



Research article

Assessment of environment impacts of egg production chain using life cycle assessment



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ABSTRACT

In this study we have to deal with the assessment of environment impacts of laying hen in the Alborz province, Iran. This assessment was carried out for one kg of egg during a period of 420 days for 1000 chickens. Then due to significant consumption of diet during period of question, three main products including corn, soybean and wheat which are consist of 80 percent of the combination of laying chicken diet, also collected the information about their production and it has been evaluated the indicators of their environment individually and eventually, the results has been considered as a title for inputs of poultry. Data for production of inputs were taken from EcoInvent 2.0 database, and SimaPro software was used for analysis. Ten classification impacts including Abiotic Depletion potential, Acidification potential, Eutrophication potential, Global Warming potential for time horizon 100 years, Ozone Depletion potential, Human Toxicity potential, Freshwater and Marine Aquatic Eco-toxicity potential, Terrestrial Eco-toxicity potential, and Photochemical Oxidation potential were selected based on the CML 2 baseline 2000 V2/world, 1990/characterization method. Due to the results, for each kilograms of egg, 30/09 MJ and also the value of greenhouse gas emissions is 4/07 Kg CO₂ eq was calculated. According to the obtained results, the production of diet has made the most negative charge of environment among the inputs.

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1. Introduction

Today, increasing the humans population and the activity caused by different industrial fields, transportation, agriculture and etc, lead to increasing the concentration of green houses to excess value in the atmosphere which is lead to greenhouse impacts and incidence climate change such as global warming and the destruction of ozone layer (Vitousek et al., 1997). If climate change trends continue, the people of the world will face with significant changes such as melting of polar ice, rising the water of sea level, changes in type of atmospheric precipitation, extreme storms, decreasing in value of agriculture production by frostbite, hail, freezing, drought, flood, erosion, flooding in agriculture lands, changes of seasons precipitation and also destruction of biological, plant and animal diversity (Peters and Darling, 1985). So increasing of earth temperature has different impacts and implication in different perspective (Mitchell, 2003).

In recent years, attention to environmental problem has been

increased. By increasing the knowledge of environment, different part of economic has been busy on evaluating of environmental impacts of their own activities (Nemecek et al., 2008). Agriculture is one of the important parts of economic which has a lot of impacts on environment (Hongmin et al., 2008). During the 20th century, the agricultural products has increased dramatically which the increasing of mechanization, improving the production method, extensive use of fertilizer and pesticide and advances in animal husbandry has helped a lot to increasing the production. But increasing the production and extensive use of inputs lead to kind of environmental problem (Brenttrup et al., 2004a).

Greenhouse gases has different heating impacts on world climate because the molecular weight and the ability to retain the heat and their life is different in atmosphere (EPA, 2009). The GWP idea which is developed by the Intergovernmental Panel on Climate Change (IPCC), is compared the ability of each greenhouse gas in trapping the heat in atmosphere relative to some reference gases (Holden and Høyer, 2005). GWP is considered as the indicator for measuring the value of particle of greenhouse gases which is effective in global warming. This is a relative scale which calculated in a certain time distance (IPCC, 2006). CO₂ is a reference gas with

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GWP value by 1. The GWP values for methane and nitrogen oxide are 21 and 310 respectively in a period of 100 years (Lo et al., 2005). Table 1, is indicative of GWP value of some pollutant. Gases emission is reported on GWP weight equivalent of CO₂. Methane and nitrogen oxide usually are reported equivalent of carbon dioxide and using of weight indicators. The equivalent of carbon dioxide is carbon dioxide emission value which in the specific time period as an emission value from one greenhouse gas with long life lead to value to global warming. The equivalent of carbon dioxide is obtained by multiply the emission of one greenhouse gas in GWP value (Change, 2006) (see Table 2).

The greenhouse gases are the gases which is trapping the heat in atmosphere. Greenhouse gases usually are water vapor, CO₂, CH₄, N₂O, O₃ (Mitchell, 1989). The water vapor of major gas is the climate control but the emission of water vapor from the fossil fuel forms the very low proportion of global evaporation in world (about 0.0013 percent) (Delucchi, 2003). Natural processes constantly spread or removed the CO₂ gases, CH₄ and N₂O from atmosphere but the humans activity can reduce or increase greenhouse gases in atmosphere and changes the world average (Houghton, 2009). Ozone won't spread direct but as the result, the chemical reactions which are including carbon monoxide (CO), nitrogen oxides (NO_x) and hydrocarbons (HC) is produced (EPA, 2009).

Poultry industry is in the order of the largest and most developed of existing industries in the agriculture sector and by increasing the population, increasing the income level and people welfare and as the result increasing the demand for protein products, extension and development of poultry industry seams necessary (Etches, 1998). The activities of breeding the laying hen is very important, because the main product and the final production of these category of poultry is the edible egg which has a significant share as an important protein and nutritious product in supplying a part of animal protein which is in the society required (Barbut, 2001).

According to research conducted in the United States, 4.6 percent of greenhouse gas emissions in the agricultural industry, which is approximately 37 percent owned by the production of beef, 5.11% for maintenance and milk production of dairy cows, 4.4% maintenance and production of pork and poultry was 0.06 percent. The amount of greenhouse gas emissions for poultry production appears low compared to other livestock industry, In this way, The life cycle and supply chain of poultry production as a source of greenhouse gas emissions are negligible appointed, But understanding how and at what stages in poultry production is the largest amount of greenhouse gas emissions is important.

Agriculture and Animal Husbandry Industry must devise and management of resources and environmental impact, improve performance in key areas such as water use, energy consumption

Table 2
Different input value to produce egg.

Inputs	Unit	For 1000 chicken during 420 days
Land	m ²	1025.54
Labor	H	1279.23
Fuel		
Diesel	L	1038.78
Natural gas	m ³	671.25
Sour gas (Electricity)	kWh	1218.26
Poultry feed	Kg	45,595.2
Water consumption	L	88,200

and environmental pollution.

The researchers used the method of LCA to assess the environmental impact of crop production and horticulture and the milk production in Iran have done research, But in the production of eggs, this research has been done the first time.

According to Decker and collaborate on research with non-cage hens organic conducted in the Netherlands in 2008, Greenhouse gas emissions to produce 1 kg of organic eggs 4 kg equivalent CO₂ was determined that emissions of oxides of nitrogen (N₂O) with a share of 77 percent, Carbon dioxide (CO₂) 21 percent and methane (CH₄) 3 percent was estimated that production of poultry feed is the most important factor in the release of the index, also the two main factors in energy consumption were feed production (62 percent) and transportation (33%).

Cederberg et al., 2009 in Sweden surveyed on identifying environmental maintenance egg production systems and multiple production (38% of the cage, the cage 56 percent no and 6% organically). Laying hens in the poultry kept for 72 weeks and according to reports, around 300 eggs per hen were produced. Global warming emissions to produce 1 kg of eggs were calculated 4/1 kg equivalent of CO₂, that share of each gas N₂O, CO₂ and CH₄ respectively 56 percent, 39 percent and 4 percent, with 85 percent of the emissions related has been producing chicken feed (Cederberg et al., 2009).

Wiedemann and McGahan study carried out on Environmental Impact Assessment one kg of egg production chain using LCA in 2011. Greenhouse gas emissions was declared 3.1 kg eq CO₂ for cage system and 1.6 kg eq CO₂ for without cage, that preparation of feed for laying hens will have the greatest impact on emissions. The amount of energy to produce 1 kg of eggs in cage systems and without cage was calculated respectively 7.10 and 1.3 Mj, that preparation of feed has the highest energy consumption (Wiedemann and McGahan, 2011).

Fantin et al., (2012) also has evaluate the environmental impacts on 1 kg of milk which the acidity potential of 9.9×10^{-3} kg SO₂ equivalent, global warming potential of 1.5 kg CO₂ equivalent and

Table 1
GWP value and the life of some emission gases to environment.

Species	Chemical formula	Lifetime in atmosphere (years)	Global warming potential (100-year)
Carbon dioxide	CO ₂	Variable	1
Methane	CH ₄	12.3	21
Nitrous oxide	N ₂ O	120	310
HFC-23	CHF ₃	264	12,000
HFC-32	CH ₂ F ₂	5.6	550
HFC-41	CH ₃ F	3.7	97
HFC-43-10mee	C ₂ H ₂ F ₁₀	17.1	1500
HFC-125	C ₂ HF ₅	32.6	3400
HFC-134	C ₂ H ₂ F ₄	10.6	1100
Chloroform	CHCl ₃	0.51	4
Methylene chloride	CH ₂ Cl ₂	0.46	9
Sulfur hexafluoride	SF ₆	3200	23,900
Perfluorohexane	C ₆ F ₁₄	3200	9000

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