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Comparison on Energy Use in Thai Native Chicken and Nile Tilapia Productions in Nakhon Ratchasima Province, Thailand

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Thai native chicken and Nile tilapia productions usually have 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 Thai native chicken and Nile tilapia productions in Nakhon Ratchasima province, Thailand during January to June 2016. Survey and questionnaires were made and data were collected at 400 farms in districts of study area. The results showed that the highest carbon emission was from transportation of animal feed to farms (11.062±4.832 kg.C/kg.Thai native chicken/day and 6.520±4.954 kg.C/kg. Nile tilapia/day). The energy use for transportation of Thai native chicken to slaughterhouse was 0.767±0.460 kg.C/kg.Thai native chicken/day and of Nile tilapia to markets was 0.427±0.360 kg.C/kg. Nile tilapia/day. In addition, the energy uses for incubation of Thai native chicken and of Nile were 0.0003±0.0004 kg.C/kg.Thai native chicken/day and 0.0001±0.0003 kg.C/kg. Nile tilapia/day, respectively. Thai native chicken production also emitted higher total carbon than Nile tilapia production at 11.829±5.292 kg.C/kg.Thai native chicken/day and 6.947±5.314 kg.C/kg. Nile tilapia /day ($P \leq 0.05$). It can be concluded that most of carbon emission was from transportation of animals feed from factories/wholesales to farms followed by transportation of animals to slaughterhouse/markets and incubation of young animals and farms management in their farms.

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

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Introduction

Greenhouse gases (GHG) cause the greenhouse effect which negatively affects 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 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 and fishery products; largely meat, milk and eggs, is increasing globally. As a result, the world's livestock and fishery sector is also growing. Livestock and fishery production are growing faster than any other agricultural sub-sector and it is predicted that by 2020, livestock and fishery will produce more than half of the total global agricultural output in value terms (Delgado *et al*., 1999); Upton, 2004). Livestock and fishery 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).

The previous assessments of the Livestock Environment and Development (LEAD) initiative emphasized the livestock sector perspective and analyzed livestock-environment interactions from the perspective of a livestock production system. This updated assessment inverts this approach and starts from an environmental perspective. It attempts to provide an objective assessment of the many diverse livestock environment interactions. Economic, social and public health objectives are of course taken into account so as to reach realistic conclusions. This assessment then outlines a series of potential solutions that can effectively address the negative consequences of livestock and fishery productions (De Haan *et al.*, 1997; Steinfeld *et al.*, 1997; Tantipanatip *et al.*, 2014).

Thus, the objectives of this rescaech were to in vestigate total carbon emission from the use of energy and to compare carbon emission between Thai native chicken and Nile tilapia production in Nakhon Ratchasima province, Thailand.

Materials and methods

Study area

Nakhon Ratchasima is the largest province in Thailand and it locates in the Northeastern. Nakhon Ratchasima province was selected as study area where many Thai native chicken and Nile tilapia have been raised based on the data of Nakhon Ratchasima provincial Livestovk Office and Department of Fisheries Nakhon Ratchasima (2013). The selected districts of Nakhon Ratchasima province were Mueang Nakhon Ratchasima and Pak Thong Chai. The study areas are shown in Fig.1 Fig. 2 and Table 1.

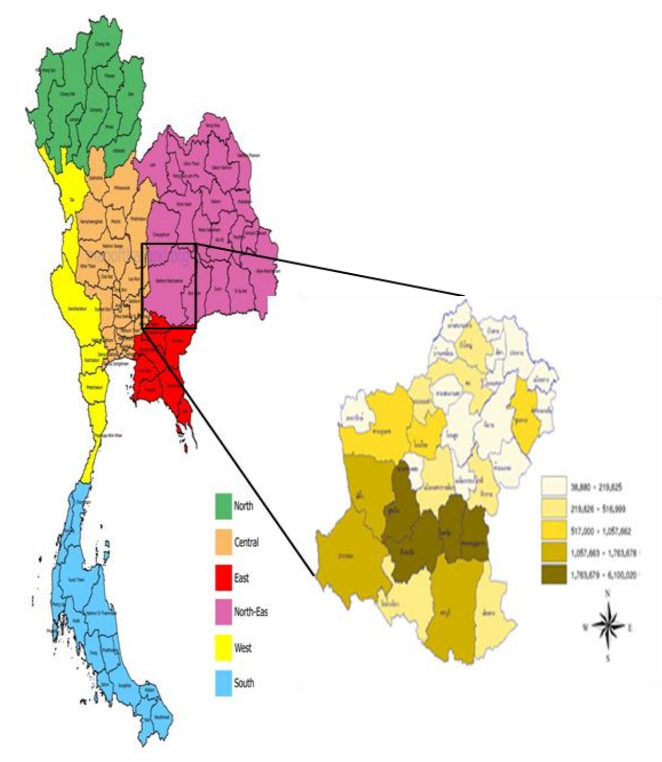

Fig. 1 The map of Nakhon Ratchasima province.
Ref:http://www.mapsofworld.com/thailand/provinces/nakhonratchasima-map.html

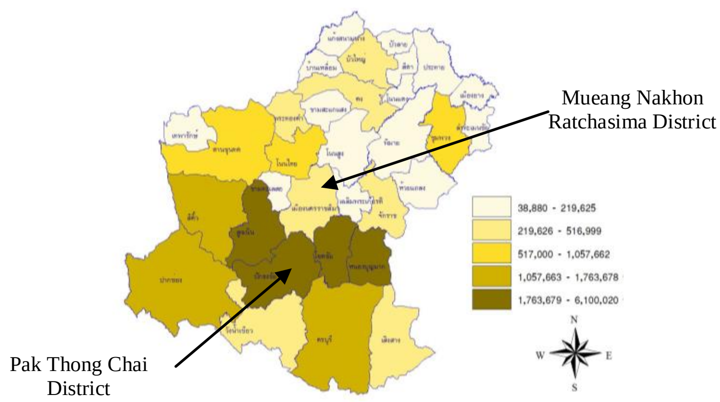

Fig. 2 Districts in Nakhon Ratchasima showing numbers of chicken productions.
Ref: http://pvlo-nak.dld.go.th/data/zone/zone57/chic57.jpg

Table 1 The number of Nile tilapia farms in Mueang Nakhon Ratchasima and Pak Thong Chai distric**ts** in 2015.

Districts	The size of farm				Subsistence farming	Commercial farming
	<1 rais and feed	1 - 5 rais and feed	>5 rais and feed	Sum		
Mueang Nakhon Ratchasima	223	655	62	940	808	132
Pak Thong Chai	402	656	8	1,066	1,043	23
Total				2,006	1,851	155

Source: Fishery Office in Nakhon Ratchasima, (2015).

Site sampling and analytical methods

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

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

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

According to the calculation the number of Thai native chicken farm and Nile tilapia farms were each of 400, and Thai native chickens and Nile tilapia were each of 400 individuals. Statistical analyses were performed using SPSS versions 18, significance was based on $P \leq 0.05$ between Thai native chicken and Nile tilapia productions.

Results and discussions

The total carbon emission from energy use

The survey, questionares and analyses of farms and slaughterhouses for energy use in chicken and fish production in Nakhon Ratchasima province found that Thai native chicken and Nile tilapia farms had used much energy for raising chicken and fish. The total carbon emission (C-emission) from energy use of Thai native chicken and Nile tilapia productions were 11.829±5.292 kg.C/kg.Thai native chicken/day and 6.947±5.314 kg.C/kg.Nile tilapia/day. Most energy was used for transportation of animal feed to farms and of animal to slaughterhouses, and using electricity for incubation of animals and farm management. The results of each C-emission from the energy use showed that C-emission from transportation of animal feed was the highest at 11.062±4.832 kg.C/kg.Thai native chicken/day and 6.520±4.954 kg.C/kg.Nile tilapia/day followed by transportation of animal to slaughterhouses or markets and the energy use for incubation of animals and for farm mangement at 0.767±0.460 and 0.0003±0.0004 kg.C/kg.Thai native chicken/day for Thai native chicken and 0.427±0.360 and 0.0001±0.0003 kg.C/kg.Nile tilapia/day for Nile tilapia, respectively.

The content and proportion of C-emission from the use of energy in Thai native chicken and Nile tilapia productions in Nakhon Ratchasima province are shown in Table 2 and Fig. 3.

Table 2 The carbon emission from Thai native chicken and Nile tilapia productions from farm management

Parameter	Thai native chicken (kg.C/kg.Thai native chicken/day)	Nile tilapia (kg.C/kg. Nile tilapia /day)
Energy use of animal feed transportation	11.062±4.832	6.520±4.954
Energy use of animal transportation	0.767±0.460	0.427±0.360
Energy use of animal incubation/ management	0.0003±0.0004	0.0001±0.0003

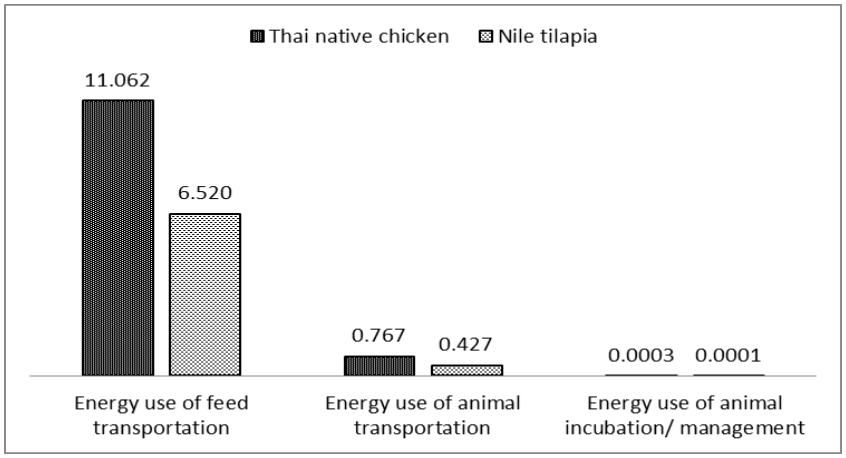

Fig. 3 The proportion of carbon emission from Thai native chicken and Nile tilapia productions in Nakhon Ratchasima province.

The total carbon emission from transportation

In Thai native chicken and Nile tilapia productions, total C-emission from transportation of chicken feed to farms were 11.829±5.292 kg.C/kg.Thai native chicken/day and 6.947±5.314 kg.C/kg.Nile tilapia/day. and 11.062±4.832 kg.C/kg.Thai native chicken/day and 6.520±4.954 kg.C/kg.Nile, respectively. The relationship between these two sources of emission is shown in Fig. 4 and Fig. 5.

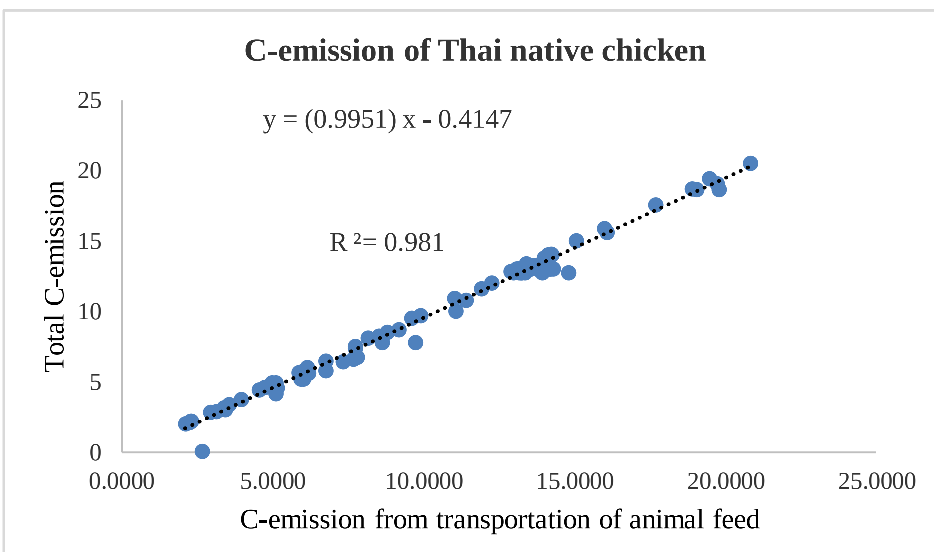

Fig. 4 The relationship between C-emission from energy use of Thai native chicken and C-emission from transportation of chicken feed at a confidence level of 95%.

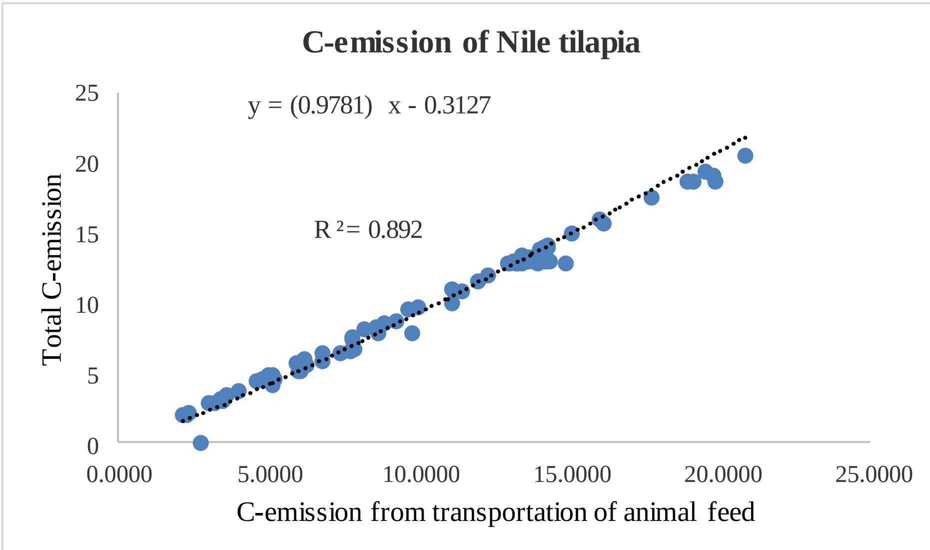

Fig. 5 The relationship between C-emission from energy use of Nile tilapia and C-emission from transportation of fishery feed at a confidence level of 95%.

Thai native chicken:

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:

$$y = 0.9951\,(x) - 0.4147 \qquad (R^2 = 0.981)$$

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

Nile tilapia:

The result found that total C-emission positively correlated with C-emission from transportation of fishery feed to farms ($P \leq 0.05$). The regression equation is also shown as follow:

$$y = 0.9781\,(x) - 0.3127 \qquad (R^2 = 0.892)$$

Y = Total C-emission of Nile tilapia
x = C-emission from transportation of fishery feed

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 productions were 11.11 x 10^{-3} and 8.3 x 10^{-3} kg.C/living weight/day. They also discussed that most carbon emission was 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 between Thai native chicken and Nile tilapia productions

The two different groups of animals were selected in Nakhon Ratchasima province. They were Thai native chicken and Nile tilapia. In comparison of both animals, the result revealed that Thai native chicken emitted higher carbon (11.829±5.292 kg.C/kg.Thai native chicken/day) than Nile tilapia (6.947±5.314 kg.C/kg.Nile tilapia/day). There was significantly different ($P \leq 0.05$) between these two groups of animals. The results are illustrated in Fig. 6 and the regression formula is as follow:

$$Y = 0.9829 (x) – 3.8751 \qquad (R^2 = 0.612)$$

Y = C-emission of Thai native chicken

x = C-emission of Nile tilapia

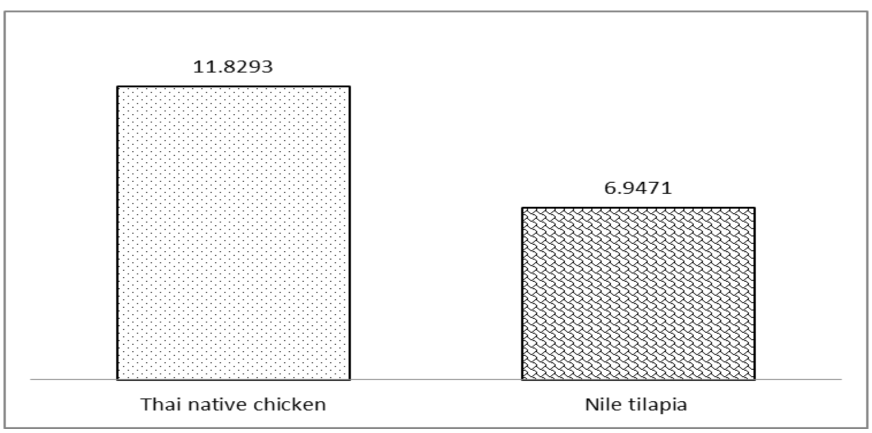

Fig. 6 The comparison of tota C-emission from energy use between Thai native chicken and Nile tilapia.

This results can be concluded that in both animals, Thai native chicken emitted higher carbon than Nile tilapia. 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 was 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. Pelltier and Tyedmers (2010) and Tantipanatip (2014) also reported that most carbon emission from aquatic products and seafood in Indonesia and Thailand came 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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