Inventory Data on Commercial Broiler Chicken Production System using Life Cycle Assessment Approach: A Case Study

S A Suffian¹, A A Sidek¹, H M Yusof¹, M H F Al-Hazza¹
¹Department of Manufacturing and Materials Engineering, International Islamic University Malaysia (IIUM), Jalan Gombak, 53100 Kuala Lumpur, Malaysia.

Email: syakiraaffiqah93@gmail.com

Abstract. An inventory analysis of the life cycle of broiler chicken production from cradle-to-gate perspective was carried out with the aim to identify possible input and output parameters involved in the system. To do so, broiler chicken production in Myra Chicken Farm and Services was investigated in detail. Result shows the inventory data on feed consumption, transportation, physical performance parameter and other utilities that affect the product which is broilers. Broilers production in fact shows escalation year by year because of high demand from consumer. A cradle-to-gate assessment was conducted based on ISO 14040/14044 guidelines. Inventory data was gathered from farmers and available literature. Improving all the input and output system will increase the level of productivity and the cost of the production. Thus, at the end of the research, it will able to make industry player to understand and take into consideration the solutions in order to promote a green broiler chicken production.

1. Introduction

Broiler meat is a primary protein source for the majority of Malaysian populations [1]. Chicken production systems can be classified into two groups according to the farming scheme [2]: free range chicken, which is reared outdoors with a purely vegetable diet and broiler (or conventional) chicken, which is reared on farms with industrial feed as the base diet [3]. The overall production of broiler has expanded steadily, in line with the growth in local demand and could be exported to some countries [1]. The development of broiler industry in Malaysia is supported by good production technology.

One of the most widely accepted international methods of quantifying inventory analysis of food products is Life Cycle Assessment (LCA) [4]. Life Cycle Assessment (LCA) is a standardized and holllistic methodology that allows the identification of the environmental consequences of the life cycle of the product [5]. By using LCA framework, life cycle inventories must be defined in order to quantify the environmental impact of the food product.

In LCA studies, it is important to consider real data to obtain representative and relevant results. Life cycle inventory (LCI) or inventory analysis is a data collection stage. At this stage, input and output data will be collected. Inputs are anything that enter the system and help to produce the product during their processing stages such as any energy, water and raw materials. On the other hand, outputs are anything that release from the system or processing stages such as waste. This phase summarize the processes, input and output of the product.

2. Research Methodology
The broiler chicken farm was assessed and inventoried in detail to gather representative data. In this study, life cycle inventory (LCI) data for the subsystem was collected through interviews and visit to the broiler chicken farm. All data recorded are valid for all four chicken coops that consist of 106,000 broiler chicks. In order to get the data accurately, information was gathered from all workers to see if there is any uncertainty in data collection. Functional unit, 3kg of broiler chicken meat ready to be distributed to the point of sale, was chosen because a) it is the amount of raw chicken that contains recommended daily protein supply for an average family (four people). b) it is the average weight of a broiler chicken (excluding packaging) available for consumption in Malaysian markets.

![Figure 1. Steps in collecting data on inventory analysis of cradle-to-gate for broiler chicken production system [7].](image)

Figure 1 shows steps in collecting data on inventory analysis of cradle-to-gate for broiler chicken production system. Inventory analysis consists of detail measurement of input and output parameters that enters and exits the system boundaries.

3. Results and Discussion
In LCA studies, it is important to consider real data in order to obtain representative and relevant environmental results. In this study, life cycle inventory (LCI) data was collected. The broiler chicken farm was assessed and inventoried in detail to gather the information. Information concerning all feed intake, transportation related, physical performance of the chicken and utilities were provided by Myra Chicken Farm and Services.
Table 1. Inventory data of the chicken farm per functional unit.

| Type of Input          | Measurement/Unit | Types of Output | Measurement/unit |
|------------------------|------------------|-----------------|------------------|
| Feed Intake:           |                  | Solid waste:    |                  |
| Pre-starter            | 325g             | Municipal solid waste | 1.10g           |
| Starter                | 807g             |                 |                  |
| Grower                 | 2.4kg            |                 |                  |
| Transportation related:|                  | Air Emission:   |                  |
| Distance               | 20588km          | NH₃             | 21.5g            |
| Amount of inputs       | 106 000 chicks   | CO              | 15.7g            |
| Type of transport      | lorry            | CO₂ fossils     | 92.6mg           |
| Physical Performance   |                  | Water Emission: |                  |
| parameter:             |                  | NO₃             | 5.31g            |
| Number of birds        | 106 000 chicks   | PO₄             | 0.12g            |
| Start weight           | 100g             |                 |                  |
| Finish weight          | 2.5-3kg          |                 |                  |
| Feed intake per bird   | 3.5kg/bird       |                 |                  |
| Feed conversion ratio  | 1.78             |                 |                  |
| Mortality rate         | 3.6              |                 |                  |
| Utilities:             |                  |                 |                  |
| Electricity use        | 0.02kWh          |                 |                  |
| Amount of water for drinking | 0.1m³  |                |                  |
| Amount of bedding used  | 0.3kg           |                 |                  |

Table 1 shows the inventory data for all broilers in the case study farm. In order to obtain the inventory data per functional unit, all data must be divided by the amount of broilers in the broiler farm. Output data was obtained from available literature from previous researcher.

3.1 Feed Intake
Throughout the growth period, chicken are fed for 35 days with a ratio of 85g of feed per day per chicken. The feed is mainly composed of maize, wheat, soybean cake, soybean oil, monocalcium phosphate, protein concentrate and fats.

Table 2. Total weight of feed consumed by the broilers throughout one cycle.

| Type of feed | No. of bags | Total weight (1000kg) |
|--------------|-------------|-----------------------|
| Starter      | 689         | 34.45 kg              |
| Starter crumble | 1711      | 85.55 kg              |
| Grower pellet | 5023       | 251.15kg              |
| Total        |             | 371.15 kg             |

3.2 Transportation
Transport activities required to provide inputs to the production line were also taken into account. From the data obtained, carbon footprint of fuel can be calculated.

Table 3. Total distance and number of trips for transportation involved in the system.

| Vehicle         | No. of trip | Distance                        | Total distance (km) |
|-----------------|-------------|---------------------------------|---------------------|
| Lorry (feed)    | 13          | Kalumpang - Port Klang (106 km) | 1378                |
| Lorry (waste)   | 6           | Kalumpang - Cameron Highland (140km) | 840                |
| Lorry (broiler in) | 10        | Kalumpang - Desaru, Johor (479 km) | 4790               |
| Lorry (broiler out) | 97         | Kalumpang - Cameron Highland (140 km) | 13580              |
| Total           |             |                                 | 20588               |
Distance travel per unit of fuel used in km per liter (km/l) = 9.67 km/l (2)
Total liter usage = 20588 liter x 9.67 km/liter = 199085.96 liter

3.3 Electricity use
Electricity is one of the major input that affect the performance of the broiler chicken and contribute the most to the carbon footprint. Equipment involved are lamp, pump and fan.

**Table 4. Inventory data of the chicken farm per all broilers.**

| Equipment          | No. of equipment | Consumption per day | Day per batch | Total consumption per equipment |
|--------------------|-------------------|---------------------|---------------|---------------------------------|
| Lamp               | 124               | 0.207kWh            | 33            | 847.044 kWh                     |
| Pump (water)       | 2                 | 7.2kWh              | 33            | 475.2 kWh                       |
| Pump (feed)        | 3                 | 0.27kWh             | 33            | 26.73 kWh                       |
| Fan (ventilation)  | -                 | -                   | -             | 805 kWh                         |
| **Total**          |                   |                     |               | **2153.97 kWh**                 |

The total consumption for equipment considering the number of equipment used for each farm. For lamp, there are 124 bulbs, 2 water pump and 3 feeding pump. The total amount of electricity consumption for one batch of broiler production is:

\[ 2153.97 \text{ kWh} \times 4 = 8,615,160 \approx 8.61 \text{ Wh} \]

4. Conclusion
The result of the study shows inventory data for broiler chicken production system in Myra Chicken farm and Services. From the analysis, input and output parameters are identified successfully. Thus, further research on environmental impact assessment can be done.

**Acknowledgement**
Ministry of Higher Education (MOHE) through Fundamental Research Grant Scheme (FRGS) financially supported this work, to which the author are grateful. Special thanks also goes to respected broiler chicken farm, all interviewed broiler chicken workers and other participants who helped to carry out every activity.

**References**
[1] Syauqi M et al 2015 *Broiler Industry in Malaysia*
[2] Bengtsson J and Seddon J 2013 *Journal of Cleaner Production* **41** 291-300
[3] Castellini C et al 2006 *J Agriculture Ecosystem Environment* **114** 343-350
[4] Prorosh R 2009 A Review of *Life Cycle Assessment (LCA) on some food products*
[5] ISO 14040:2006, ISO 14040:2006 2017-Environmental management--Life cycle assessment: Principle and Framework
[6] Sara G et al 2014 *Journal of Cleaner Production* **74** 125-134
[7] EuLa. *Environmental Impact Assessment (LCA) Life Cycle Analysis*