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Factors Affecting Profitability of Layer Hens Enterprises

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Abstract: Problem statement: Layer hen enterprises suffer from low profitability or losses in many of developing countries all over the world. Jordan is not an acceptance. **Approach:** This study aimed at investigating the influence of ten main factors affecting the profitability of layer hen producers. The investigated factors include price of purchased pullet, feed price, cost of labor, cost of veterinary service and medicine, building and machinery depreciation, repairs and maintenance and miscellaneous costs, length of production cycle, feed conversion ratio, mortality rate, egg sale price and laying percentage. **Results:** The study used a multiple regression profit model to estimate the effect of the above mentioned factors on profit per kg egg produced. The direction and quantity of relationship between profit per kg egg and variables affecting profit were investigated. Data from 40 operating and randomly selected egg production enterprises in the country was collected. Data was obtained directly from the producers during April to mid August 2010. Semi structured interviews were conducted with a pre-tested questionnaire. The data obtained via interview surveys were processed to calculate profit per kg egg and other relevant information for inclusion in a profit function model. Fifteen eggs are registered to be 1 kg in the study. Cost and income items used to calculate profit in the study. The results of the study revealed that the feed price was found to be the factor which has the highest negative impact on the profitability showing the coefficient-3.01. The egg sale price was with high positive impact on profitability showing the coefficient 2.633. **Conclusion/Recommendations:** From the results of the study it could be concluded that higher prices of purchased or breeding pullet, higher feed price, higher cost of labor, higher cost of veterinary service and medicine, higher other costs including building and machinery depreciation, repairs and maintenance and miscellaneous costs, higher feed quantity to be converted to eggs and higher mortality rate are associated with lower profitability of laying hen enterprises, while higher length of production cycle, higher egg sale price and higher laying percentage are associated with higher profitability. 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.

Key words: Egg production enterprises, layer, profitability, multiple regression model

INTRODUCTION

Poultry enterprises may vary from basic backyard poultry keeping to mechanized and automated production plants. The importance of the poultry industry is that it concentrates in providing employment not only to those engaged in production directly, but also for the hatchery operations, feed dealers, manufactures of incubators, building materials, processors of egg and poultry products and all dealers engaged in the marketing of egg and poultry from the time they leave the producer until they are in hands of consumers (Morly, 1982).

Augmenting the production of laying chickens is an important objective in helping to meet the nutritional needs of growing populations in developing countries. Commercial layer production is perhaps the most significant sources of quality protein and income as compared with other livestock production activities. Layer chickens are prolific, easy to rise and their output can be generally expanded more rapidly and easily than that of other livestock. Furthermore, they are adaptable to various climates and altitudes. Poultry rising can often be combined with other types of farming and offers the possibility to raise extra revenue for farmers. Egg production involves the use of good layer birds for the purpose of table egg production. The eggs are sold in off fresh to the public while the layers, which are no longer laying eggs well, are culled off from the farm. Poultry are good converter of feed to egg and meat

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within a short period of time. In the nutritive value, poultry egg rank second to cow milk. Apart from providing employment and a livelihood to thousands of people, it also provides a remarkably high quality nutritious food. The egg is a complete protein with excellent quality; one egg will give 6g of protein. Egg-white protein has a biological value of 100, the highest biological value of any single food protein (FAO, 2005).

Many investigated factors that affect the performance of laying hens and hence their profitability, have been studied. Ghasemi *et al*. (2010) investigated whether the supplementation of a diet with a mixture powder of garlic and thyme may assist in improving performance of laying hens and egg quality traits and the study concluded that dietary inclusion of garlic and thyme can have beneficial effects on performance of laying hens in terms of improving egg weight and yolk color. Effects of dietary inclusion of feed additives (Yeasturer, A-Max, Thepax, Fermacto and Biomin) on performance of laying hens on performance of laying hens were investigated by Zarei *et al*. (2011) and they recommended that probiotic Yesture and A-Max can be included in laying hens diets to improve EM. In addition, the commercial feed additives (Yeasturer, A-Max, Thepax, Fermacto and Biomin) used in this study had beneficial effects on egg shell quality characteristics in terms of shell weight and thickness and to decrease egg abnormalities due to poor shell, these feed additives could be recommendable. Ehsani and Torki (2010) evaluated effects of enzyme supplementation of GM-included diets on productive performance of laying hens, they concluded that including GM in laying hens' diets more than 3% may decrease productive performance. Supplementing cornsoybean or corn-soybean-GM diets by β-mannanase would have beneficial effects on performance of hens especially in terms of FCR and EP. Khajali *et al*. (2008) evaluated the physiological response and postmolt performance of laying hens subjected to non-feed removal molting programs and they indicated that hens subjected to CFR went out of production by Day 5 while those on corn or wheat diets with or without salt ceased egg production from Day 7 to Day 13. Nevertheless, postmolt egg production did not significantly differed among the treatments. Body weight loss in feed-deprived hens during molt was significantly ($p<0.05$) greater than non-feed removal treatments when measured on Day 7 and Day 12.

Analysis has been made with econometric models and techniques in the determination of factors affecting profits in commercial egg production. Econometric models, such as the one used in this study, have been utilized as decision support for progressive planning of the enterprises in livestock sector. Quantitative models have been utilized as decision support tools in poultry production since the 1960s. Oğuz *et al*. (2004), Tijani *et al*. (2006) and Yusuf and Malomo (2007), have established profit function models and determined the marginal impact factor of the independent variable. Profit functions have been utilized as selection criteria in dairy cattle breeding (Dartt *et al*., 1999, Stott and Delorenzo, 1988 and Johan and Arendonk, 1991) and in broiler production systems (Dekkers *et al*., 1995 and Pribylova *et al*., 1996). Many Cobb-Douglas and quadratic type production models have been used to determine marginal effects of the corn and soybean on body weight gain in broilers. Productivity analysis and determination of return of scale in broiler production after estimating Cobb-Douglas type production function has been investigated by Sakarya (1990). Regression model as a quantitative model to determine factors affecting profits of broiler enterprises has been used by Cevger and Yalcin, 2002). Profit function is used with the aim of selection in dairy (Andrus and McGillard, 1975; Gill and Allaire, 1976; Stott and Delorenzo, 1988), commercial layer and breeding layer enterprises (Pribylova *et al*., 1996).

Costs of production are one of the most important factors that affect layer enterprises. Commercial egg production enterprise can be made more profitable if critical standard limits for cost of production are determined and given close attention. Variability in cost components is mainly attributable to management conditions (Farooq *et al*., 2001a), size of the operation (Ames and Ngemba, 1986; Kumar and Mahalati, 1998, mortality Manes, 1991) management conditions and feed efficiency (Elwardany *et al*., 1998).

Eggs are the major business outputs in commercial table egg production and the higher the egg production the better will be the profit. Farooq *et al* (2001b) found positive association of egg production with net profit and reported major contribution of eggs in total returns.

Egg production is a dependent variable and in Jordan it is influenced by several factors. Some of these factors were investigated in this study. The main objective of this study was to examine the profitability of layers production in Jordan. To achieve the goal of the study factors affecting layers production were investigated. A profit function model to estimate factors affecting profit per kg egg in laying period was formulated. The established model was evaluated whether it could be used as a practical decision support tool in the field by the producers as well as by the decision makers.

Egg production cycle: Birds usually start to lay at around five months (20 - 21 weeks) of age and continue to lay for 12 months (52 weeks) on average, laying fewer eggs as they near the moulting period. As described by the typical production cycle lasts about 17

months (72 weeks) and involves three distinct phases, as follows:

Phase 1: Small chicks or brooders. This phase lasts from 0 to 2 months (0-8 weeks) during which time small chicks are kept in facilities (brooder houses) separate from laying birds.

Phase 2: Growers. This phase lasts about 3 months, from the ninth to the twentieth week of age. Growers may be either housed separately from small chicks or continue to be reared in brooder-cum-grower houses. Between their seventeenth and twentieth week of age growers reproductive organs develop.

Phase 3: Layers. Growers are transferred from the grower house to the layer house when they are 18 weeks old to prepare for the laying cycle. Birds typically lay for a twelve-month period starting when they are about 21 weeks old and lasting until they are about 72 weeks old.

Figures 1 and 2 show percentage of productive laying flock and number of eggs produced over a period of egg production cycle.

Factors affecting egg production: In Jordan as well as in other countries many factors influence egg production during the egg production cycle. To provide maximum output and profitability the cycle must be managed effectively and efficiently through controlling most of these factors. Hunton (1995) and Kekeocha (1984) stated the following factors to be considered in this manner:

Breed: The breed of the laying bird influences egg production. Management and feeding practices, however, are the key determining features for egg production.

Mortality rate: Mortality rate may rise due to disease, predation or high temperature. The mortality rate of small chicks (up to eight weeks of age) is about 4 percent; that of growers (between eight and 20 weeks of age) is about 15 percent; and that of layers (between 20 and 72 weeks of age) is about 12 percent. The average mortality rate of a flock is from 20 to 25 percent per year.

Age: Birds typically begin producing eggs in their twentieth or twenty-first weeks and continue for slightly over a year. This is the best laying period and eggs tend to increase in size until the end of the egg production cycle.

Body weight: In general, optimum body weight during the laying period should be around 1.5 kg, although this varies according to breed. Underweight as well as overweight birds lay eggs at a lower rate.

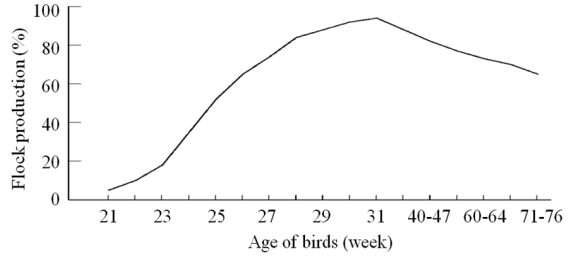

Fig. 1: Percentage of productive laying flock over a period of egg production cycle (Source: FAO, 1961).

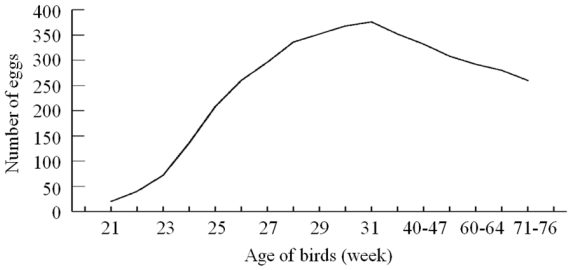

Fig. 2: Number of eggs produced over a period of egg production cycle (Source: FAO, 1961)

Proper management and the correct amount of feed are necessary in order to achieve optimum body weight.

Laying house: The laying house should be built according to local climatic conditions and the farmer's finances. A good house protects laying birds from theft, predation, direct sunlight, rain, excessive wind, heat and cold, as well as sudden changes in temperature and excessive dust. If the climate is hot and humid, for example, the use of an open house construction will enable ventilation. The inside of the house should be arranged so that it requires minimum labor and time to care for the birds.

Lighting schedule: Egg production is stimulated by daylight; therefore, as the days grow longer production increases. In open houses, found commonly in the tropics, artificial lighting may be used to increase the laying period. When darkness falls artificial lighting can be introduced for two to three h, which may increase egg production by 20 to 30 percent. In closed houses, where layers are not exposed to natural light, the length of the artificial day should be increased either in one step or in a number of steps until the artificial day reaches 16-17 h, which will ensure constant and maximized egg production. Effective day length should never decrease during the laying period.

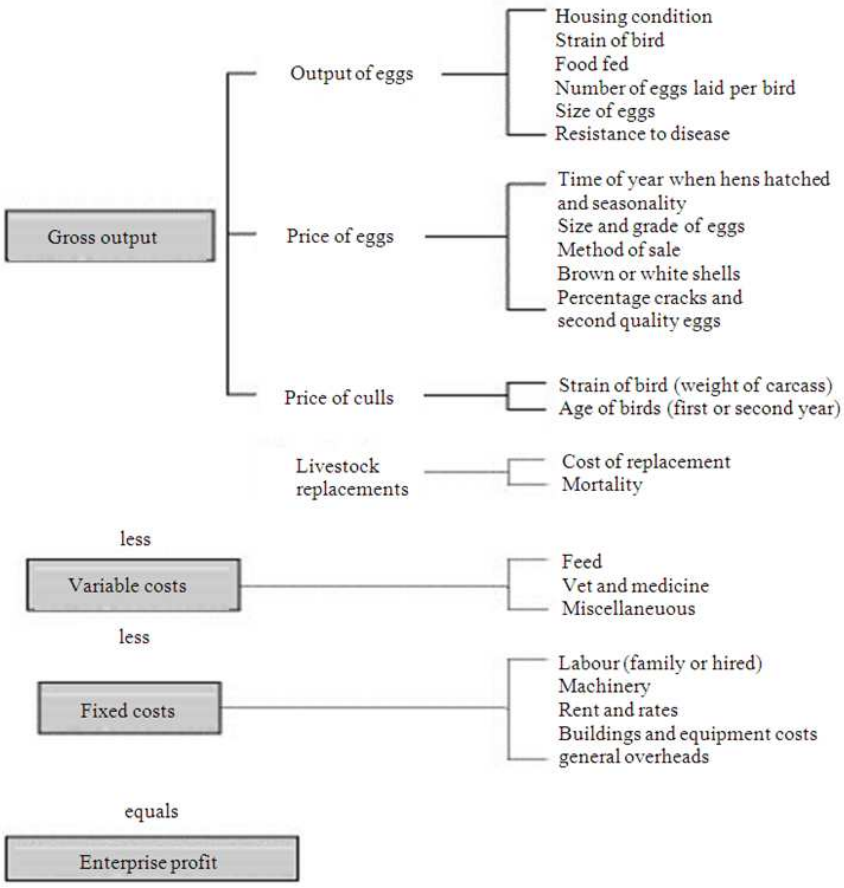

Fig. 3: Gross output and factors affecting the profitability of a layer enterprise**Source: Draft Farm Management Training Manual, AGSF, Rome, 2002.

Feed: Free-range hens will produce more meat and eggs with supplemental feed, but only if they are improved breeds or crossbreeds. The selection of local hens is done on the basis of resistance and other criteria rather than feed utilization for production.

Culling: Culling is the removal of undesirable (sick and/or unproductive) birds, from the flock. There are two methods of culling: mass culling, when the entire flock is removed and replaced at the end of the laying cycle; and selective culling, when the farmer removes individual unproductive or sick birds. Culling enables a high level of egg production to be maintained, prevents feed waste on unproductive birds and may avert the spreading of diseases.

Climate: The optimal laying temperature is between 11° and 26° C. A humidity level above 75 percent will cause a reduction in egg laying.

Management factors: Effective and efficient management techniques are necessary to increase the productivity of the birds and consequently increase income. This entails not only proper housing and feeding, but also careful rearing and good treatment of the birds.

Vaccination and disease control: Diseases and parasites can cause losses in egg production. Some of the diseases are as follows: bacterial: tuberculosis, fowl typhoid. Viral: Newcastle, fowl plague. Fungal: aspergillosis. Protozoan: coccidiosis. Nutritional: rickets, perosis. Some of the parasites are: external: lice, mites and internal: roundworms, tapeworms.

Collection of eggs: Frequent egg collection will prevent hens from brooding eggs or trying to eat them and will also prevent the eggs from becoming damaged or dirty.

The gross output and the previously mentioned factors and their related sub-factors which have a direct effect on egg production enterprises could be fully understood using Fig. 3.

Table 1: Total number of poultry farms in Jordan according to type (2005-2010)

Year	Layer	Broiler	Parent Stocks	Hatcheries
2005	293	2202	117	41
2006	263	2039	114	41
2007	262	1940	114	45
2008	277	1887	117	42
2009	283	1866	105	44
2010	208	1909	87	46

Source: Ministry of Agriculture Annual Report, 2010

Poultry industry in Jordan: The poultry sector in Jordan is considered one of the most productive sectors in the field of agriculture. It is estimated that the value of investments in this sector approach JD 500 million and these represent more than 55% of the volume of investments. The estimated value of production of this sector is about JD 180 million in 2005, representing 55.6% of the total production of the livestock sector (most reliable poultry industry analysis conducted in year 2005). In addition to the direct contribution of the poultry sector in form of value added, the Jordanian poultry sub-sector contributes to the national economy through enhancing investment in related activities. The expansion of poultry production has led to the creation of many feed processing houses (17 in 2005) to produce the ready, concentrated feed. In addition, 7 processing houses have been established to convert poultry slaughtering by-products. The production of these firms amounted to 250 thousand tons, used as organic fertilizers in crop production and for animal feed. There is also investment in poultry slaughtering houses, processing, preparing and packaging. These investments create job opportunities and contribute to the national economy (MOA, 2009).

However, poultry production in Jordan faces many problems and obstacles such as:

- Competition between local produce and high-quality, subsidized European imported products
- Technical and health problems that increase the mortality rate in poultry farms to about 20% compared to 10% in developed countries
- Inadequate number of laboratories and diagnosis centers for poultry diseases with specialized veterinarians
- High production cost due to increased cost of imported feed, which is the main component of production inputs

The commercial poultry industry has undergone a rapid development in recent years as a result of many factors including:

- A shortage in the supply of competitive products (red meat)
- High prices of competitive products compared to the production cost of poultry
- Low level of capital investment required by poultry enterprises compared to other agricultural projects
- Good profits and a quick turnover of capital
- The growing role of companies specialized in importing production inputs and selling them to small farmers
- The role of the government, including access to agricultural credit, extension, health services, rules and production/distribution of multi-purpose chicks during the early seventies
- Favorable climate for low cost poultry production

As a result of this rapid development, poultry production in Jordan achieved a high level of self-sufficiency; however in the early eighties, the market started to suffer from a surplus of poultry products, particularly broiler meat and table eggs. Since Jordanian poultry products were not able to compete in export markets, the government was forced to implement production control programs in order to harmonize local production levels with domestic consumption. By taking advantage of such programs, producers were able to harvest a good profit during the eighties. However, these programs had also negative impacts on the whole sector as poultry farms felt no imperative to keep up with technical developments in the sector.

In order to qualify as a member of the WTO, Jordan applied a restructuring program to the agricultural sector in the nineties. Horizontal and vertical expansion in poultry projects took place and the number and capacity of poultry farms doubled within a period of five years. On becoming a member of the WTO in 2000, Jordanian poultry producers were faced with new challenges. The severe competition of good quality imported poultry products at low prices forced producers to upgrade their farms; new high-tech farms were established and an integrated production system was adopted by the large companies. Table 1 shows the total number of poultry farms in Jordan according to type (2005-2010).

Layer industry in Jordan: In Jordan, layer hen enterprise is one of the most important agricultural enterprises among livestock sector. It has become a rapidly developing enterprise among the other sectors of poultry production. Production value of 293 working layer farms in the country estimated to be 65,795,610 Jordan Dinars or JDs* (DOS, 2009). This value include 43,921,410 JDs from table eggs, 82600 JDs from Layer Organic fertilizer and 21,791,600 JDs from related industrial activities (1 JD = 1.4 US$).

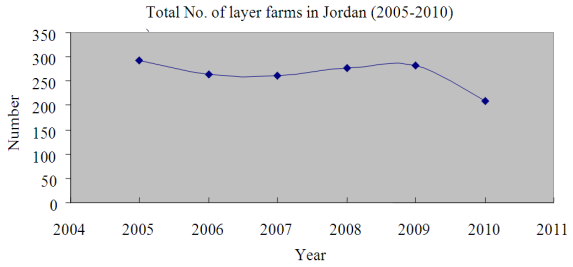

Fig 4: Trend of layer farms in Jordan Since 2005

Table 2: Total number and capacity of layer farms in Jordan (2005 – 2010)

Year	Number of farms	Capacity (1000)
2005	293	7580
2006	263	7600
2007	262	6745
2008	277	6720
2009	283	7600
2010	208	5830

Source: Ministry of Agriculture Annual Report, 2010

As shown in Table 2, the total number of layer farms in Jordan was 208 in the year 2010 with a capacity of 5,829,000 birds. The total number of table eggs produced by these farms was 934,000,000 in the same year from which 136,700,000 eggs were exported. Fig. 4 shows that the total number of layer farms in Jordan is nearly stable with an average of 275 farms from 2005-2009, but in the year 2010 it decreased to 208 farms. The decrease in number in the year 2010 may be attributed to the losses of the producers. Of the total number of parent stocks of layer birds on Jordanian farms, the Haysesex breed comprises 40% of the total, followed by Babkok (32.7%). The remaining are Lohman and Haylayan breeds with a percentages of 18.7% and 10.7% respectively.

MATERIALS AND METHODS

The aim of this study was to use the profit function model to estimate factors affecting profit per kg egg in laying period. To achieve the objective of the study, data from 40 operating and randomly selected egg production enterprises was collected. Data regarding a whole production period were obtained directly from the producers during April to mid August 2010. Semi structured interviews were conducted with a pre-tested questionnaire. Entrepreneurs themselves were involved in providing data so the reliability and accuracy of data were encouraging. The data obtained via interview surveys were processed to calculate profit per kg egg and other relevant information for inclusion in a profit function model. 15 eggs are registered to be 1 kg in the study. Table 3 shows the items of costs and income calculated to obtain profits.

Table 3; Cost and income items used to calculate profit in the study:

I. Costs	II. Income	III. Profit
Rearing	Sale of eggs	
Houses	Sale of culled birds	
Equipment	Sale of manure	
Feed	…….	
Labor	……..…	
Vaccinations	…….	
Marketing costs	…….	
Various expenses	……	……
Total costs	Total income	II – I

Before carrying out the multiple regression analysis the relationships between the dependent variable Y and each explanatory variable were examined by drawing scatter graphs for linear, quadratic and cubic forms. The relationships between Y and all explanatory variables were observed to be linear.

The regression equation was estimated by applying a stepwise regression procedure in the SPSS Statistical Package, version 12. In the stepwise procedure, independent variables are included in the equation respectively starting from a variable having the highest correlation with a dependent variable and the ones that are deemed to be statistically insignificant at $p < 0.05$ are automatically dropped from the equation. Thus, the best model explaining the dependent variable can be without a need of trial and error of several models. Only their linear terms were, therefore, included in the model. The multiple regression models were used to estimate the direction and quantity of relationship between profit per kg egg and variables affecting profit. The constructed regression model is:

$$Y = f (X1, X2, X3, X4, X5, X6, X7, X8, X9, X10)$$

Where:

Y: Profit (JDs /kg eggs)
X1: Price of purchased or breeding pullet (JDs /hen)
X2: Feed price (JDs /kg)
X3: Cost of labor (TL/per kg eggs)
X4: Cost of veterinary service and medicine (JDs /per kg eggs)
X5: Other costs including building and machinery depreciation, repairs and maintenance and miscellaneous costs (JDs /per kg eggs)
X6: Length of production cycle (day)
X7: Feed conversion ratio - FCR (kg feed consumed per kg eggs)
X8: Mortality rate (%)
X9: Egg sale price (JDs /kg)
X10: Laying percentage (%)

RESULTS

The model was estimated with stepwise regression method. The relevant statistical tests are shown in Table 4.

Table 4: The estimated regression model:

Variables	β Value	T value	Sig.t	R^2	F value	Sig.f
Constant	0.684	17.53	0.000	0.931	2258.992	0.000
X1	- 0.048	- 37.58	0.000			
X2	- 3.012	- 77.55	0.000			
X3	- 0.962	- 17.63	0.000			
X4	- 0.899	- 5.020	0.000			
X5	- 1.042	- 18.04	0.000			
X6	0.008	15.87	0.000			
X7	- 0.501	- 51.06	0.000			
X8	- 0.347	- 1.975	0.000			
X9	2.633	64.97	0.000			
X10	1.299	14.19	0.000			

The R^2 of the model was 93% which means that the independent variables included in the model explains 93% of the variation occurring. The beta (β) values depicted in Table 4 are the estimated coefficient values. Each coefficient demonstrates what the percentage of change will be in the dependent variable (Y) against each one unit change on the independent variable (X).

The model could be written as follows:

$$Y = 0.684 - 0.048\ X_1 - 3.012\ X_2 - 0.962\ X_3 - 0.899\ X_4 - 1.042\ X_5 + 0.008\ X_6 - 0.501\ X_7 - 0.347\ X_8 + 2.633\ X_9 + 1.299\ X_{10}$$

DISCUSSION

As Table 4 shows, the effect of all independent variables on Y has been found to be statistically important ($p < 0.001$ and $p < 0.05$). The results revealed that a rise in one JD in price of purchased or breeding pullet (X1) and feed price/ per kg (X2) will cause a decrease on the profit per kg egg as 0.048 and 3.012 JDs in percentage points. The rises in X3 (labor cost), X4 (veterinary-medicine expenditures) and X5 (other costs) will lead to decrease on profit per kg egg as 0.963; 0.899 and 1.042 JDs respectively. An increase of 1 kg in feed conversion ratio (X7) will lead to decrease on profit/per kg eggs as 0.501 JDs and 1 % increase in mortality rate (X8) will also lead to decrease per kg egg profit as 0.347 JDs. A 1 JDs increase in egg sale price (X9) will lead to increase in Y as 2.633 JDs. While 1 % increase in the laying percentage (X10) will lead to increase in Y as 1.299 JDs., lengthening the production period (X6) for one more day had a limited positive effect on Y (0.008 JDs).

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.

CONCLUSION

The profitability of layer farming depends on several factors. The most important factors were investigated in this study. These include; Price of purchased or breeding pullet (JDs /hen), Feed price (JDs /kg), Cost of labor (JDs/per kg eggs), Cost of veterinary service and medicine (JDs /per kg eggs), Other costs including building and machinery depreciation, repairs and maintenance and miscellaneous costs (JDs /per kg eggs), Length of production cycle (day), Feed conversion ratio - FCR (kg feed consumed per kg eggs), Mortality rate (%), Egg sale price (JDs /kg), Laying percentage (%).

The feed price was found to be the factor which has the highest negative impact on the profitability showing the coefficient - 3.01. This indicates how important the use of good quality feed is in a profitable production. The effect of feed price has a great impact on profitability because feed price was varying according the brand, purchased amount, the distance between the farm and the market and the dealer. The egg sale price was with high positive impact on profitability showing the coefficient 2.633. The remaining investigated factors vary in their impact on profitability. Generally speaking higher prices of purchased or breeding pullet, higher feed price, higher cost of labor, higher cost of veterinary service and medicine, higher other costs including building and machinery depreciation, repairs and maintenance and miscellaneous costs, higher feed quantity to be converted to eggs and higher mortality rate are associated with lower profitability of laying hen enterprises, while higher length of production cycle, higher egg sale price and higher laying percentage are with higher profitability.

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