Effect of Milk Yield on Economic Profitability of Holstein Friesian Cows under Intensive Production System in Egypt

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ABSTRACT
Data of productive and reproductive traits of 1961 of lactation records were obtained from 763 Dutch Friesian cows grew up at Wadi El-Sharkia farm, El-Salheia, Egypt. These data were analyzed to empirical comparison between the profitability of three herds under intensive production system in Egypt. The second herd (H2) produced average milk yield of 8619 kg/lactation, followed by first herd (H1) (5138 kg/lactation) which was lower than the H2 by at least one standard deviation (SD = 2935 kg). The third herd (H3) produced high milk yield equal to the average of H2 plus at least one standard deviation. Traits studied were milk yield per day (M/D, kg), total milk yield (TMY, kg), lactation period (LP, day), dry period (DP, day), annual milk yield (AMY, kg), days open (DO, day), number of services per conception (NSPC), calving interval (CI, day), number of lactation completed (NLC) and age at first calving (AFC). Least squares analysis of variance showed highly significant (P<0.01) effects of all factors on all traits studied except the effect of month and year of calving on NSPC that was non-significant. For comparing between the three herds, the deterministic model was used to estimate the annual gross margin and benefit/cost ratio as economic parameters. Prices of inputs and outputs were based on market and farm gate prices during the period from 1998 to 2007. DO, CI and NSPC were increased in H3 vs. H2 and H1, indicating poorer reproductive efficiency of high yielding herd. Moreover, H3 gave 1.03 and 1.5 parity less for each cow than that of H2 and H1, respectively. Economic evaluations indicated that the annual variable cost were (LE) (Egyptian pound = 0.17 USD and = 0.13 EUR) 5136, 6910 and 7845 of H1, H2 and H3, respectively. However, the annual gross margin of H3 was higher than that of H1 and H2 by 79 and 24%, respectively, and the benefit/cost ratio of H3 was 1.90 relative to 1.63 and 1.68 for H1 and H2, respectively. The profit per cow during the lifetime production of H3 was 72 and 19.04% more than of H1 and H2, respectively. It is concluded that under intensive production system, extension of calving interval for high yielding herds seem more profitable than the herds that have shorter calving interval and lactation period.

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INTRODUCTION
Profitability of dairy cows is influenced by the herd's level of production and reproduction (Baharizadeh, 2012). Milk yield is considered the major source of farm revenues (Rehman and Khan, 2012). Annual milk yield is an index, which reflects the intensity of lactation and combines milk yield and reproductive efficiency of a dairy cow (Gorgulu, 2011; Katok and Yanar, 2012). Producing more milk annually is a primary measure of efficiency because maximum production of dairy cows has typically occurred with optimal management conditions (Kellogg et al., 2001; Khan et al., 2012). Milk production in Egypt is less than the threshold of self-sufficiency representing 72% of the domestic demand (MALR, 2000). Because the low milk production of local breeds, exotic breeds are adopted to increase milk production in commercial herds where intensive systems are followed.

The revenues of milk production depend on the reproductive efficiency of the herd (Ahmed et al., 2000). Days open and NSPC of the cows have been studied by several investigators due to the economic importance
associated with the reproductive efficiency and fertility in dairy cattle. They are important in determining calving interval and influencing milk production (Ali et al., 2003; Riecka and Candrak, 2011). Regular calving (every 12-13 months) is one of the main targets of dairy farmers. Thus, we can reach the available maximum number of lactations per lifetime production of cows and provide the farmer with more progenies for replacement or sale.

Long calving interval may be the main reproductive disorder of high yielding dairy cattle. Mainly, that is due to either low conception rate (40-50%) and/or high early embryonic mortality (Rossi et al., 2008). The poor reproductive performance of high yielding cows may affect the overall economic performance of the herd especially under high ambient temperature (Jainudeen and Hafez, 2000).

We can judge the profitability of farm by the gross margins of the enterprise. A major reason for difference of gross margin is the level of yield obtained and price of the products. High yielding cows need additional costs. When this incurred, we must take the decision based on whether the extra returns would be greater than the additional costs involved or not. Therefore, the aim of the present study was to evaluate the economic performance of three Holstein Friesian herds having different levels of milk production and calving intervals under intensive farming system.

**MATERIALS AND METHODS**

**Data and management:** Productive and reproductive data of 1961 lactation records, starting from 1961 to 2007, obtained from 763 Dutch Holstein Friesian cows mating by 171 sires, belonging to Wadi El-Sharkia farm, El-Salheia, Egypt, were analyzed for empirical comparison between the profitability of three herds under intensive production system. According to the level of milk yield, the records were divided into three herds. The first herd (less than 20 kg/day) having average milk production decreased at least by one standard deviation (x̄ ± 1 SD, SD = 2935 kg), the second herd (between 20-25 kg/day) had milk production equal to the average of Holstein Friesian under the intensive dairy farms in Egypt (8719 kg). The third herd contained the high yielding cows (more than 25 kg/day) which produced more than the average milk production at least by one standard deviation.

Animals of the three herds were kept under the same system of feeding and management in the original farm. Cows were fed according to their live body weight, milk production level, and pregnancy status (National Research Council, 2001). Cows were fed on corn silage along with Egyptian clover (Tritium alexandrinum) for about six months during the year from December to May with concentrate ration. During summer and autumn cows were fed by corn silage along with Barseem hay and concentrate ration (total mixed ration). Percentage of protein in the concentrate mixture ranged from 17 to 19% for high milk yield herd, from 16 to 17% for medium milk yield herd and from 14 to 16% for low milk yield herd. Clean water and mineral mixture were available all time. Cows were artificially inseminated within 12 hours after the detection of heat using frozen semen (Friesian Bulls) imported from Germany, Netherlands and USA. Pregnancy test was made after 42 days of insemination by rectal palpation. Cows in estrus before pregnancy test were artificially inseminated immediately. Cows were initially served 60–70 days after parturition. Cows with less than 3 or more than 5 lactations were excluded.

Cows were milked 2-4 times daily according to their milk production level. Milk yield was recorded to the nearest 0.1 kg daily at each milking. Costs and revenues were estimated according to technical coefficients and management practices in the farm.

**Traits, technical coefficients and assumptions:** Data were statistically analyzed to estimate the productive technical coefficients of the three herds. The terms of productive traits study were, milk production per day (M/D, kg), total milk yield (TMY, kg), lactation period (LP, day), dry period (DP, day), and annual milk yield (AMY, kg equals TMY, kg divided by CI in days multiplied by 365), while reproductive traits terms were, days open (DO, day), number of services per conception (NSPC), calving interval (CI, days), number of lactations completed [parities of the cow (NLC)] and age at first calving (AFC). Table 1 shows assumptions that were adopted in calculating the farm budget.

* Number of lactations completed (NLC) by herd 1 (H1) assumed to be 4 according to (El-Gharabawy, 2008) as a control.
* Culling age = [AFC of H1 + (4 NLC x CI of H1)]
  = (24 month x 30.5 day) + (4 x 442)
  = 732 + 1768 = 2500 days (6.85 years).
* The prices of inputs were estimated based on the market price during the period from 1998 to 2007.
* The prices of outputs were estimated based on the Wadi El-Sharkia farm gate price during the period from 1998 to 2007.
* Gross margin is one of the more realistic measures to evaluate farm profitability (Barnard and Mix, 1993). To compare among three herds, the annual gross margins as well as, discounted measure, benefit/cost ratio (present worth of benefits divided by present worth of costs) were used as economic tools for comparing three herds.

**Statistical analysis:** Data were analyzed using General Linear Model (GLM) procedure of SAS (2006) to determine the fixed effects and to develop technical coefficients of the three herds. The statistically model included months (1 to 12) and years (1998 to 2007) of calving, parity of cow (1 to ≥5), herds (1, 2 and 3). The following statistically model was used:

\[
Y_{ijklm} = \mu + M_i + R_j + T_k + H_l + \beta (AFC) + e_{ijklm}
\]

Where:

- \(Y_{ijklm}\) = observation of productive and reproductive traits,
- \(\mu\) = the overall mean,
- \(M_i\) = fixed effect of month of calving k (i=1, 2, ..., 12),
- \(R_j\) = fixed effect of year of calving l (j=1, 2, ..., 10),
- \(T_k\) = fixed effect of parity m of the cow (k=1, 2, ..., 5),
- \(H_l\) = fixed effect of herd level production (l=1, 2 and 3),
- \(\beta\) = the linear regression coefficient of the studied trait on AFC and
- \(e_{ijklm}\) = random error.

**RESULTS AND DISCUSSION**

Means and standard deviation (SD) for productive and reproductive traits studied in all parities at three herds are shown in Table 2. TMY of H3 increased as 1.60 and
2.71 times more than H2 and H3, respectively, while H2 increased as 1.70 times more than H1 for the same trait. The results showed that H1 had poorer reproductive performance than H2 and H3. Table 2 indicated that high milk producer cows had longer interval from calving to the conception. This consequently prolonged the calving interval due to the increase in number of services per conception by about 1.44 times (H1 vs. H3), 2.25 times (H2 vs. H1 and H3) and 1.56 times (H2 vs. H1).

This result may be attributed mainly to the negative energy balance of the high yielding cows particularly during the peak of lactation (Rossi et al., 2008). High milk production mainly at high ambient temperature can cause physiological stress that may lead to a depression of the interior pituitary secretion. Such depression causes delay in resumption of ovarian activity post-partum which explains the increase of post-partum service interval. Moreover, the early embryo mortality (Dunne et al., 2000) is a major cause of reproductive failure in cattle and of serious financial loss to dairy and beef farmers, therefore, leading to increased number of services per conception and prolonged calving interval. The low reproductive efficiency for high milk producing cows observed in the present study was similar to those reported by Muller et al. (2000) and Rossi et al. (2008).

Economic evaluation: Income (gross output) of H3 was more than that H2 and H1 as about 17.61 and 62.91%, respectively, while H2 increase than H1 by about 13.53 and 52.78%, respectively (Table 3). Annual variable cost per cow of H3 was higher (P<0.01) than those of H2 and H1 by about 13.53 and 52.78%, respectively, while H2 was higher than H1 by about 34.57%. This difference among three herds can explained the increase of post-partum service interval. The low reproductive efficiency for high milk producing cows observed in the present study was similar to those reported by Muller et al. (2000) and Rossi et al. (2008).

Table 2: Means and standard deviations for productive, reproductive and lifetime production traits for the three herds investigated.

Table 3: Analysis of the annual gross output (income) and variable costs per cow of the three herds.
intensive production system. Due to longer calving interval of $H_2$, each cow gave 1.03 and 1.5 parity less than that of $H_2$ and $H_3$, respectively (Table 2). In this respect, Ahmed et al. (2002) reported that the high yielding cows gave 0.9 parity less than that of the $H_1$ which produced the average lactation yield of Holstein. Results of Table 4 showed that the average variable cost for the whole lifetime production of $H_3$ exceeded that of $H_1$ and $H_2$ by 46.62 and 9.36%, respectively. On the other hand, the total gross output of $H_1$ exceeded those of $H_1$ and $H_2$ by 56.00 and 13.28%, respectively. Moreover, the profit per cow during the lifetime production of $H_1$ was 72 and 19.04% more than of $H_1$ and $H_2$, respectively.

**Table 4:** Financial analysis (LE) for lifetime production per cow of the three herds and percentages of difference among herds investigations

<table>
<thead>
<tr>
<th>Item</th>
<th>Herd</th>
<th>% difference between the herds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross output</td>
<td>$H_2$</td>
<td>$H_1$</td>
</tr>
<tr>
<td>Variable cost</td>
<td>28037</td>
<td>37590</td>
</tr>
<tr>
<td>Gross margin</td>
<td>17778</td>
<td>25641</td>
</tr>
</tbody>
</table>

Khan et al. (2010) calculated the economic profitability for Red Chittagong cows (RCC) under the rural area in the Chittagong district of Bangladesh by using a deterministic linear model. The income was derived from the sale of milk, beef and manure and costs included only for feed and fixed costs. The milk payment for the farmers was based on milk volume only and was used to calculate the profit. They found lower profitability than the present finding. Also they added that differences of profitability were attributed due to the differences of the prices of feed, milk, meat and the differences of breeds.

Uddin et al. (2010) concluded that the degree of intensification and potential availability of input and support services play a great role in reducing the costs by increasing the return and improving productivity. The institutional arrangements and natural resource endowments in each system also influence the costs of inputs and support services. They added that the intensive dairy farming system produces higher milk with lower cost, hence it is more competitive. Moreover, the intensive farmers are at a better position in terms of costs and profits than extensive and traditional systems and are more competitive, due to lower per unit costs, higher milk prices, higher milk production, higher land and labour productivity.

**Conclusion:** From the results, it can conclude that under the intensive production system, high milk producer cows with longer calving interval are more profitable than those having regular calving every 12-13 months, regardless the value of genetic losses in the form of heifers for replacement and or bulls for insemination. This needs more investigations to quantify the value of such losses and its impact on herd dynamic. Furthermore, from the genetic point of view, criteria of selection planning would be more efficient when information comes from high yielding cows.

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