Soybean Checkoff-funded Research

Project Title: Effects of different soybean meal inclusion in gestation and lactation diets on sow and litter performance

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I. Introduction:

Soybean meal is a major protein source of gestation and lactating sow diets because of its high protein quality and amino acid profile. But the quality of soybean meal varies depending upon the origin of soybeans and processing technology.

It is well known that the U.S.-originated dehulled soybean meal has an excellent nutrient profile compared to other country-originated soybean meals and other plant protein sources (Swick, 1995; Swick, 1998). Because of the relatively good amino acid profile, it is usually used to balance the dietary amino acid levels with cereal grains and their by-products in swine feeds. According to the NOPA (National Oilseed Processors Association) specification, crude protein contents of soybean meal vary from 47.5 to 49.0% without soy hulls.

For the calculation of extra amino acid value, the lysine and methionine contents of 3.04% and 0.68% in dehulled meal and of 2.80% and 0.63% in non-dehulled meal can be used as those values were obtained from enough number of dehulled meal amino acid assays (Swick, 1998).

Although soybean meal provides some commonly limited amino acids such as lysine to the diets, it contains anti-nutritional factors as well. The anti-nutritional factors such as trypsin inhibitor, lectins and lipoxygenase must be destroyed by toasting process of soybean meal (Ward, 1996; Swick, 1998). Because the over toasting may destroy or denature the proteins in soybean meal, proper toasting is required. In other words, the quality of soybean meal is largely dependent upon the processing technology. Soybean meal must be processed properly with heat treatment after solvent extraction. Imported soybean meal from China, India and Brazil have not been consistent with its quality due to either under or over heating (Joo et al., 1994; Lee et al., 1994; Paik et al., 1988).

Relatively simple and reliable methods evaluating the heat treatment of soybean meal have been developed and NOPA uses it as a part of the soybean meal quality specifications for fair trade of soybean meal. Urease activity as measured by the increase in pH of the mixture of soybean meal and urea in water (A.O.C.S., 1970), that is indirect measurement of the presence of the trypsin inhibitor, to estimate the under heat processing and the protein solubility in a solution of 0.2% KOH to estimate over heat processing (Araba and Dale, 1990) is generally accepted (Kohlmeier, 1993; Swick, 1998, Ward, 1996).

The high quality of U.S.-originated dehulled soybean meal has been proved by numerous animal experiments. Also there is a number of experimental data to demonstrate the economic feasibility of U.S.-originated dehulled soybean meal in swine feeds. Chung *et al.* (1988) conducted a feeding trial with weaning pigs. They found that there were no statistically significant differences in feed intake and body weight gain but weight gain was numerically higher for the dehulled soybean meal and could save feed cost by 6.3%. Recently in China, dehulled and non-dehulled meals were compared in a feeding trial with growing pigs. Body weight gain at the late grower phase was significantly higher for the pigs received the dehulled soybean meal diet and could save the feed cost for the gain remarkably (Bushman, 1998).

Park (1998) reported that pigs consumed high-energy diets including U.S. dehulled soybean meal showed the best performance, and improved growth rate and feed utilization, and thereby reduced feed cost per pig in growing pigs.

However, the effect of the U.S.-originated dehulled soybean meal in gestation and lactating sow diets is not well studied despite the growth performance during the gestation and lactating periods affects litter performance. Sows commonly experience negative energy and protein balance during lactation, as shown by loss of maternal body weight (Johnston et al., 1993). Negative nutrient balance and the associated loss of body weight may decrease milk production (Eastham et al., 1988) and compromise subsequent reproductive performance of sows (King and Williams, 1984). Also, a rate of estrus expression after weaning and conception is important for efficient and profitable swine production.

This experiment is designed to evaluate utilization and economic feasibility of the U.S.-originated dehulled soybean meal in gestation and lactating sow feeds.

II. Materials and Methods:

The experiment is being carried out at Du-Lae Cooperative Farm located in I-Cheon City, Kyunggi-Province, Korea.

One hundred and twenty crossbred multiparous sows (Yorkshire × Landrace) were assigned to 3 treatments consisting of 40 replicates and fed corn-soy based diets. Treatments were diets containing U.S. dehulled, Brazilian, and Indian soybean meal for gestation and lactating sows (Table 1).

Experiment was carried out for approximately 145 days to cover all gestation, lactating periods and day of weaning-to-estrus.

Analytical values of soybean meals used in this experiment are shown Table 2. Crude Protein of Brazil-originated soybean meal was 44.08% and India-originated soybean meal was 44.63% as non-dehulled regular soybean meal. The protein content of the U.S. originated dehulled soybean meal was 47.33%.

Experimental diets were least-cost formulated to meet or exceed nutrient requirements suggested by NRC (1998). The compositions of the experimental diets are shown in Table 3 (gestation) and Table 4 (lactation). Dietary treatments were imposed on the day of breeding and were continued until re-estrus after weaning. From day 0 to d 84 gestation, sows were fed 2.5 kg/d of a 14% CP diet and from d 85 to farrowing, sows were fed 3.3 kg/d of a 14% CP diet as well. On day 100 of gestation, sows were moved to a confinement farrowing facility. Sows were allowed *ad libitum* access to diet from the day of parturition until day of weaning.

Sow weight was recorded on d 30, d 100 of gestation and at weaning. Backfat depth was determined ultrasonically (LEAN-MEATER; Renco, Minneapolis, MN) 60 mm lateral to the dorsal midline opposite to the last rib within 24 h on d 30, d 100 of gestation and at weaning. Feed conversion ratio, body weight change, and backfat thickness change were measured at d 30 when pregnancy was confirmed, day 100 when sows were moved from gestation stall to farrowing facility and day of weaning.

Litter size and weights of pigs were recorded at birth and at weaning. On the day of weaning, sows were separated from their litters and moved to a confinement breeding facility. Sows were checked daily for signs of estrus and the days from weaning to estrus were recorded.

The data were analyzed by ANOVA as a completely randomized design. All statistical analyses were computed using the GLM procedure of SAS (1998). Differences among treatment means were tested by Duncan's New Multiple Range Test (Duncan, 1955). The

standard errors of means were calculated from the treatments with replicates.
All general management of sows was followed to management rules of Du-Lae Cooperative Farm.

III. Results and Discussion

Table 5 shows the performance of sows from day 30 of gestation to d 100 of gestation when they were fed diets included three different originated soybean meals. A total of five sows, three in Brazilian soybean meal and two in Indian soybean meal treatments, were excluded for data analysis because of conception failure. Average daily feed intake of sows during gestation was not statistically different among sows assigned to the three experimental diets (Table 5). Body weights at day 100 of gestation appeared in the order of Brazilian, U.S. dehulled, Indian soybean meal diet (243.35 kg, 235.98 kg, and 235.20 kg), but the differences were reflected on weight change in gestation period and did not show statistical significance. Average daily gain (ADG) and feed conversion ratio (FCR) of sows fed the U.S. originated dehulled soybean meal diet during this period were higher than those of sows fed other country originated soybean meal diets even though there was no statistical significance. This result suggests that soybean meals of different origins would affect the FCR and ADG in sows consumed the diets including same protein content (14%) because of difference of nutrient bioavailability.

Gestational changes of backfat depth were higher in Indian soybean meal (0.22 cm), and then U.S. dehulled soybean meal (0.17 cm) and Brazilian soybean meal (0.16 cm) were similar. The tendency of d 30 of backfat depth change was similar to that of body weight change. During the first stage of gestation, backfat depths were different among treatment, but backfat depths were similar among the treatment in the last stage of gestation. In other words, the sows with thinner backfat at the early stage of gestation gained more body fat during the entire gestation period.

The performance of sows during lactation are shown in Table 6. A sow in Indian soybean meal treatment was removed from the experiment because of hind-leg paralysis. Average daily feed intake of sows during lactation was not significant among sows assigned to three experimental diets. In a six-state cooperative experiment in the States, the NCR-42 Committee on Swine Nutrition (1978) reported no effect of dietary protein level during lactation on voluntary feed intake when sows received gestation diets containing 9% or 15% CP. In the present experiment, sows of all treatments consumed gestation diets that contained 14% CP and lactation diets that contained 18% CP. Therefore, dietary protein source (soybean meals from different origins) has little effect on voluntary feed intake during lactation.

In the U.S. dehulled soybean meal diet, lactational change of sow's body weight was significantly higher than those of sows fed other country originated soybean meal diets ($P<0.1$). This result implicated that body weight change was affected by number of born alive and litter weight at birth. Sow's body weight change was affected by not only weight of piglet but also the organ of associated with pregnancy of uterus, placenta, and fluid. Also, because sows fed the U.S. dehulled meal diet raised more piglets and heavier litter weight at weaning than other country originated soybean meals during lactation period.

Neither backfat depth of sows nor loss of backfat was influenced by treatment. Brendemuhl et al. (1987) reported that diet modulates composition of body weight loss during lactation. Sows fed high-protein, low-energy diets lost a similar amount of body weight but more backfat than sows fed low-protein, high-energy diets. In the present experiment, origins of soybean meal used as protein source were different but energy and protein contents of experimental diets were same. Therefore, the tendency of backfat loss was similar to that of body weight loss.

Weaning-to-estrus interval was not influenced among treatments in this experiment. The interval in present study was around 6 days. Reducing lactational protein intake by 50% from a standard of approximately 750 g/d prolongs the postweaning interval to estrus in primiparous sows (Brendemuhl et al., 1987; King and Martin, 1989). However, Stahly et al. (1990) and Johnston et al. (1993) suggested that increases in the protein intake (> 750 g/d) for multiparous sows have little affected an interval to postweaning estrus, when dietary energy supply was adequate. Our data was similar to result of latter as level of protein intake was 777.6 to 792 g/d and dietary energy supply was enough.

Because sows among treatments were not different in body weight loss and change of backfat depth during lactation period, and the days to estrus did not differ.

Table 7 shows the performance of litter in sows fed three different originated soybean meal diets from gestation to lactation. Lactation length was about 20 days over all treatments (Table 7). In sows fed U.S. dehulled soybean meal diet, total number of born (10.80), and number of weaned pigs were higher than those of pigs fed other originated soybean meal diet without significant difference. But number of born alive was different among U.S. dehulled (10.03), Brazilian (8.72) and Indian soybean meal (9.38) treatments ($P<0.1$) and that of the U.S. dehulled soybean meal treatment was significantly higher than that of the Brazilian soybean meal treatment.

In sows fed the U.S. dehulled soybean meal diet, litter weight at birth was significantly higher than Brazilian soybean meal diet (14.33 kg, 11.86 kg; $P<0.05$), but no statistical significance was found with Indian soybean meal diet (13.02 kg). Weaning litter weight appeared in the order of U.S. dehulled, Indian, and Brazilian meal diet (56.10 kg, 54.42 kg, and 52.93 kg), but differences was not statistically detected (P>0.1). Previous work has demonstrated that weaning weight was predictive of overall pig performance and days-to-market weight (Mahan *et al.*, 1991), and it is generally accepted that differences in weaning weight at a given age were a function of milk production (Lewis *et al.*, 1978). Also, Graham *et al.* (1981) demonstrated that body weight gains postweaning were influenced by weaning weight; weight gains of heavier pigs at weaning exhibited higher growth rate until market weight. Yen et al. (1991) had reported that low birth weight was an important factor contributing to piglet mortality, following the causes of death by sow-overlaid and piglet starvation.

Table 8 shows the result of economic evaluation based on litter size and weight from gestation and lactating periods in sows. Feed cost per unit of born alive number and litter weight gain at birth was calculated from feed cost during gestation and lactation divided by number of born alive and litter weight gain. The unit feed costs (Won/kg feed) in the U.S. dehulled soybean meal and Brazilian soybean meal treatments were the highest during gestation and lactation periods, respectively. However, feed costs required per number of born alive and litter weight at birth of the U.S. dehulled soybean meal treatment were lower than those of the Brazilian and Indian soybean meal treatments. And then, the feed cost required per unit one parity was the higher for U.S. dehulled soybean meal treatment (63,344.1 Won/parity) than other soybean meal treatments as the litter weaning number calculated by 95.7% survivability of born alive piglets.

However, at weaning the economic advantage in the U.S. dehulled soybean meal treatment (416,762.4 Won/parity) calculated by piglet cost was higher than that of Brizil (354,771.5 Won/parity) and Indian (386,626.1 Won/parity) soybean meal treatment.

The economic advantage estimated from the weaning pig to the market weight pig was calculated by difference between market weight pig price (150,000 Won/head) and feed cost for the entire growing period (120,000 Won/head). The economic advantage estimated from the weaning pig to the market weight pig was higher in the U.S. dehulled soybean meal (288,063.9 Won/parity) treatment than that of other originated soybean meal treatments.

To estimate economic feasibility of using soybean meals of different origins, the amount and the cost of soybean meal required for a piglet and a kg of litter weight were calculated as shown in Table 9. Although the soybean meal cost (Won/kg) was the highest in the U.S. dehulled soybean meal, soybean meal cost required per unit born alive number and litter weight at birth were lower than those of the Brazilian and Indian soybean meal.

The soybean meal cost required per unit one parity in the U.S. dehulled soybean meal (16,726.2 Won/parity) was higher than that of Brazilian (15,071.1 Won/parity) and Indian

(15,651.8 Won/parity) soybean meal. However, at weaning the economic advantage of U.S. dehulled soybean meal calculated by piglet selling price was higher than that of Brazilian and Indian soybean meal. The economic advantage estimated from the weaning pig to the market weight pig was higher in the U.S. dehulled soybean meal (28,806.4 Won/parity) than that of other originated soybean meals.

In conclusion, U.S. dehulled soybean meal was validated as a high quality protein source in gestation and lactating sow diets than other country originated soybean meals. This result proved that soybean meal quality varies according to the origin of soybean meal as well as its processing conditions. Also, it was well demonstrated that the U.S. dehulled soybean meal has an excellent nutrient profile and a higher energy values and contains more digestible nutrients compared to other country originated soybean meals (Swick, 1995; Swick, 1998). In this experiment, it is proven that U.S. dehulled soybean meal has not only nutritional advantages but economical feasibility in gestation and lactating sow diets. Therefore it is recommendable to include the U.S. dehulled soybean meal in gestation and lactating sow diets to increase born alive and litter weight at birth, resulting in more net return to pig producers.

Table 1. Sow assignment and soybean meal origins used in the experimental diets

Treatment	SBM origin	Number of sow per pen	Replicates	Total number of sows
1	U.S.dehulled[1]	1	40	40
2	Brazil[2]	1	40	40
3	India[3]	1	40	40
			Total	120

[1] Dehulled soybean meal from U.S.

[2] Non-dehulled soybean meal from Brazil.

[3] Non-dehulled soybean meal from India.

Table 2. Analytical values of soybean meals used in the experiment

Item	US Dehulled SBM	Brazil-Originated SBM	India-Originated SBM
Proximate analysis[1], %			
Dry matter	90.0	86.71	87.92
Crude protein	47.33	44.08	44.63
Crude fat	0.50	0.65	0.83
Crude fiber	3.30	4.93	6.29
Amino acids[2], %			
Arginine	3.77	3.32	3.48
Aspartic acid	5.82	5.21	5.58
Glutamic acid	9.37	8.33	8.96
Histidine	1.40	1.26	1.31
Isoleucine	2.43	2.21	2.32
Leucine	3.97	3.72	3.91
Lysine	3.25	2.82	3.11
Methionine	0.73	0.62	0.67
Phenylalanine	2.67	2.52	2.64
Threonine	2.03	1.83	1.92
Valine	2.56	2.34	2.35
Cystine	0.73	0.63	0.68
Tyrosine	1.69	1.64	1.68
Serine	2.53	2.34	2.53
Glycine	2.21	2.04	2.12
Alanine	2.21	2.03	2.11
KOH(0.2%) solubility[3], %	82.6	74.8	85.6
UAI[4]	0.14	0.18	0.25
PDI[5], %	12.76	9.17	15.48

[1] Methods outlined by the AOAC (1990).

[2] Analysed by Hitachi® Amino Acid Analysis System.

[3] Evaluated by method of Araba and Dale (1990).

[4] Urease Activity Index, evaluated by method of Caskey and Knapp (1944).

[5] Protein Dispersibility Index, evaluated by method of Yasumatsu *et al*. (1972).

Table 3. Composition of experimental diets for gestation sows

Ingredient	U.S. dehulled	Brazil	India
Corn	45.44	44.92	45.6
U.S. dehulled SBM[1]	9.61	-	-
Brazilian SBM[2]	-	10.5	-
Indian SBM[3]	-	-	10.45
Wheat	15.0	15.0	15.0
Wheat Bran	14.0	14.0	14.0
Rice Bran	3.0	3.0	3.0
Corn Gluten Feed	5.0	5.0	5.0
Soy Hulls	3.75	3.2	2.74
Limestone	1.6	1.58	1.59
Tallow	1.3	1.42	1.29
Lysine HCl, 80%	0.02	0.05	0.01
Salt	0.3	0.3	0.3
Dicalcium Phosphate, 60%	0.44	0.49	0.48
Mineral[4]	0.15	0.15	0.15
Choline Cl, 60%	0.13	0.13	0.13
Enfeed[5]	0.1	0.1	0.1
En-320[6]	0.1	0.1	0.1
Micotox[7]	0.05	0.05	0.05
Oxyguard[8]	0.01	0.01	0.01
Total	100	100	100
Calculated Values			
NE, Kcal/kg	2300	2300	2300
Crude Protein, %	14.0	14.0	14.0
Crude Fat, %	4.59	4.7	4.6
Crude Fiber, %	4.88	4.88	4.88
Calcium, %	0.79	0.78	0.78
Phosphorous, %	0.6	0.58	0.58
Available Phosphorous, %	0.25	0.25	0.25
Lysine, %	0.67	0.65	0.65

[1] Dehulled soybean meal from U.S.

[2] Non-dehulled soybean meal from Brazil.

[3] Non-dehulled soybean meal from India.

[4] Contributed in mg per kilogram of diet: Fe: 73,500; Zn: 56,000; Cu: 86,100; Mn: 15750, Co: 158; I: 175;
Se: 105.

[5] 5.0×10^8cfu/g ~ 9.5×10^9cfu/g : *Bacillus spp., Streptococcus sp., Lactobacillus sp., Saccharomyces sp.*,
Photosynthetic bacteria.

[6] Provided the following per kilogram of diet: Vit A: 12,000,000 IU; Vit E: 50,000 IU; Vit B_{12}: 33,000 mg;
Biotin: 200 mg; Niacin: 30,000 mg; Vit D_3: 2,000,000 IU, Vit K_3: 3,300 mg; Vit B_2: 3,000 mg.

[7] Oxyquinol 50 g, Di-chloro4thymol-sulfide 0.44 g, Micronized brewer's yeast q.s. ad 1,000 g/25kg, Sanofi, Co., France.

[8] Ethoxyquin, Butylated hydroxyanisole, Butylated hydroxytolune, chelating agent.

Table 4. Composition of experimental diets for lactating sows

Ingredient	U.S. dehulled	Brazil	India
Corn	59.10	60.61	62.82
U.S. dehulled SBM[1]	24.66	-	-
Brazilian SBM[2]	-	28.09	-
Indian SBM[3]	-	-	28.26
Rice Bran	5.98	1.4	1.61
Corn Gluten Feed	2.0	1.17	0.1
Soy Hulls	1.7	1.13	0.1
Limestone	1.68	1.4	1.4
Tallow	3.21	3.94	3.56
Lysine HCl, 80%	0.15	0.21	0.11
Salt	0.3	0.3	0.3
Dicalcium Phosphate, 60%	0.6	1.14	1.13
Mineral[4]	0.15	0.15	0.15
Moreclean[5]	0.1	0.1	0.1
Choline Cl, 60%	0.09	0.09	0.09
Enfeed[6]	0.1	0.1	0.1
En-320[7]	0.1	0.1	0.1
Micotox[8]	0.05	0.05	0.05
Oxyguard[9]	0.01	0.01	0.01
Tocomix[10]	0.01	0.01	0.01
Total	100	100	100
Calculated Values			
NE, Kcal/kg	2495	2495	2495
Crude Protein, %	18.0	18.0	18.0
Crude Fat, %	6.7	6.7	6.45
Crude Fiber, %	3.41	3.41	3.43
Calcium, %	0.89	0.89	0.89
Phosphorous, %	0.59	0.59	0.59
Available Phosphorous, %	0.26	0.26	0.26
Lysine, %	1.13	1.13	1.13

[1] Dehulled soybean meal from U.S.

[2] Non-dehulled soybean meal from Brazil.

[3] Non-dehulled soybean meal from India.

[4] Contributed in mg per kilogram of diet: Fe: 73,500; Zn: 56,000; Cu: 86,100; Mn: 15750, Co: 158; I: 175; Se: 105.

[5] Yeast culture, fungi extraction, Dong-wha microbial institute, Korea.

[6] 5.0×10^8cfu/g ~ 9.5×10^9cfu/g : *Bacillus spp., Streptococcus sp., Lactobacillus sp., Saccharomyces sp.*, Photosynthetic bacteria.

[7] Provided the following per kilogram of diet: Vit A: 12,000,000 IU; Vit E: 50,000 IU; Vit B_{12}: 33,000 mg;

Biotin: 200 mg; Niacin: 30,000 mg; Vit D_3: 2,000,000 IU, Vit K_3: 3,300 mg; Vit B_2: 3,000 mg.

[8] Oxyquinol 50 g, Di-chloro4thymol-sulfide 0.44 g, Micronized brewer's yeast q.s. ad 1,000 g/25kg, Sanofi, Co., France.

[9] Ethoxyquin, Butylated hydroxyanisole, Butylated hydroxytolune, chelating agent.

[10] DL-alpha-tocopheryl acetate 100g/kg.

Table 5. Effect of different originated-soybean meal inclusion in gestation diets on sow performance

Trait	U.S. dehulled	Brazil	India	SEM[1]
No. of sows	40	37	39	-
Feed intake, kg/d	3.07	3.06	3.08	0.005
Sow wt, kg				
Day 30 of gestation	204.03	211.11	204.88	3.010
Day 100 of gestation	235.98	243.35	235.20	3.113
Average daily gain	0.47	0.44	0.44	0.025
Feed/Gain	8.42	9.32	9.82	1.054
Sow backfat depth, cm				
Day 30 of gestation	2.21^{ab}	2.31^{a}	2.06^{b}	0.055
Day 100 of gestation	2.38	2.45	2.28	0.065
Gestational change	0.17	0.16	0.22	0.051

[ab] Mean values in the same row with different superscripts are significantly different as determined by one-way ANOVA and Duncan's multiple range test ($p<0.05$).

[1] Standard error of means.

Table 6. Effect of different originated-soybean meal inclusion in lactation diets on sow performance

Trait	U.S. dehulled	Brazil	India	SEM[1]
No. of sows	40	37	38	-
Feed intake, kg/d	5.02	4.90	4.93	0.125
Sow wt, kg				
Day 100 of gestation	235.98	243.89	235.20	3.131
At weaning	213.80	226.00	218.58	3.028
Lactational change	-22.18^{a}	-15.29^{b}	-15.53^{ab}	2.090
Sow backfat depth, cm				
Day 100 of gestation	2.38	2.44	2.28	0.065
At weaning	1.99	2.22	2.03	0.059
Lactational change	-0.38	-0.24	-0.28	0.046
Weaning-to-estrus interval, d	6.08	5.79	5.86	0.334

[ab] Mean values in the same row with different superscripts are significantly different as determined by one-way ANOVA and Duncan's multiple range test ($p<0.1$).

[1] Standard error of means.

Table 7. Effect of different originated-soybean meal inclusion in gestation and lactating sow diets on litter performance

Trait	U.S. dehulled	Brazil	India	SEM[1]
Lactation length, d	19.95	20.08	20.18	0.128
Litter size				
Total no. born	10.80	9.58	10.62	0.363
Born alive	10.03^{a}	8.72^{b}	9.38^{ab}	0.346
At weaning	9.13	8.69	9.11	0.160
Litter wt, kg				
At birth	14.33^{c}	11.86^{d}	13.02^{cd}	0.503
At weaning	56.10	52.93	54.42	1.352

[ab] Mean values in the same row with different superscripts are significantly different as determined by one-way ANOVA and Duncan's multiple range test ($p<0.1$).

[cd] Mean values in the same row with different superscripts are significantly different as determined by one-way ANOVA and Duncan's multiple range test ($p<0.05$).

[1] Standard error of means.

Table 8. Analyses of economic feasibility of soybean meal in gestation and lactating sow diets

Item	U.S. dehulled	Brazil	India
Feed intake, kg/d			
Gestation (Day 30 to 100)	3.07	3.06	3.08
Lactation (Day 100 to Estrus)	4.40	4.32	4.37
Feed cost, Won/kg feed			
Gestation	159.6	156.1	154.6
Lactation	192.3	193.1	189.8
Feed cost per piglet			
Born alive, Won/pig	6,315.5	7,182.2	6,648.9
Birth weight, Won/kg	4,420.4	5,280.7	4,790.1
Feed cost per parity			
At weaning, Won/parity[1]	63,344.1	62,629.1	62,366.7
At weaning, Won/all parity[2]	380,064.5	375,774.9	374,200.0
Economic advantage			
Days to weaning weight, Won/parity[3]	416,762.4	354,771.5	386,626.2
Days to market weight, Won/parity[4]	288,063.9	250,440.4	269,395.7
Days to weaning weight, Won/all parity	2,500,074	2,128,629	2,319,757
Days to market weight, Won/all parity	1,728,383	1,502,642	1,616,374

[1] Survivability at weaning: 95.7%.

[2] For 6 parities.

[3] Piglet selling price per parity at weaning – Feed cost per parity; Piglet selling price is 50,000 Won.

[4] Selling price of market weight pig per parity – Feed cost per market weight pig production; Feed cost per market weight pig production (from weaning to market weight) is 120,000 Won; Selling price of market weight pig is 150,000 Won.

Table 9. Analyses of economic feasibility of soybean meals from different origins

Item	U.S. dehulled	Brazil	India
Soybean meal intake, g/d			
Gestation (Day 30 to 100)	295.0	321.3	321.8
Lactation (Day 100 to Estrus)	1,085.0	1,213.4	1,234.9
Soybean meal cost, Won/kg	271.28	241.51	241.51
SBM cost per piglet			
Born alive, Won/pig	1,585.6	1,799.1	1,692.8
Birth weight, Won/kg	1,109.8	1,322.8	1,219.6
SBM cost per parity			
At weaning, Won/parity[1]	16,726.2	15,071.1	15,651.8
At weaning, Won/all parity[2]	100,357.2	90,426.5	93,911.0
Economic advantage			
Days to weaning weight, Won/parity[3]	31,284.4	26,668.9	29,247.4
Days to market weight, Won/parity[4]	28,806.4	25,044.0	26,939.6
Days to weaning weight, Won/all parity	187,706.6	160,013.8	175,484.6
Days to market weight, Won/all parity	172,838.3	150,264.2	161,637.4

[1] Survivability at weaning: 95.7%.

[2] For 6 parities.

[3] Piglet selling price per parity at weaning – SBM cost per parity; Piglet selling price is 50,000 Won.

[4] Selling price of market weight pig per parity – SBM cost per market weight pig production; SBM cost per market weight pig production (from weaning to market weight) is120,000 Won; Selling price of market weight pig is 150,000 Won.

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