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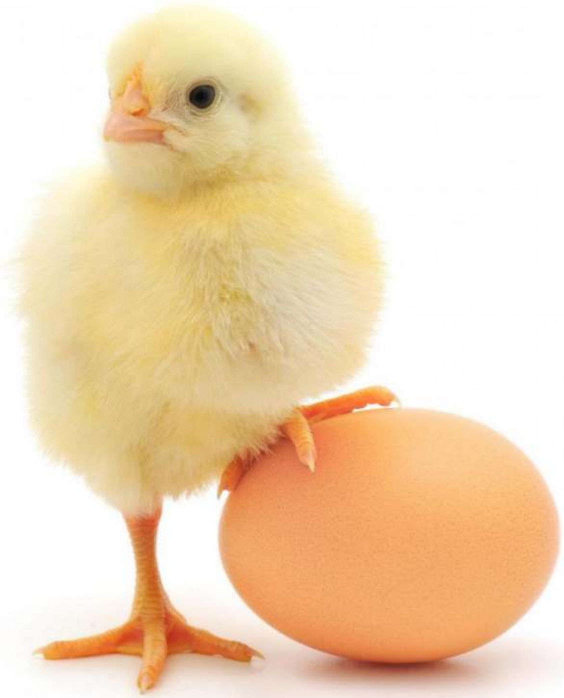

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# Standardizing Limits for Cost of Production in Commercial Egg Operation

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**Abstract**: A study was undertaken in Chakwal during 2000-2001 while collecting data from 109 flocks to predict standard limits for various cost components in commercial egg production enterprise. Net profit per bird was taken as response variable and the cost components one by one were standardized using quadratic functions. Maximum critical limit for total predicted cost of production per bird, cost of: feed, labor, day-old chick, building and equipment, immunization, medication, transportation, miscellaneous items, bedding and electricity was Rs. 343.41, Rs. 22.97, Rs. 21.63, Rs. 17.39, Rs. 9.08, Rs. 7.80, Rs. 3.32, Rs. 3.30, Rs. 2.05, Rs. 2.03, respectively. The critical maximum limits were the indicators suggesting that any increase beyond those limits would render the enterprise uneconomical. The information provided may serve a useful purpose for the commercial layer farms in improving net profit from commercial layers in Chakwal.

**Key Words:** Cost components, standard limits, table egg production

## Introduction

Cost of production and returns are the two major concerns in commercial egg production provided other production parameters are within the normal range as suggested for better productivity. Assuming management and production factors to be normally executable, commercial egg production enterprise can be made more profitable if critical standard limits for cost of production are determined and given close attention. Aside from prevalent market prices of various poultry goods, variability in cost components is mainly attributable to management conditions (Farooq *et al*., 2001), size of the operation (Ames and Ngemba, 1986; Kumar and Mahalati, 1998; Ascard *et al*,.1995, mortality (North, 1984; Kitsopanidis and Manes, 1991; Zahir-ud-Din *et al*., 2001; Asghar *et al*., 2000) management conditions (Zahir-ud-Din *et al*., 2001) and feed efficiency (Elwardany *et al*., 1998). Efforts shall be made to complete the aforementioned activities in the normal range, thus reducing production cost through better planning and management, and alleviating any adverse affect. When production activities are markedly executed, the development of standards for various cost components would offer a guideline for the producer to adjust their budget accordingly, providing better definition of the critical limits beyond which the enterprise will run in loss. The present study was therefore, an effort to predict critical standards for cost of production in commercial egg production operation. With all previously mentioned sources of variability in place, a large sample was needed to investigate the economic status of commercial layer production in Pakistan. Reliability could be increased and error of prediction could be reduced through increasing sample size and/or eliminating certain sources of variability. Study based on large number of farms existing in the same geo-physical environment would help refine the parameters' estimates, increase reliability, and reduce error of predictions. District of Ckakwal in Punjab province was therefore, selected as the target area for the present study, where commercial layers' farms are concentrated and well established. A comprehensive study in the poultry specialized area would provide a vivid picture of the status of egg-type layers' propositions in Pakistan in general and Chakwal in particular. Recommendations based on the results of the study could be helpful to entrepreneurs in the study area and beyond for improving management efficiency.

## Materials and Methods

The present study was carried out during 2000-2001 to investigate critical limits for various traits of economic importance in commercial egg production enterprises in Chakwal, Pakistan. Sample size for the study was predicted by calculating coefficient of variation from the data generated by Tariq (2000). Maximum coefficient of variation was found for the total number of eggs produced per flock and was therefore, selected as an index for predicting sample size to accommodate both maximum and minimum values of variations in various traits. The following model, developed by Casley and Kumar (1989) was adopted for determining sample size.

$$N = K^2 * V^2 / D^2$$

Where "N" was sample size, "K" the normal deviation at 95% confidence interval "V" the absolute value of coefficient of variation of the selected variable and "D" the margin of error assumed to be 0.1.

**Data collection:** Data during 2000-2001 were collected from 109 flocks pertaining to flock size, mortality, culling, cost of feed, day-old chick, medicine, litter, brooding, labor, electricity, transportation, marketing, miscellaneous items and returns from the sale of eggs, culled birds, manure and empty bags. Total cost of production, gross income and net profit per bird was calculated from the generated data.

**Data analysis :** The data were analyzed through quadratic functions to study relative association among net profit and cost components one by one using the following form of quadratic function;

$$Y = ß_0 + ß_1X_i + ß_2X^2_i$$

where; "Y" was response variable, "$ß_0$" the intercept, "$ß_1$" first slope of the regression line, "$ß_2$" second slope of the regression line and "$X_i$" the regressors.

To develop standard limits for an individual parameter, results obtained from the aforementioned equation were solved one by one, taking first and second derivatives of the slopes of the regression lines. First derivative revealed the standard limit or break-even-point while the negative or positive sign of the second derivative decided the first derivative to be either the maximum or minimum limit.

## Results and discussion

Based on the findings of the quadratic function and taking derivatives of the regression slopes, standards were developed for each cost component. The results are presented and discussed as follows.

**Cost of production:** Cost of production has a major bearing on profitability of egg laying operation. Thus, it is highly important to predict its critical limit in order to make sure that enterprise runs in profit. A quadratic relationship was found between cost of production (CP) and net profit per bird (NP) as is shown in equation I.

$$NP = -251.862498 + 1.449634CP - 0.001674\ CP\ sq \quad (I)$$

$(t=-0.990)^{NS}$; $(t=1.282)^{NS;}$ $(t=-1.432)^{NS}$

$(R^2 = 0.0355$; adjusted $R^2 = 0.0171$; $F = 1.932)$

($^{NS}$ = Not significant)

$x' = 432.98$; $x'' = -0.001674$.

Taking derivative ($\partial NP/\partial CP = x'$) of the first regression slope, Rs. 432.98 was found to be the optimum limit of cost of production per bird over 52 weeks of growth and production period. The negative sign of second derivative ($x'' = -0.001674$) of the equation "I" revealed that critical maximum limit of cost of production per bird was Rs. 432.98. Any increase in cost of production beyond this limit will result in loss. The observed cost of production per bird in the present study was lower (Rs. 393.88; Table 1) than the predicted limit of Rs. 432.98, showing that the business was profitable in the target area. Zahid (1994) on the other hand reported a lower cost of production per layer (Rs. 277.36) than the present findings. This could be attributed to the increased inflation rate over the years.

**Feed cost:** Feed cost is the major component among various cost components. However, it may not be under the direct influence of the farmers when feed is purchased from the market. Thus, the cost could only be efficiently reduced through better care of the flock and minimal wastage of feed. A quadratic relationship was found between feed cost (FC) and net profit per bird (NP) as is shown in equation II.

P=-426.324348 + 2.650682FC - 0.0038593 FC sq (II)
(t=-3.188)*** (t=3.646)*** (t=-3.795)***
($R^2$ = 0.0668; adjusted $R^2$ = 0.0581; F = 7.697).
(*** = Highly significant);
x′ = Rs. 343.41; x′′ = -0.0038593

As evident from the negative sign of the second derivative (x′′), first derivative (x′) of the equation II suggested Rs. 343.41 (79.31% of the total predicted cost) to be the maximal limit of feed cost per bird. Any increase in feed cost above this limit will result in economic losses. The observed feed cost per bird in the present study was lower (Rs. 302.23 or 76.73% of the total cost of production per bird; Table 1) than the predicted limit (Rs. 343.41), suggesting better use of the feed for economical egg production in the target area. Hatter (1983; 72.38%) and Qunaibet *et al.* (1992; 70%) reported lower while Zahid (1994; 81.76%) reported higher contribution of feed cost to the total cost of production. The variability in feed cost is attributed to variable management regiemns followed for commercial egg production.

**Labor charges :**Labor is another component of production cost in commercial egg operation. Efficiency of labor would be an important step in reducing cost of production per bird. A quadratic relationship was found between net profit (NP) per bird and labor cost (LC) as is given in Equation III.

NP = 216.564691 + 17.035968LC - 0.370790LCsq (III)
(t=2.444) ** (t=1.804) * (t=-1.542)$^{NS}$
($R^2$ = 0.1300; adjusted $R^2$ = 0.1049; F = 5.180).
($^{NS}$= Non - significant; ** = Significant;
* = Relatively significant) ;
x′ = Rs. 22.97; x′′ = -0.74158.

The negative sign of the second derivative (x′′) of equation III indicated that the value obtained (Rs. 22.97) after taking the derivative (x′) of the first regression slope was the critical maximal limit of labor cost/bird. Increase beyond this limit will render the enterprise uneconomical. The observed labor cost per bird (19.90, 5.05% of the total cost; Table 1) was lower than the predicted critical maximal limit of Rs. 22.97 (5.30% of the total predicted cost of production per bird), suggesting that farmers in the project area were managing labor in a better way. Hatter (1983) reported higher contribution (6.52%), whereas, Zahid (1994) observed smaller contribution of labor cost (3.53%) to total cost of production. Variability in labor cost is attributable to skill of labors. Skilled labors are usually given more wages than unskilled or inexperienced labors.

**Day-old chick cost:** Day-old chick cost vary from time to time and place to place and therefore, its predicted limit may not be applicable everywhere and on a consistent basis. However, its predicted value was computed just to provide a guideline in the project area and to offer a guideline to farmers involved in the business. A quadratic relationship was found between day-old chick cost (DOC) and net profit per bird (NP) as is shown in equation IV.

NP= 2540.871678 + 233.26424DOC – 5.391806DOC (IV)
(t=0.480) $^{NS}$ (t=0.434) $^{NS}$ (t=-0.395) $^{NS}$
($R^2$ = 0.0234; adjusted $R^2$ = 0.0143; F = 2.574).
($^{NS}$ = Non - significant);
x′ = Rs. 21.63; x′′ = -5.391806

As evident from the negative sign of the second derivative (x′′), first derivative (x′) of the equation IV indicated Rs. 21.63 to be the maximal limit of incurred cost on day-old chick. Any increase in day-old chick cost above this limit will result in economic losses provided no increase in egg price is observed in the market. The observed cost of day-old chick in the present study was lower (Rs. 19.75; Table 1) than the predicted limit of Rs. 21.63. Hatter (1983; 4.17%) and Zahid (1994; 4.56%) reported smaller

Table 1: Observed and predicted critical limits of cost of production per bird and its various cost components

| Variable | Observed | First derivative ($x'$) | Second derivative ($x''$) | Percentage contribution of predicted cost components to total predicted cost of production % |
|---|---|---|---|---|
| Feed cost (Rs.) | 302.23 (76.73%) | 343.41 | -0.0077187 | 79.31 |
| Labor charges (Rs.) | 19.90 (5.05%) | 22.97 | -0.74158 | 5.30 |
| Day-old chick cost (Rs.) | 19.75 (5.01%) | 21.63 | -5.391806 | 5.00 |
| Rent of building and equipments (Rs.) | 16.25 (4.13%) | 17.39 | -0.74158 | 4.02 |
| Vaccination cost (Rs.) | 12.80 (3.25%) | 9.08 | -0.74158 | 2.10 |
| Medicament cost (Rs.) | 10.90 (2.77%) | 7.80 | -0.434796 | 1.80 |
| Transportation charges (Rs.) | 1.90 (0.48%) | 3.32 | -17.173792 | 0.77 |
| Miscellaneous (Rs.) | 4.35 (1.10%) | 3.30 | -7.21068 | 0.76 |
| Bedding cost (Rs.) | 2.65 (0.67%) | 2.05 | -0.66717 | 0.47 |
| Electricity charges (Rs.) | 3.15 (0.80%) | 2.03 | -54.490844 | 0.46 |
| Total variable cost (Rs.) | 393.88 | 432.98 | -0.003348 | |

contribution of the cost of day-old chick to total cost of production than the present findings which is attributable to seasonal fluctuations in market price of day-old chicks.

**Rent of building and equipments:** A quadratic relationship was found between net profit (NP) per bird and rent of building and equipments (BR) as is shown in Equation V.

NP = -216.564691 + 17.035968BR - 0.370790 BR sq (V)

(t=-2.444) ** (t=1.804) * (t=-1.542)$^{NS}$

($R^2$ =0.0620; adjusted $R^2$ = 0.0349; F = 2.291).

($^{NS}$ = Non-significant; ***= Highly significant; *=Relatively significant)

$x'$ = Rs. 17.39; $x''$ = -0.74158

Taking the derivative ($x'$) of the first regression slope in the aforementioned equation, Rs. 17.39 was found to be the critical maximum limit of BR/bird as was confirmed by the negative sign of the second derivative. The findings therefore, suggested that any increase beyond this predicted limit would not be economical. The observed BR per bird (Rs. 16.25; Table 1) was lower than the predicted critical maximum limit of BR/bird (Rs. 17.39). Findings of the present study suggested that prevalent rent of buildings and equipment in the target area was within profitable range.

**Vaccination and Medication Cost:** Vaccination and medication cost also contribute a significant portion to the total cost of production. Immunization is extremely important for the prevention of diseases in poultry and the cost involved in highly productive. On the other hand, every effort is required to reduce the cost of medication through effective and efficient management, yielding the enterprise more economical. A quadratic relationship was found between net profit (NP) per bird and vaccination cost (VC) as shown in equation VI.

NP = -251.574697 + 65.492712VC - 3.605881 VC sq (VI)

(t=-0.691)$^{NS}$ (t=0.955)$^{NS}$ (t=-1.126)$^{NS}$

($R^2$ =0.0417; Adjusted $R^2$ =0.0235; F =2.287).

($^{NS}$ = Non-significant)

$x'$ = Rs. 9.08 ; $x''$ = -0.74158

As evident from the negative sign of the second derivative ($x''$), the first derivative ($x'$) of the equation VI indicated that critical maximum limit of vaccination cost per bird was Rs. 9.08. The observed cost per bird (Rs. 12.80; Table 1) was higher than the predicted critical maximum limit (Rs. 9.08). The higher cost could be due to higher emphasis on prevention, poor hygienic conditions and less efficient preventive strategies adapted by flock owners in the project area.

Medication cost (MC) had a quadratic relationship with net profit (NP) per bird as shown in equation VII.

P = 83.394918 - 3.391272MC - 0.217398MCsq (VII)

(t=2.142)$^{**}$ (t=-0.494)$^{NS}$ (t=-0.915)$^{NS}$

($R^2$ =0.2185; adjusted $R^2$ = 0.2036; F =14.677)

($^{NS}$ = Non-significant; ** = Relatively significant)
$x'$ = Rs. 7.80; $x''$ = -0.434796
As evident from the negative sign of the second derivative ($x''$), first derivative ($x'$) of the equation VII indicated that critical maximum limit of medication cost per bird was Rs. 7.80. The negative sign of second derivative suggested that increase beyond the maximum critical limit is not desirable. The observed medication cost per bird (Rs. 10.90; Table 1) was higher than the predicted critical maximum limit of Rs. 7.80, indicating poor management, lower standard of hygiene and other medication attributable to unnecessary prescription of a variety of medicines simultaneously by practitioners. Better management, efficient and effective preventive strategy, and appropriate prescription after exact diagnosis will assist in reducing therapeutic cost. Hatter (1983) reported a little higher whereas Zahid (1994) reported a lower medication cost than the present findings.

**Transportation cost :** In commercial egg operations, and primarily those on a larger scale, transportation expenses are born by suppliers, allowing feed and chicks to be delivered directly to the farm. The transportation cost thus, mainly includes marketing costs and expenditures for the flock owner to attend the market for purchase of medicines or other necessary goods. A quadratic relationship was found between transportation cost (TC) and net profit (NP) per bird as shown in equation VIII.

NP =108.398779 + 56.966056TC - 8.586896TCsq (VIII)
(t=3.424)***; (t=1.791)* ; (t=-1.239)$^{NS}$
($R^2$ = 0.0744; adjusted $R^2$ = 0.0567; F = 4.218).
($^{NS}$ = Non - significant; *** = Highly significant; ** = Relatively significant) ;
$x'$ = Rs. 3.32; $x''$ = -17.173792
First derivative ($x'$) of the equation VIII indicated that Rs. 3.32/bird was the maximum critical limit of transportation cost as was confirmed by the negative sign of the second derivative ($x''$=-17.173792). Predicted critical limit of transportation cost was higher than the observed transportation cost (Rs. 1.93) in the present study (Table 1), indicating that farmers were able to keep transportation cost as low as possible.

**Electricity charges:** A quadratic relationship was found between net profit (NP) and electricity charges (EC) as shown in equation IX.

NP = -320.091542 + 110.604069EC - 27.245422 E Csq (IX)
(t=-7.575) *** (t=2.508) * (t=-2.666)**
($R^2$ = 0.0691; adjusted $R^2$ = 0.0513; F = 3.894).
(*** = Highly significant; ** = Significant; * = Relatively significant)
$x'$ = Rs. 2.03 ; $x''$ = -54.490844
As evident from the negative sign of the second derivative ($x''$), the first derivative ($x'$) of the equation IX revealed Rs. 2.03/bird to be the maximal limit of electricity charges. Predicted critical limit of electricity charges was lower than that observed (Rs. 3.15) in the present study (Table 1). The findings indicated less efficient use of electricity, which could be avoided for better profitability.

**Bedding cost:** A quadratic relationship was found between net profit (NP) and bedding cost (BC) as shown in equation X.

NP = 327.272395+ 1.369557BC - 0.333585BCsq (X)
(t=-3.647) *** (t=0.110)$^{NS}$ (t=-0.785)$^{NS}$
($R^2$ = 0.2900; adjusted $R^2$ = 0.2765; F =21.449).
(*** = Highly significant; $^{NS}$ = Non-significant)
$x'$ = Rs. 2.05; $x''$ = -0.66717
As evident from the negative sign of the second derivative ($x''$), the first derivative ($x'$) of the equation X indicated Rs. 2.05/bird to be the maximum critical limit of bedding cost. Predicted limit of bedding cost was lower than the observed bedding cost (Rs. 2.65) in the present study. It should be effectively reduced to allow egg operation more profitable. Bedding cost could efficiently be reduced through proper handling of the bedding material, its purchase in bulk and resorting to cages rather than floor system rearing of layers.

**Miscellaneous expenditures:** A quadratic relationship was found between net profit (NP) per bird and miscellaneous expenditures (ME) as shown in equation XI.

NP = -442.539716 + 23.823609ME - 3.605340MEsq (XI)
(t=-16.704)*** (t=0.774)$^{NS}$ (t=-0.497)$^{NS}$

(*** = Highly significant; $^{NS}$ = Non-significant)
($R^2$ = 0.0247; adjusted $R^2$ = 0.0061; F =1.328).
$x'$ = Rs. 3.30; $x''$ = -7.21068

As evident from the negative sign of the second derivative ($x''$), first derivative ($x'$) of the equation XI indicated that Rs. 3.30 was the critical maximum limit of ME cost/bird. Predicted critical limit of ME was lower than the observed ME per bird (Rs. 4.35; Table 1), suggesting that farmers in the project area were spending a little higher on miscellaneous items than what was required.

**Conclusions and recommendations:** Maximum predicted critical limit for the total predicted cost of production per bird, cost of: feed, labor, day-old chick, building and equipments, vaccination, medicaments, transportation, miscellaneous items, bedding and electricity was Rs. 343.41, Rs. 22.97, Rs. 21.63, Rs. 17.39, Rs. 9.08, Rs. 7.80, Rs. 3.32, Rs. 3.30, Rs. 2.05, Rs. 2.03, respectively. Critical limits indicated for various cost components should be used as a guideline to adjust budget in commercial egg operation thereby, ensuring higher net profit per bird. In addition, a study should be planned to study production and economic implications of commercial egg production operation extended to variable egg laying periods and/or following molting procedure which was not in practice in the study area.

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