Financial stochastic model to measure minimum rearing capacity laying hen farms

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Abstract. Big and medium scale of laying hen farms face up with higher odor pollution risk than the smaller, but more efficient opportunity of cost efficiency. Besides of scale and environment problem, laying hens farm must deal with egg and feed price fluctuation, labor cost, mortality and productivity. The research directed to: (i) analyze technical aspects of small scale farmers, (ii) analyze farmers financial performance, (iii) simulate performance in six scales of farms by introducing uncertain (probabilistic) factors: rearing capacity, egg and feed price, and capability to produce eggs. Research method was observation by in laying hens farms in Banyumas and Cilacap Regency with 37 respondents, rearing capacity from 100 to 1,500 hens. Data were analyze descriptively, financial cross tabulation data and statistical simulation Montecarlo. Laying hens farm which the cage above pond have higher profit. Rearing scale below 500 hens tend to have loss. Labor and feed efficiency can be achieved at 1,500 hens rearing scale. Financial simulation results minimum productivity level to avoid negative impact of egg and feed price fluctuation as well as mortality was 70% or above. Laying hens rearing on land was more vulnerable to negative impact of odor pollution than above on fish pond.

1. Introduction
Laying hen farms in rural areas rear from 100 hens up to 1,500 hens; the cage located in backyard or paddy field near community settlement. One major problem faced by laying hen farms is odor pollution. Odor pollution negatively impact capability to produce eggs [1]. The odor pollution usually emerge in the third year operations and onwards. To avoid odor negative impact some of the farmers build hens cage above the fish pond, while farming above land periodically clean the bottom of the cage. Nevertheless periodic clean up the bottom of the cage cannot eliminate odor problem. Cage construction above the pond needs the land which has good water availability and appropriate steep land contour. There is only a few of hen farmer has land with those conditions. Alternatively farmers should rent a suitable land with higher price.

Another laying hen farms problems are come from economics aspect such as: egg price, labor cost, mortality, feed price. Economics combined with odor problem will make managing hen laying farms is more complicated. Egg price always fluctuate, in February 2015 egg price down to IDR 16.000/kg and gradually increase to IDR 21.000/kg in July 2015. Feed components such as corn, concentrate feed and bran are increase annually, those must be manage properly because it has great impact to increase feed cost. Seasonally egg price increase before Idul Fitri and Idul Adha feast, Christmas and New Year and declining thereafter. Feed (concentrate, corn and bran) are also fluctuate and likely to increase.
Concentrate feed annually increase 5-7%, corn price in drought season 2015 (November – February) has increase dramatically up from IDR 2.900,-/kg to IDR 6.000,0 /kg. Fortunatelly it has decrease to IDR 3.000/kg in April 2015 and beyond. Corn price contribute 50% of feed cost. Feed cost has very significant contribution to total cost because its accumulate 76% of poultry egg farms total cost [1].

By using deterministic financial analysis found that small farms laying hens (500 hen/period) has net profit IDR 450.000/month on average [2]. Those profit include farmer labor as cost (IDR 40.000,-/day), if it is exclude the profit become IDR 1.650.000,-/month. That is a high profit for rural income, but in fact less than one fifth small farms could expand their business [2]. Alleged the errors calculation is profit count only on average, ignore some probabilistic factors such as: egg price fluctuation, feed price, hens mortality, inconsistent hens capability to produce eggs and increasing of operating expenses. In case of probabilistic condition it would be better when use simulation method. One of the common simulation method used is Montecarlo. In the method, probabilistic situation encountered in the key success factors could be represent by random number in accordance with certain probability prior to.

The research aimed to: (i) analyze technical aspects of small scale egg farmers activity, (ii) analyze laying hen farmers financial performance, (iii) simulate hens laying farm performance by introduce uncertain (probabilistic) factors : hens rearing capacity, egg price, feed price, hens capability to produce eggs.

2. Methods

2.1. Sampling method

Research method is observation, data collected by surveying small poultry egg farms in Banyumas and Cilacap Regency using structured questionnaire. Number poultry egg farms sample was 43 with rearing capacity each farmers range between 100–1,500 hens. Samples were divided into 6 category of scales, that were 100, 200, 350, 500, 1,000 and 1,500 hens.

2.2. Conceptual framework

Stochastic financial measures was carried out by attaching probabilities of occurrence to the possible values of the key variables in each financial variables by generating the probability distribution of possible outcomes [3]. The probabilities used to the personal or subjective probabilities based on experience, intuition and/or any other available information. Uncertain outcome from external sources can be specified in the form of a subjective probability distribution [4]. It is corresponding directly to their personal degrees of belief in the occurrence of the possible outcomes [5]. If a person believe there are n possible outcomes, denoted O1, O2,..., On to a specified decision, he or she can attach a subjective probability of occurrence is P(Oi) to each outcome i, for i = 1, 2,..., n.

2.3. Data analysis

Data analysis using: descriptive method, cross tabulation, deterministic financial, and financial simulation (cost, revenue, profit, profit probability). Financial simulation using Montecarlo method, package program using Excel. Profit equation simulation model is:

\[
\pi_{\text{sim}} = (X1_{\text{sim}} \times X2_{\text{sim}} \times X3_{\text{sim}}) - (X4_{\text{sim}} \times X5_{\text{sim}} + X6) \quad \ldots \ldots \quad (1)
\]

Note :

- \(X1_{\text{sim}}\) : number of hens life (head), simulated
- \(X2_{\text{sim}}\) : hens capability to produce egg across its life period (%), simulated
- \(X3_{\text{sim}}\) : egg price (IDR per kilogram), simulated
- Variable \((X1_{\text{sim}} \times X2_{\text{sim}} \times X3_{\text{sim}})\) : egg sale revenue ( IDR), simulated
- \(X4\) : number of feed (kg), not simulated
- \(X5_{\text{sim}}\) : feed price IDR, simulated
- \((X4 \times X5_{\text{sim}})\) : Feed cost (IDR)
- \(X6\) : fixed cost (IDR) not simulated
Simulation was done by generating the random number using syntax `RAND()` in Excel, number of simulation iteration 1,127 times.

3. Results and discussions

3.1. Rearing capacity
Rearing capacity in small intensive laying hens farms range between 100 hens per-period up to 1,500 hens per-period. Small farms which has a good financial performance will expand their farm capacity. Not of all hens reared are alive, average range of hens alive on each rearing capacity and the probability on each can be seen in Table 1. Higher rearing capacity tend to have higher liveability.

| Rearing Capacity (Hens) | Hens Alive | Livability (%) |
|-------------------------|------------|----------------|
| 100                     | 85 - 90    | 60 - 75        |
| 200                     | 180 - 190  | 60 - 75        |
| 350                     | 310 - 340  | 60 - 75        |
| 500                     | 480 - 490  | 60 - 75        |
| 1,000                   | 960 - 980  | 63 - 77        |
| 1,500                   | 1,440 - 1,470 | 70 - 80   |

3.2. Housing and cage
Most of housing are made of bamboo and wood material, asbestos roof, roof tile or tin roof. Housing dimension are 4–4.5 m wide; 20–21 m long, or could be longer depend on land condition. Height of hens floor housing between 1.2–1.5 m from land. Housing floor made of bamboo, base floor are compacted land. Hens are put on three level bamboo cage box, each box consist of 2–3 hens. In order to avoid odor pollution and diversified activity the cage build in above of pond. The cage construction need land with a good water irrigation, otherwise it will produce a great odor pollution as well. The land with good irrigation have higher productivity and so land rent is higher than usual, that is IDR 10 million per-year compare with 6 million per-year for usual paddy land. Recently the land is more difficult for rent. The infrastructure can be use for 6 years (three ime production cycle). Cost construction included in fixed cost, not simulated.

3.3. Feeding
Recommended hens feed consist of: feed concentrate, milled corn and bran, composition are 2 : 3 : 1. All of the sample has known the important of good quality feed so they are try hard to do so. Research result of Diarra and Tabuaciri [6] recommended that in high environment temperature nutrient sufficiency and water management must be done accurately to alleviate hens negative impact. Feed price are fluctuate depend on the feed price component, so cost of feed are simulated. In the table 2 below seen that on small rearing capacity feed price tend to be higher than in high rearing. This is due to economic order quantity. Range of mixed feed price on each rearing capacity is presented in Table 2.

| Rearing Cap (Hens) | Feed Price Range (IDR/kg) | Probability of Feed Price (%) |
|--------------------|---------------------------|------------------------------|
| 100-350            | 6.250 – 6.750             | 60 - 40                      |
| 500 and 750        | 6.000 - 6.500             | 60 - 40                      |
| 1,000              | 5.750 - 6.250             | 55 - 45                      |
| 1,500              | 5.300 - 6.000             | 40 - 80                      |
3.4. Pullet
Most of pullet strains are ISA Brown and Lohman. Those strains have bigger egg (16-17 eggs/kg), higher productivity (potentially could be up to 85%), and longer laying period (80–84 weeks). Maoba [7] reported that intensive small scale layer farm (587 hens) in South Africa is a profitable business. Average hens day productive (ISA Brown) in Africa is 85%, higher than in this research result, this is due to more suitable temperature in those region.

3.5. Biosecurity
Biosecurity activities done by farmers are: hens vaccination, addition of vitamin, collect dirt and cleaning cages before reuse. Lestari et al. [8] said that actually biosecurity contains 9 activities but most of small farms observed only adopt partial of those activities. In large scale farms, health chicken service usually done by DOC company include in buying term [8]. The service is more effective than by self or by government worker service. Cost of hens health maintenance are include in fixed cost, not simulated.

3.6. Hens capability to produce eggs (hens day productivity)
Hens capability to produce eggs on specified productive period was calculated as ratio between number egg produce across hens life and total hens reared (%). Research result seen that average productions were between 65-80%. There is relationship between scale of hens maintained and level of productivity [1]. Most of small farm scale (1,000 birds and below) have low productivity (65-75%). Higher rearing capacity (1,500 hens and more) have 70-80% productivity.

3.7. Egg marketing and price
Eggs selling is easy, when number of egg sale is small (below 50 kg per day) selling is in local market (local shop). Higher egg selling is in regional market such as in Purwokerto city or another surrounding city. Egg price are fluctuate seasonally, egg price up happen before Idhul Fitri and Idul Adha, Christmas and New Year and declining thereafter. In February 2015 egg price decline to IDR 16,000 and up to IDR 21,000 in July 2015. Egg price fluctuation probability is between 40-60%.

3.8. Family workers
Most of small laying hen farm operated and managed by using family workers. One worker could manage up to 1,500 hens in one cage. To calculate economic and financial analysis worker family treated as a hired labor by using their opportunity cost. Maximum labor wage per day is IDR 90,000,- to manage 1,500 hens. Minimum wage is IDR 45,000 for a half day.

3.9. Simulation variables
Simulation done based on four stochastic variables: level of hens productivity, rearing capacity, number of hens alive, feed price, egg price and one deterministic variable: fixed cost. Hens productivity has two values: on land and above pond. Each of simulation variable has lowest, average and highest value.

| Simulation Variables | Lowest Value | Average | Highest Value |
|---------------------|--------------|---------|---------------|
| Feed price (IDR/kg) | 5,000        | 5,142   | 5,500         |
| Mortality (%)       | 2            | 5       | 10            |
| Egg price (IDR/kg)  | 19,000       | 20,500  | 21,000        |
| Hens productivity on land (%) | 70 | 75 | 78 |
| Hens prodvt above pond (%) | 75 | 80 | 85 |

Source : Data Analysis, 2018

In Table 3, each variables has their value, especially for hens productivity seen that overall the value is higher on above pond. Cage above pond has positive impact on minimum odor pollution. Cages with high odor pollution will reduce the ability of hens to produce eggs [9, 10].
3.10. Profit (loss) simulation result
Simulation was done in six level rearing scales (100 to 1,500 hens). Result on each of scale has categorize of: average profit (loss) farm cage on land, average (loss) farm cage above pond, highest profit simulation result cage on land, highest profit simulation result cage above pond, highest loss simulation result cage on land and highest profit simulation result cage above pond. Table 4 shows deterministically average profit of cage on land is still negative up to 500 hens rearing scale, on the other hand average profit in cage above pond is positive when rearing scale is 350 and more. The result of highest loss and profit simulation are seen good result of farm cage above pond than on land.

Table 4. Simulation result of profit (loss) in every rearing scale cage on land and above pond

| Hens Rearing Scale (bird) | Deterministic Average Loss of Cage on Land (IDR) | Deterministic Average Loss of Cage Above Pond (IDR) | Highest Loss Simulation Result of Cage on Land (IDR) | Highest Simulation Result of Cage Above Pond (IDR) |
|---------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| 100                       | (688,366)                                     | (434,644)                                     | (650,000)                                     | 50,000 (1)                                   |
| 200                       | (652,738)                                     | (139,540)                                     | (812,500)                                     | 625,000                                      |
| 350                       | 380,632                                       | 384,000                                       | (384,000)                                     | 1,100,000                                    |
| 500                       | 361,716                                       | 497,475                                       | (750,000)                                     | 3,125,000                                    |
| 1,000                     | 1,781,311                                     | 2,371,764                                     | (750,000)                                     | 6,500,000                                    |
| 1,500                     | 4,552,787                                     | 6,767,402                                     | 1,125,000                                     | 9,750,000                                    |

3.11. Profit probability simulation result
Profit probability simulation result on each hens rearing scale is presented in Table 5. Overall profit probability is higher in cage above pond than cage on land. Higher rearing scale tend to have higher profit probability.

Table 5. Profit probability simulation result

| Rearing Scale (birds) | Profit Probability of Cage on land (%) | Profit Probability of Cage above pond (%) |
|-----------------------|----------------------------------------|------------------------------------------|
| 100                   | 0                                      | 0                                        |
| 200                   | 0.60                                   | 28                                       |
| 350                   | 2.70                                   | 35.60                                    |
| 500                   | 52.70                                  | 97.10                                    |
| 1,000                 | 78.40                                  | 98.80                                    |
| 1,500                 | 97.80                                  | 98.50                                    |

4. Conclusion
Laying hens farm which the cage above pond have higher profit. Rearing scale below 500 hens tend to have loss. Labor and feed efficiency can be achieved in 1,500 hens rearing scale. Financial simulation result minimum productivity level to avoid negative impact of egg price and feed price fluctuation and also mortality was 70% or above. Laying hens rearing on land more vulnerable to negative impact of odor pollution than cage above on fish pond.

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