.91	3.20	8.67	4.47	29
	2 (1+3)/2	Mean of non-DDGS periods		3.88	3.24	8.69	4.46	32
C	1	Non-DDGS	4	3.86	3.20	8.75	4.55	17
	2	DDGS	5	3.72	3.18	8.67	4.49	15
	3	Non-DDGS	4	3.70	3.16	8.67	4.51	12
	2 (1+3)/2	Mean of non-DDGS periods		3.78	3.18	8.71	4.53	15

[Reference Table] Milk components at different farms on different testing dates

Farm	Period	Test date	Milk fat (%)	Milk protein (%)	Non-fat solids (%)	Milk sugar (%)	Somatic cells (x 10^4)
A	1	3/9	4.23	3.33	8.67	4.34	12
		3/17	4.23	3.29	8.63	4.34	39
		3/25	4.21	3.37	8.79	4.42	13
		Mean	4.22	3.33	8.70	4.37	21
	2	4/12	4.19	3.34	8.68	4.34	11
		4/20	4.03	3.31	8.62	4.31	31
		4/27	3.99	3.29	8.67	4.38	16
		5/6	4.08	3.27	8.67	4.40	12
		Mean	4.07	3.30	8.66	4.36	18
	3	5/19	3.96	3.29	8.58	4.29	28
		5/24	4.03	3.31	8.62	4.31	25
		6/8	3.94	3.26	8.53	4.27	15
		Mean	3.98	3.29	8.58	4.29	23
B	1	3/18	3.91	3.23	8.67	4.44	35
		3/24	3.85	3.28	8.71	4.43	35
		4/1	3.77	3.29	8.73	4.44	31
		Mean	3.84	3.27	8.70	4.44	34
	2	4/22	3.95	3.27	8.70	4.43	35
		4/28	3.89	3.25	8.69	4.44	33
		5/7	3.82	3.23	8.70	4.47	38
		Mean	3.89	3.25	8.70	4.45	35
	3	5/18	3.89	3.20	8.69	4.49	28
		5/25	3.95	3.21	8.65	4.44	32
		6/7	3.90	3.20	8.67	4.47	26
		Mean	3.91	3.20	8.67	4.47	29
C	1	2/9	3.82	3.18	8.73	4.55	18
		2/17	3.94	3.18	8.77	4.59	13
		2/26	3.84	3.18	8.76	4.58	20
		3/8	3.82	3.25	8.73	4.48	15
		Mean	3.86	3.20	8.75	4.55	17
	2	3/22	3.82	3.25	8.76	4.51	11
		3/29	3.74	3.20	8.71	4.51	18
		4/6	3.65	3.15	8.63	4.48	12
		4/13	3.69	3.16	8.62	4.46	18
		4/21	3.72	3.13	8.64	4.51	17
		Mean	3.72	3.18	8.67	4.49	15
	3	5/6	3.72	3.15	8.67	4.52	13
		5/13	3.68	3.16	8.65	4.49	10
		5/20	3.64	3.16	8.67	4.51	10
		5/26	3.76	3.16	8.67	4.51	16
		Mean	3.70	3.16	8.67	4.51	12