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Carbon emission from energy use in Thai native chicken production in Nakhon Ratchasima province, Thailand

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The chicken production usually has impacts on the environment such as soil, water and air quality. The purposes of this research were to evaluate total carbon emission and to compare carbon emission between traditional and manufactural rairing systems in Thai native chicken production in Nakhon Ratchasima province during January to June 2015. Survey and questionnaire were made and data were collected at 400 farms in districts of study area. The results showed that the highest total carbon emission was from transportation of animal feed to farms at 10.062±4.832 kg.C/kg. Thai native chicken/day followed by from transportation of chicken to slaughterhouses and from chicken incubation at 0.467±0.460 and 0.0003±0.0004 kg.C/kg.Thai native chicken/day. For raising systems, the traditional system emitted higher carbon (11.777±4.252 kg.C/kg.Thai native chicken/day) than the manufactural system (7.720±4.954 kg.C/kg.Thai native chicken/day). It can be concluded that most of carbon emission in energy use was from the transportation of both chicken feed and of chicken to slaughterhouses and small farm also emitted higher carbon than large farm ($P \leq 0.05$).

Keywords: Carbon emission, energy use, Thai native chicken, Nakhon Ratchasima province

Introduction

A part of global warming problem is caused by livestock production which is a source of carbondioxide (CO_2), nitrogen oxides (NO_x) and methane (CH_4) that are released to the atmosphere (Thanee *et al.*, 2008). These greenhouse gases (GHG) cause the greenhouse effect which negatively affect the Earth's environment. Livestock farming contributes about 18% of world GHG emission, accounting for 9% of CO_2, 37-50% of CH_4 and 20-70% of

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nitrous oxide (N_2O) (OECD, 2000; IPCC, 2001; FAO, 2006; IPCC, 2007). The Intergovernmental Panel on Climate Change (IPCC, 1995) in England in 1995 concluded that global climate change has been mainly caused by GHG which most of them had been released from human activities. The Panel predicted that in 2100 the sea level will be raised up about 3 feet higher than the present level and the environment will be changed. Our world will face the serious environmental problems such as the decling of forests, the distribution and increase of pathogens, pollution, heat wave, drought, flood and storm. The IPCC (2007) suggested that GHG emission must be reduced considerably from their present levels in order to avoid climate change of a magnitude that will have serious negative consequences for the world communities (IPCC, 2007; Stern, 2006).

The demand for livestock products; largely meat, milk and eggs, is increasing globally. As a result, the world's livestock sector is also growing. Livestock production is growing faster than any other agricultural sub-sector and it is predicted that by 2020, livestock will produce more than half of the total global agricultural output in value terms (Delgado *et al*., 1999; Upton, 2004). Livestock production in Thailand has been increased considerably especially chicken and ducks for their meat and eggs. Thai native chicken are one of preferred poultry for consumers and producers. However, data on carbon mass flow, carbon emission and carbon footprint in Thai native chicken production are still scanty (Vichairattanatragul, 2014).

Thus, the objectives of this research were to investigate total carbon emission from the use of energy and to compare carbon emission between traditional and manufactural raising systems in Thai native chicken production in Nakhon Ratchasima province, Thailand.

Materials and methods

Study area

Nakhon Ratchasima or "Khorat" is the largest province, situates in the northeastern plateau in Thailand and has an area of around 20,494 square kilometres (7,913 sq mi). Nakhon Ratchasima province was selected as study area where many Thai native chickens have been raised based on the data of Nakhon Ratchasima provincial Livestock Office (2013). The selected districts of Nakhon Ratchasima province were Mueang Nakhon Ratchasima, Kham Thale So, Sung Noen and Pak Thong Chai. The study areas are shown in Figure 1 and Figure 2.

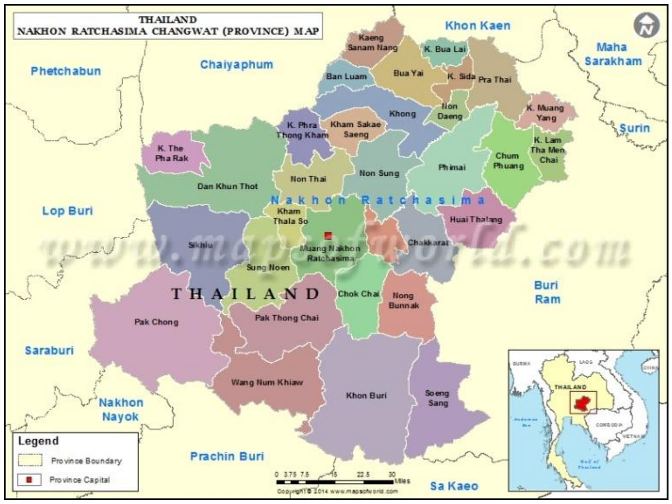

Figure 1. The map of Nakhon Ratchasima province (*Source: :http://www.mapsofworld. com/thailand/provinces/nakhonratchasima-map.html*)

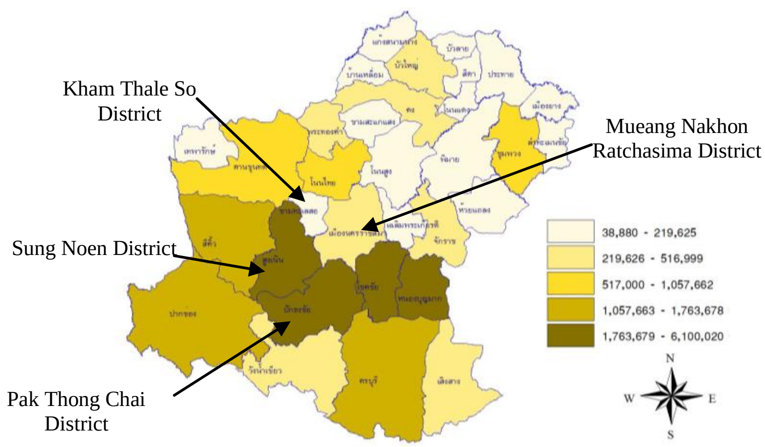

Figure 2. Districts in Nakhon Ratchasima showing numbers of chicken production *(Source: http://pvlo-nak.dld.go.th/data/zone/zone57/chic57.jpg)*

Site sampling and analytical methods

The numbers of farms and Thai native chicken in each district of selected provinces were calculated by Taro Yamane's formula (Yamane, 1973) as follow:

$$n = \frac{N}{1+Ne^2} \quad (1)$$

Where: n = Sample size, N = Population size, e = The error of sampling

The calculation showed that sample sizes were 400 Thai native chicken farms and 400 Thai native chickens. All selected farm were divided into two groups; traditional raising system and manufactural raising system, depended on the number and the raising system of Thai native chicken production. The traditional system raised under 100 chickens per a farm while the manufactural had higher number of chicken (Personal communication). Statistical analyses were performed using SPSS versions 18; significance was based on $P \leq 0.05$ between traditional and manufactural systems.

Results and Discussions

The total carbon emission from energy use

The survey, questionnaires and analyses of farms and slaughterhouses for energy use in chicken production in Nakhon Ratchasima province found that Thai native chicken farms had used much energy for raising chicken per kilogramme livestock animal per day (kg.C/kg.Thai native chicken/day). The total carbon emission (C-emission) from energy use of Thai native chicken production was 10.529±4.834 kg.C/kg.Thai native chicken/day. Most energy was used for transportation of animal feed to farms and of Thai native chicken to slaughterhouses, and using electricity for incubation of small chicken and farm management. The results of each C-emission from the energy usage showed that C-emission form transportation of animal feed was the highest at 10.062±4.832 kg.C/kg.Thai native chicken/day followed by transportation of chicken to slaughterhouses and the energy used for incubation of small chicken at 0.467±0.460 and 0.0003±0.0004 kg.C/kg.Thai native chicken/day, respectively. The content and proportion of C-emission from the use of energy in Thai native chicken production in Nakhon Ratchasima province are shown in Table 1 and Figure 3

Table 1. The carbon emission from Thai native chicken production from farm management

Parameter	Thai native chicken (kg.C/kg.Thai native chicken/day)
Energy used of animal feed transportation	10.062±4.832
Energy used of animal transportation	0.467±0.460
Energy used of electricity	0.0003±0.0004

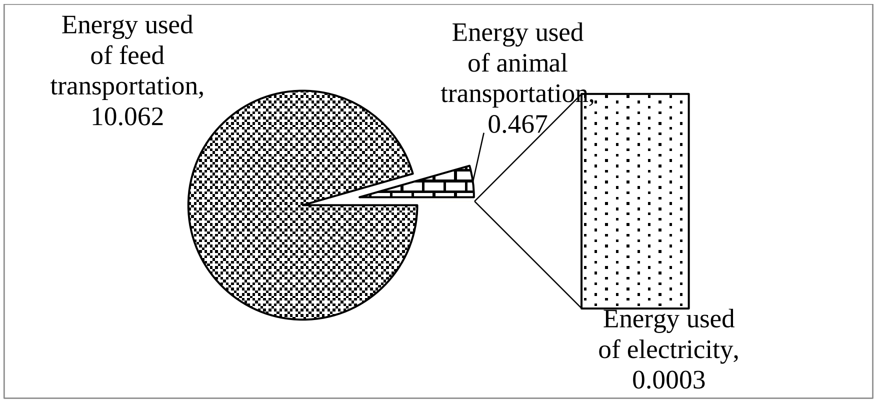

Figure 3. The proportion of carbon emission from Thai native chicken production in NaKhon Ratchasima province

The total carbon emission and carbon emission from transportation

In Thai native chicken production, total C-emission and C-emission from transportation of chicken feed to farms were 10.529±4.834 and 10.062±4.832 kg.C/kg.Thai native chicken/day, respectively. The relationship between these two sources of emission is shown in Figure 4. The result found that total C-emission positively correlated with C-emission from transportation of chicken feed to farms ($P \leq 0.05$). The regression equation is also shown as follow:

$$Y = 0.9951 (x) – 0.4147 \qquad (R^2 = 0.991)$$

Where: - Y = Total C-emission of Thai native chicken
- x = C-emission from transportation of chicken feed

Table 2. The C-emission of Thai native chicken production between traditional raising system and manufactural raising system

Model	C-emission (kg.C/kg.Thai native chicken/day)
Traditional raising system	11.777± 4.252
Manufactural raising system	7.720± 4.954

Table 3. Carbon emission scenarios from Thai native chicken production models follow the Payoff Matrix Principle

Alternative of model	Scenarios of C-emission (kg.C/kg.Thai native chicken/day)	
	C-emission from fuel	C-emission from electricity
Traditional raising system	11.150	0.00040
Manufactural raising system	7.614	0.00012

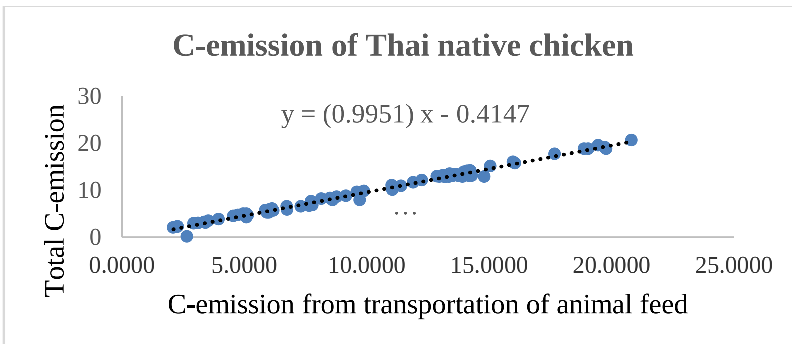

Figure 4. The relationship between total C-emissionfrom energy use of Thai native chicken and C-emission from transportation of chicken feed at a confidence level of 95%.

The result coincide with the findings of Keeratiurai and Thanee (2000) who reported that carbon emission of layer chicken farms in Nakhon Ratchasima province was 36.65 x 10^{-3} kg.C/living weight/day. Keeratiurai and Thanee (2013) also found that carbon emission from broiler chicken production and young layer chicken production was 11.11 x 10^{-3} and 8.3 x 10^{-3} kg.C/living weight/day. They also discussed that most carbon emission is from the transportation of animal feed, transportation of animals to the markets and slaughterhouses. However, Poritosh *et al*. (2013) showed that carbon emission of chicken meat production in Japan was 18.45 kg.C/living weight/day. It is clear that most of livestock production, especially in South East Asia, emit the most carbon into the atmosphere.

The C-emission from Thai native chicken between traditional and manufactural raising systems

There were two raising systems in Thai native chicken in selected districts of Nakhon Ratchasima province. They were traditional and manufactural raising systems. In comparison of both systems, the result revealed that traditional raising system emitted higher carbon (11.777±4.252 kg.C/kg.Thai native chicken/day) than manufactural raising system (7.720± 4.954 kg.C/kg.Thai native chicken/day). There was significantly different ($P \leq 0.05$) between these two raising systems. The result is illustrated in Figure 5 and the regression formula is as follow:

$$Y = 0.9949\,(x) - 3.7684 \qquad (R^2 = 0.813)$$

Where: - Y = C-emission of traditional raising system
- x = C-emission of manufactural raising system

Table 4. Carbon emission scenarios for Thai native chicken production from the application of the Laplace's Rule

Alternative of model	(C-emission from fuel + C-emission from electricity)
Traditional raising system*	(11.150+0.00040)/2 = 5.575
Manufactural raising system	(7.614+0.00012)/2= 3.807

Remark: *Selected livestock create maximum environmental problem

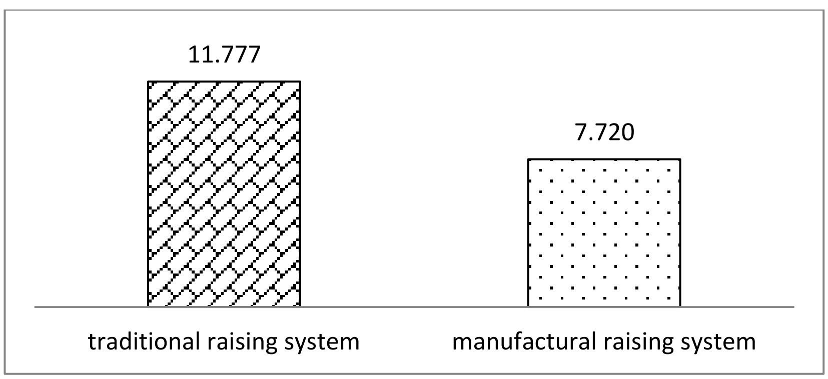

Figure 5. The comparison of C-emission between traditional raising system and manufactural raising system

This result can be concluded that in Thai native chicken production, the traditional raising system which had low number of chicken (lower than 100 chicken) emitted higher carbon than the manufactural raising system (higher than 100 chicken). This finding agree with the reports of Keeratiurai and Thanee (2010, 2013) and Keeratiurai *et al*. (2013) who found that most carbon in egg production, broiler meat production and layer farming in Nakhon

Ratchasima province is from the use of energy for transportation of animal feed and transportation of animals to slaughterhouses. Moreover, smaller farms emit higher carbon because small farms normally use the same amount of oil, gas or petrol as big farms but the number of animals carried are fewer. Pelletier and Tyedmers (2007) and Tantipanatip (2014) also reported that most carbon emission from aquatic products and seafood in Indonesia and Thailand come from transportation especially in small farms. So the guidelines to reduce carbon emission from the use of energy for transportation of animal feed and transportation of animals to slaughterhouses should be considered and reduced.

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References

Delgado, C., Rosegrant, M., Steinfeld, H., Ehui, S. and Courbois, C. (1999). Livestock to 2020: The next food revolution. Food, Agriculture and Environment Discussion Paper 28. Washington DC: International Food Policy Research Institute.

Food and Agricultural Organization (FAO) (2006). World Agriculture: Towards 2030/2050. Food and Agriculture Organization of the United Nations, Rome. 7e.pdf.

Intergovernmental Panel on Climate Change (IPCC) (1995). Climate Change 1995, the Science of Climate Change. Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Syndicate of the University of Cambridge, Cambridge, U.K. p. 572.

Intergovernmental Panel on Climate Change (IPCC) (2001). The Scientific Basis is the most comprehensive and up-to-date scientific assessment of past, present and future climate change. Available online at: http://www.ipcc.ch/ipccreports/tar/wg1/pdf/WG1_TAR-FRONT.PDF.

Intergovernmental Panel on Climate Change (IPCC) (2007). Climate change-greenhouse gas emission. Available online at: http//www.epa.gov/climatechange/emission/usinven-toryreport.html.

Keeratiurai, P. and Thanee, N. (2010). Carbon massflow and greenhouse gases emissions from egg production using life cycle assessment in Nakhon Ratchasima Province, Thailand. The 3rd Technology and Innovation for Sustainable Development International Conference, Nong Khai, Thailand.

Keeratiurai, P. and Thanee, N. (2013). Comparison of carbon equivalent emissions under uncertainty of energy using for industries of pig and broiler meat production. Science Series Data Report 5(5): 55-65.

Keeratiurai, P., Thanee, N. and Vichairattanatragul (2013). Assessment of the carbon massflow from the layer farming with life cycle inventory. ARPN Journal of Agricultural and Biological Science 8(9): 673-682.

Nakhonratchasima Provincial Livestock Office. (2013). Available online at: http://pvlo-nak.dld.go.th/data/zone/zone57/chic57.jpg. Accessed date: October 2015.
Organisation for Economic Co-operation and Development [OECD]. (2000). Environmental indicators for agriculture methods and results. Executive Summary. Paris, France. 53p.
Poritosh, R.P., Orikasab, T., Thammawonga, M., Nakamuraa, N., Xua, O. and Shiinaa, T. (2013). Life cycle of meats: An opportunity to abate the greenhouse gas emission from meat industry in Japan. Journal of Environmental Management 93: 218-224.
Pelletier, N.L. and Tyedmer, P.H. (2007). Feeding farmed salmon: Is organic better?. Aquaculture. 272: 399-416.
Steinfeld, H., Wassenaar, T. and Jutzi, S. (2006). Livestock production systems in developing countries: Status, drivers, trends. Revue Scientifique et Technique de l` Office International des Epizooties 25(2): 505-516.
Stern, N. (2006). The economics of climate change. Cambridge: Cambridge University Press. 712p.
Sullivan, W.G., Wicks, E.M. and Luxhoj, J.T. (2003). Engineering Economy. 12th ed. New Jersey: Pearson Education.
Tantipanatip, W. (2014). Carbon massflow of Pacific white shrimp, giant freshwater prawn and giant perch meat production from fishery farm to devrlop carbon footprints in Trang, Songkhla and Phatthalung provinces, Thailand. Ph.D. thesis. School of Biology, Institute of scicence, Suranaree University of Technology, Nakhon Ratchasima, Thailand.
Thanee, N., Dankitikul, W. and Keeratiurai, P. (2008). Comparison of carbon emission factors from ox and buffalo farms and slaughterhouses in meat production. In: Proceeding of the International Conference on Energy Security and Climate Change: Issues, Strategies, and Option; August 6-8, 2008; Sofitel Centara Grand, Bangkok, Thailand, pp. 52-53.
Thanee, N., Dankitikul, W. and Keeratiurai, P. (2009a). The study of carbon massflow in ox, buffalo, and pig meat production from farms and slaughterhouses in Thailand. Thai Environmental Engineering 23(2): 37-51.
Thanee, N., Dankitikul, W. and Keeratiurai, P. (2009b). Comparison of carbon emitted from ox, buffalo, pig, and chicken farms and slaughterhouses in meat production. Suranaree Journal of Science and Technology 16(2): 79-90.
TGO. (2011). Common data of carbon footprint analyzes. Available online at: http://conference.tgo.or.th/download/tgo_or_th/publication/CFP_Guideline_TH_Edition 3.pdf.
Upton, M. (2004). The role of livestock in economic development and poverty reduction. Food and Agriculture Organization: Pro-Poor Livestock Policy Initiative. PPLPI Working Paper No. 10.
Vichairattanatragul, P. (2014). Carbon massflow of swine, goat, three breed-cross native chicken, puking duck and laying duck productions for carbon footprints development in Nakhon Ratchasima. Prachin Buri and Chon Buri provinces, Thailand. Ph.D. thesis. School of Biology, Institute of scicence, Suranaree University of Technology, Nakhon Ratchasima, Thailand.
Wattanachan, S., Benjakul, S. and Ledward, D.A. (2004). Composition, color, and texture of Thai indigenous and broiler chicken muscles. Poultry Science 83:123–128.
Yamane, T. (1973). Mathematics for Economists: An Elementary Survey. 2nd Ed. Prentice-Hall, New Delhi, India. p.714.