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# Dietary Hemicell® Improved Reproductive Performance of Broiler Breeders under Commercial Settings

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## Abstract

The objective of this work is to study the effect of dietary Hemicell®, a fermentation product that contains high amount of β-mannanase, on performance and health parameters of broiler breeders grown under commercial settings. Twenty six thousand broiler breeders of Ross 308 strain with an average egg production of 35% and 2600 roosters aged 26.5 weeks were used in this study and were subdivided equally into six individual environmentally controlled houses with 4333 hens per house and 10% roosters. Birds in three houses were fed regular diet provided by the Ross Company while those in the remaining three other houses were fed rations containing 250 g of Hemicell® per ton of finished feed for a period of 8.6 months.

Hemicell® in breeder diets reduced feed cost and numerically improved number of total and hatching eggs per hen housed. It also increased hatchability by 0.32% during the 8.6 months trial period. Although Hemicell® improved yolk colour, it had no effect on other egg quality parameters such as egg weight and shell thickness. Regarding health parameters, Hemicell® reduced the incidence of pododermatitis in hens and increased the serum titer for NDV towards the end of the trial. Along with the little saving in feed cost, Hemicell® resulted in a gain of around 1.20 US dollar per hen housed. These results indicate that Hemicell® inclusion in the diets of broiler breeders is beneficial to parent flock growers and makes their operations more profitable.

**Keywords:** Hemicell®; Broiler breeder; Performance; Health parameters; Profitability

## Introduction

Hemicell®, an energy sparing enzyme produced by Elanco Animal Health, is a fermentation product of Bacillus lentus. It contains high amounts of β-mannanase that hydrolyzes β-mannan in feeds [1]. β-Mannan and its derivatives (β-galacto-mannan or β-gluco-mannan) are strong anti-nutritional factors to monogastric animals found in legumes. Mannan, β-galacto-mannan at the inclusion rate of 2 to 4% in feed retarded growth and decreased feed efficiency in broilers while the addition of β-Mannanase in feed can reverse the negative impact caused by β-galacto-mannan [2-5]. Soybean meal is the major protein source in poultry rations around the globe and the β-mannan content of soybean meals is considered high and varies between 1.26 and 1.61% [6]. The beneficial effect of β-mannanase in SBM containing diets has been documented in: broilers [7-11], layers [5,12], Turkeys [13] and swine [14,15]. Moreover, Jackson et al. [16] reported that the addition of β-mannanase improved the performance of chicks experimentally inoculated with Eimeria spp. and *Clostridium perfringens*.

A laying hen of the commercial broiler breeder strains produces around 140 saleable chicks per egg production cycle. In addition to its role in decreasing fertility through causing foot pad problems in roosters, the wet litter condition in breeder flock farms is one of the causes of increasing the rate of soiled and cracked eggs in the house. These eggs, if heavily soiled, are normally discarded from being set in the incubator thus, represents a financial loss to the growers. No work has been reported on the effect of Hemicell® on egg production rate, litter quality, percentage of hatching eggs, soiled and cracked eggs, and percentage fertility and hatchability along with the immunity status in breeder flocks.

Consequently, the objective of this work is to study the effects of this Hemicell® feed additive on the above criteria in broiler breeders grown under commercial settings.

## Materials and Methods

### Birds and housing

This field trial was conducted at the premises of Tanmia Co in the Beqaa region, Lebanon. Twenty six thousand broiler breeders of Ross 308 strain and 2600 roosters aged 26.5 weeks (186 days old) with an average egg production of 35-40% were used in this study. Birds were previously reared by the same commercial farm in one environmentally controlled poultry house for pullets and another separate house for roosters, following guidelines set by the Ross 308 broiler breeder management handbook [17], parent stock nutrition specifications [18] and performance objectives [19] from hatch to 21 weeks of age, then they were randomly transferred with the corresponding males to 6 environmentally controlled layer houses standing abreast of each other. Houses are all equipped with laying nests, automatic nipple drinkers and separate automatic feeders for males and females.

### Treatments

A total of six individual environmentally controlled houses holding a capacity of 4333 hens per house with 10% roosters were used in this study. Birds in three houses were fed regular diet as recommended by the Ross company while those in the remaining three other houses were fed rations containing 250 g of Hemicell® per ton of finished feed for

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a period of 8.6 months. The experimental Hemicell® diets for rooster and laying hen diets were formulated to have the same specifications in terms of energy, crude protein, amino acids and other essential nutrients of the control diets. No oil was added to these rations, thus the cost saving due to Hemicell® was only around 1$ per ton of finished feed for roosters and hens, respectively. The feeding period lasted for 258 days (36.9 weeks). It is worth noting that the work was granted the approval of the Institutional Animal Care and Use Committee (IACUC) of the American University of Beirut.

## Performance and Health Parameters of the Broiler Breeders

### Performance parameters

The following performance parameters were recorded:

- Body weight of breeders (layers and roosters) taken on a weekly basis
- Feed intake: allocated according to breeder's manual for both roosters and layers
- Egg production: recorded daily and graded into different categories. Undersized, oversized, cracked and soiled eggs were all discarded; hatching eggs were counted and set for incubation.
- Hatching eggs: On a monthly basis, hatching eggs (750) were randomly selected from each replicate (house), labelled and set apart in the collective incubator/hatcher. Day-old chicks were counted and percent hatchability was computed.
- Egg quality: egg quality parameters including egg weight, Haugh unit score, yolk color score, and shell thickness, were determined on 20 randomly selected hatching eggs every two months from each house (60 eggs per treatment).

### Health parameters

The following measurements were taken on a bi-monthly basis:

- Serum titers for viral disease (NDV, IB and Gumboro) determined on 20 birds from each house.
- Pododermatitis scores (burned feet) performed for control and Hemicell® groups on 30 layers and 20 roosters randomly chosen per poultry house.
- Litter quality: representative litter samples were collected from 10 pre-chosen locations in each replicate, mixed and analysed for moisture content.

### Statistical analysis

A complete randomized design was used with 2 treatments and 3 replicates (houses) per treatment and an average of 4333 hens and 433 roosters per house. Data were grouped by house and one-way ANOVA was used to compare means, followed by Student's t-test for mean separation using the proper procedures of SAS [20].

## Results and Discussion

### Performance parameters

Body weights of laying hens and roosters along with the egg production curve and egg weight produced by Hemicell® fed birds as compared to the performance standards of Ross 308 broiler breeders are presented in Figures 1-4 respectively. As indicated in Figures 1 and 2, weights of laying hens and roosters fed Hemicell® and control treatments were comparable, and in general they were 100 g higher than those published by the Ross 308 company. Also, egg production curve (Figure 3) and egg weight (Figure 4) for birds fed the treatment diets throughout the 8.6-month experimental period were similar and agree with those of Ross 308 company guidelines.

The cumulative performance of birds fed the two treatment diets are presented in Table 1. The mortality of both laying hens and roosters throughout the 8.6-month experimental period for Hemicell® fed birds was numerically lower than that of the control ones. Although similar

| | Control | Hemicell® | SEM |
|---|---|---|---|
| Mortality (% Hen Housed) | 9.38 | 9.24 | 0.825 |
| Mortality (% male housed) | 14.35 | 14.19 | 4.162 |
| Feed intake (kg/HH) | 40.1 | 40.1 | 0.19 |
| Feed intake (kg/ male housed) | 32.1 | 32.1 | 1.44 |
| Egg Production per HH | 156.6 | 159.3 | 2.59 |
| Hatching Eggs/ HH | 151 | 153.7 | 2.45 |
| Large, small and cracked eggs/HH | 5.6 | 5.6 | NA |
| Body weight change (g/ hen) | 1104 | 1093 | 21.6 |

**Table 1:** Performance of Ross 308 breeders fed Hemicell® containing rations for 8.6 months (36.9 weeks).

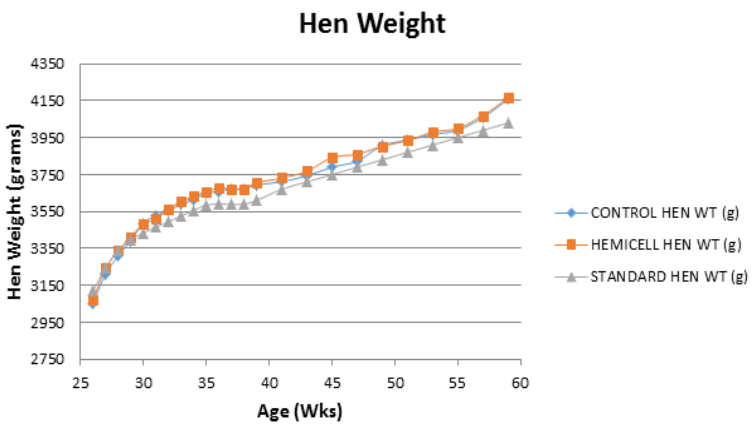


**Figure 1:** Body weight of hens in comparison with that of the Ross 308 guidelines.

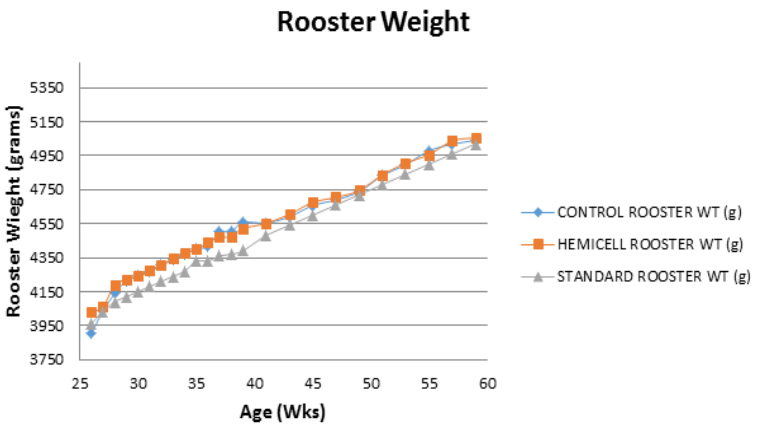


**Figure 2:** Body weight of roosters in comparison with that of the Ross 308 guidelines.

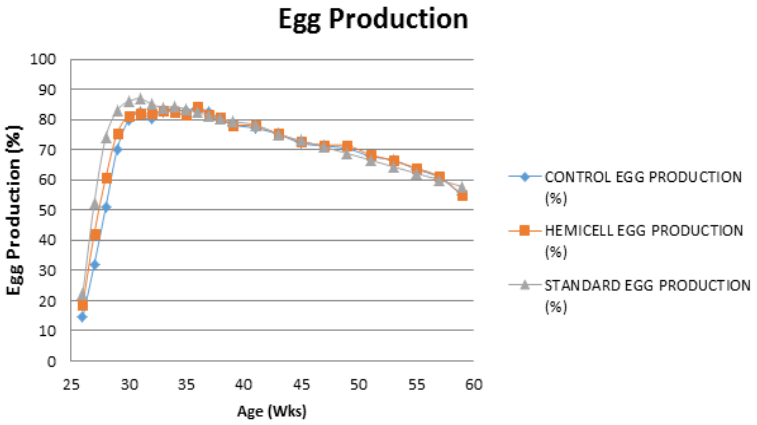


**Figure 3:** Egg production curves in comparison with that of the Ross 308 guidelines.

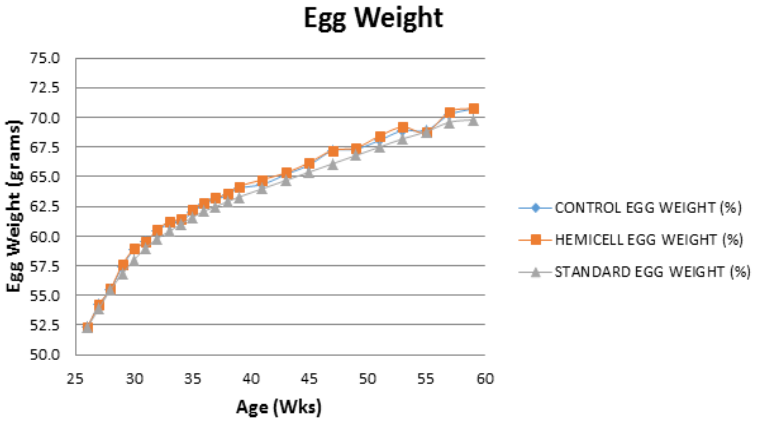


**Figure 4:** Weight of eggs produced by treated hens in comparison with that of the Ross 308 guidelines.

cumulative feed intakes for laying hens and roosters were recorded, birds fed Hemicell® diet produced 2.7 (P>0.05) more hatching eggs per hen housed (HH). The current egg production trend is in agreement with that of Jackson et al., [5] who reported an increase in egg production at 43 - 66 weeks of age and Wu et al. [12] who observed this increase at 5 - 8 weeks following Hemicell incorporation in commercial laying hen diets. The numbers of non-hatching eggs (large, small, soiled and cracked) along with body weight change of hens fed the two dietary treatments were comparable (Table 1).

The hatchability percentages of eggs (750 per house) recorded six times throughout the trial period are presented in Table 2 and averaged 69.15 and 68.83% for Hemicell® and control treatments, respectively. Similarly, on a total hatching eggs basis during the whole

experimental period, Hemicell® treatment resulted in an average of 0.32% more hatchability (P<0.05) as compared to the control. The current hatchability results are, to our knowledge, reported for the first time, thus they could not be compared with others.

In line with the above performance data and hatchability results, the economics of feeding Hemicell® to broiler breeders were made and presented in Table 3; the study was based on the market price of feed ingredients (325 and 324 USD/ton of Hemicell® and control feed, respectively) and day-old chicks (0.50 USD). Dietary Hemicell® resulted in 2.3 more chicks per HH as compared to that consuming the control diet. The sale of these additional chicks along with the difference in feed cost resulted in an additional net revenue of 1.20 USD per hen housed in favour of Hemicell®.

Table 4 summarizes the measurements of egg quality parameters recorded 4 times during the experimental period on 20 eggs randomly collected on bimonthly basis from each poultry house. Average egg weight and shell thickness values were comparable among the two dietary treatments. Compared to the control treatment, Hemicell® fed birds resulted for unexplained reason, in a slightly lower Haugh unit score but higher yolk colour score indicating that this enzyme may enhance the intestinal absorption of corn yellow pigment.

## Health parameters

Elisa titers for infectious bronchitis (IB), infectious bursitis (IBDV) and new castle disease virus (NDV) determined on sera of randomly picked 20 hens, every two months, from each poultry house are presented in Table 5. In general, the titers for these diseases were comparable in the four performed tests except for the NDV titer that was, for unexplained reasons, consistently higher in Hemicell® fed birds (P<0.05) during the last two months of the trial. The maternal immunity titers for these very same diseases were determined on sera of 15-day-old birds randomly picked from each treatment and found comparable (Table 6 and Figure 5).

The percentages of litter moisture determined in the six houses on different intervals averaged around 20% and were comparable between the two treatments (Table 7). These low moisture figures were the results of applying proper management conditions (especially ventilation) in all poultry houses irrespective of the treatment.

As indicated earlier, foot lesion scores were performed on 30 laying hens and 20 roosters randomly chosen in each house at different intervals during this trial but only the data of the sixth month post feeding Hemicell® are reported in Tables 8 and 9. Out of 150 birds in each treatment, Hemicell® resulted in less "superficial burned feet, and advanced burned feet" than the control (33 and 1 vs. 67, and 9,

| | Control | Hemicell® | Difference |
|---|---|---|---|
| Hatching Eggs in 8.6 months/HH* | 151 | 153.7 | + 2.7 eggs |
| Average Hatchability of Total Eggs over the 8.6 months** (%) | 68.84 | 69.16 | 0.32% |
| Number of Chicks Hatched/Hen Housed | 104 | 106.3 | + 2.3 chicks |
| Cumulative feed consumed in 8.6 months (kg/ HH plus 10% of feed consumed per male) | 43.31 | 43.31 | 0 |
| Cost of feed ***consumed in 8.6 months ($) | 14.08 | 14.03 | -0.05 |
| Revenues from the extra 2.3 chicks with a market price of 0.50 $ per chick ($) | 0 | 1.15 | 1.15 |
| Net profit from feeding Hemicell® in 8.6 months ($/HH) | | | 1.2 |

*HH: hen housed.
**Hatchability of all eggs tested on a daily basis throughout the trial period.
***Cost of rations: 325$/ton of control and 324$ per ton of Hemicell® diet.

**Table 2:** Economics of feeding Hemicell® to Ross 308 broiler breeders taking into consideration the current market prices of feed ingredients and day old chicks.

| Settings (month) | | 1st | 2nd | 3rd | 4th | 5th | 6th | Mean |
|---|---|---|---|---|---|---|---|---|
| Hatchability (%) | Hemicell® | 78.1[a] | 78.2 | 76.3 | 68.5 | 62.7 | 51.1 | 69.15 |
| | Control | 77.4[b] | 78 | 75.9 | 68.3 | 62.7 | 50.7 | 68.83 |
| | SEM* | 0.14 | 0.27 | 0.12 | 0.1 | 0.16 | 0.14 | |

[a,b]Within a column, for each criterion, averages with no common superscripts are significantly different (P<0.05).
*Pooled standard error of mean.

**Table 3:** Percent hatchability of eggs sampled from broiler breeder hens fed control and Hemicell® diets.

| Testing (2 months) | | 1st | 2nd | 3rd | 4th |
|---|---|---|---|---|---|
| | Hemicell® | 65 | 67.8 | 70.1 | 71.1 |
| **Egg Weight (g)** | Control | 64.3 | 67.7 | 70.1 | 71.1 |
| | SEM* | 0.51 | 0.52 | 0.49 | 0.56 |
| **Yolk Color Score** | Hemicell® | 7.1 | 8.3[a] | 8.1 | 8.4[a] |
| | Control | 6.9 | 7.5[b] | 7.9 | 8.1[b] |
| | SEM* | 0.12 | 0.11 | 0.12 | 0.1 |
| **Haugh Unit Score** | Hemicell® | 69.8[b] | 65.6[b] | 81.6 | 75.9[b] |
| | Control | 73.9[a] | 72.4[a] | 83.4 | 81.2[a] |
| | SEM* | 1.36 | 1.64 | 1.44 | 1.58 |
| **Shell Thickness (mm)** | Hemicell® | 0.349 | 0.355 | 0.35 | 0.347 |
| | Control | 0.347 | 0.349 | 0.352 | 0.344 |
| | SEM* | 0.0035 | 0.0039 | 0.0033 | 0.0038 |

[a,b]Within a column, for each criterion and each testing period, averages with no common superscripts are significantly different (P < 0.05).
*Pooled standard error of mean.

**Table 4:** Quality parameters of eggs produced by Ross 308 breeder hens fed Hemicell® containing diets and tested on bimonthly basis using 20 eggs from each house (60 per treatment) over a period of 8.6 months.

| Testing (2 months) | | 1st | 2nd | 3rd | 4th |
|---|---|---|---|---|---|
| | Hemicell® | 8972[b] | 4535[b] | 8313 | 14282 |
| **Infectious Bronchitis** | Control | 10850[a] | 5828[a] | 9267 | 14922 |
| | SEM* | 544.2 | 302.2 | 612.2 | 1594.2 |
| **Infectious Bursitis** | Hemicell® | 5832 | 8389 | 6323[b] | 11964 |
| | Control | 5520 | 8671 | 7349[a] | 11255 |
| | SEM* | 227 | 216.6 | 201.2 | 410.1 |
| **Newcastle Disease Virus** | Hemicell® | 10469 | 11401 | 9329 | 24388[a] |
| | Control | 11635 | 11826 | 10040 | 14049[b] |
| | SEM* | 428.6 | 253.9 | 272.9 | 1.58 |

[a,b]Within a column, for each criterion and each testing period, averages with no common superscripts are significantly different (P<0.05).
*Pooled standard error of mean.

**Table 5:** Elisa titers to different disease viruses of sera collected from Ross 308 breeder hens fed Hemicell® diets and tested on bimonthly basis using 20 hens from each house (60 per treatment) over a period of 8.6 months.

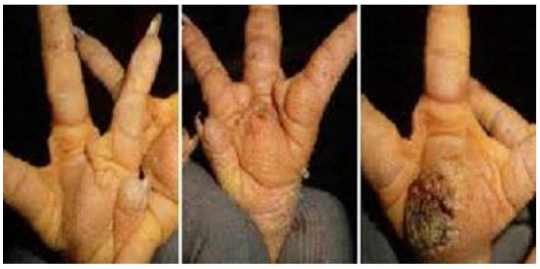


**Figure 5:** Adopted foot pad lesion scores.

| Treatment | IB | IBD | ND |
|---|---|---|---|
| Control | 6613 | 13528 | 14123 |
| Hemicell® | 6309 | 12549 | 13905 |
| SEM* | 348.2 | 408.9 | 450.8 |

*Pooled standard error of mean

**Table 6:** Maternal immunity ELISA titers of day old chicks originating from control and Hemicell® fed Ross 308 breeders to IB, IBD and ND.

| Testing every 2 months | | 1st | 2nd | 3rd | 4th | Mean |
|---|---|---|---|---|---|---|
| **Litter Moisture (%)** | Hemicell® | 17.7 | 20.7 | 16.7 | 18.6 | 18.4 |
| | Control | 22.1 | 20.7 | 19.3 | 17.5 | 19.9 |
| | SEM* | 1.44 | 1.55 | 1.94 | 1.75 | |

*Samples collected randomly from different locations in each poultry house, pooled and analyzed for moisture

**Table 7:** Litter moisture of Ross 308 broiler breeders fed control and Hemicell® diets for 8.6 months.

| House | Sex | Total | Treatment and Lesion | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Control | | | Hemicell® | | |
| | | | No Lesion | Lesion 1* | Lesion 2** | No Lesion | Lesion 1* | Lesion 2** |
| House 1 | Male | 20 | 7 | 11 | 2 | 12 | 7 | 1 |
| | Female | 30 | 17 | 11 | 2 | 21 | 9 | 0 |
| House 2 | Male | 20 | 11 | 9 | 0 | 16 | 4 | 0 |
| | Female | 30 | 13 | 15 | 2 | 28 | 2 | 0 |
| House 3 | Male | 20 | 8 | 10 | 2 | 18 | 2 | 0 |
| | Female | 30 | 18 | 11 | 1 | 21 | 9 | 0 |

*Lesion 1: Superficial burned feet.
**Lesion 2: Advanced burned feet.

**Table 8:** Foot Lesion Scores per Treatment and Gender 6 Months Post Feeding.

| Treatment | Lesion | | | |
|---|---|---|---|---|
| | No Lesion | Lesion 1* | Lesion 2** | Total |
| Control | 74 | 67 | 9 | 150 |
| Hemicell® | 116 | 33 | 1 | 150 |
| Total | 190 | 100 | 10 | |

*Lesion 1: Superficial burned feet.
**Lesion 2: Advanced burned feet.

**Table 9:** Foot Lesion Scores per Treatment 6 Months Post Feeding.

| Treatment | Probability of Lesions with 95% Confidence Interval | | |
|---|---|---|---|
| | P(0 Lesions) | P(Lesion 1)* | P(Lesion 2)** |
| Control | 0.49 (0.41-0.57) | 0.46 (0.38-0.54) | 0.05 (0.02-0.08) |
| Hemicell® | 0.78 (0.71-0.84) | 0.21 (0.15-0.27) | 0.01 (0.004-0.03) |

*Lesion 1: Superficial burned feet
**Lesion 2: Advanced burned feet.

**Table 10:** Probability of Foot Lesion Scores per Treatment 6 Months Post Feeding.

respectively). The probabilities of foot lesion scores per treatment with 95% confidence intervals are shown in Table 10. In summary and compared to the control diet, Hemicell® significantly increased the incidence of "no burned feet" and reduced the incidence of "superficially burned feet" and practically had very little "advanced burned feet".

## Conclusion and Recommendations

Hemicell® in breeder diets reduced feed cost. Hemicell® numerically improved number of total and hatching eggs. It also increased hatchability by 0.32% which resulted in 2.3 extra chicks during the 8.6 months trial period. Hemicell® had no effect on egg weight, shell thickness but improved yolk colour score. Hemicell® increased the serum titer for NDV towards the end of the trial. Along with the little saving in feed cost, Hemicell® resulted in around 1.20 US dollar per hen housed.

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### Significance of this Research

Elanco Animal Health reported that Hemicell® improves weight gain and feed conversion of broilers and egg production performance of laying hens in addition to a better litter quality in poultry houses. Breeder flocks of commercial broiler and laying hen strains are normally raised on the floor and their produced fertile eggs are used mainly for hatching purposes. A laying hen of the commercial broiler breeder strains produces around 140 saleable chicks per egg production cycle with an average market price in Lebanon of 0.70 and 0.55 USD per chick during 2015 and 2016, respectively. In addition to its role in decreasing fertility through causing foot pad problems in roosters, the wet litter condition in breeder flock farms is one of the causes of increasing the rate of soiled and cracked eggs in the house. These eggs, if heavily soiled, are normally discarded from being set in the incubator thus, decreasing the number of chicks hatched which in turn represents a financial loss to the growers. The effect of Hemicell® on egg production rate, litter quality, percentage of hatching eggs, soiled and cracked eggs, and percentage fertility and hatchability along with the immunity status in breeder flocks has been investigated in this study. The results proved that the use of Hemicell® is beneficial for both performance and health parameters observed in broiler breeders. These results would help in making proper recommendations to parent flock growers for them to reduce the production cost of day-old chicks and make their operations profitable.

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