Carbon Footprint from Meat Production of Thai Cross Breed Native Chicken in Nakhon Ratchasima Province, Thailand

Panisara Vichairattanatragul, Prayong Keeratiurai, and Nathawut Thanee

***Abstract*—**Poultry production in Thailand has been increased in the past years. Species of chicken have been genetically developed for commercialization. Thai cross breed native chickens are the cross breeds of Thai male indigenous fighting cocks and female broilers. The objectives of this research were to compare carbon massflow and carbon footprint of Thai cross breed native chicken production between a state farm and private farms in Nakhon Ratchasima province, Thailand. The results revealed that carbon input (C-input) were 1.030±0.032 and 1.049±0.026 kg.C/individual/day, carbon fixation (C-fixation) were 0.853±0.013 and 0.868±0.034 kg.C/individual/day, and carbon output (C-output) were 0.180±0.006 and 0.181±0.037 kg.C/individual/day, respectively. The carbon footprint (CFP) of Thai cross breed native chicken were 0.760±0.054 kg.$C0_2$.eq./1 kg.individual and 0.7741±0.056 kg.$C0_2$.eq./1 kg.individual, respectively. Furthermore, the carbon footprint of Thai cross breed native chicken in Nakhon Ratchasima provience from the use of energy was 15.123 kg.$C0_2$.eq./1 kg.individual, individual Thai cross breed native chicken was 0.767 kg.$C0_2$.eq./1 kg.individual. It can be concluded from the findings that the carbon footprints (CFP) are almost from the energy use in transportation, it should be the first consideration to reduce energy use in chicken production.

***Keywords*—**carbon emission, carbon footprint, Nakhon Ratchasima, Thai cross breed native chicken

I. Introduction

CLIMATE changes are mainly caused by the greenhouse gases released from human activities and other sources to the atmosphere. The livestock production is included into one of the major sources of air pollution, especially carbon dioxide (CO_2), methane (CH_4) and nitrogen oxides (NO_x) [1, 2]. Livestock animals meet a variety of food needs for people [3]. Therefore, the poultry production in Thailand has been increased in the past years. Species of chicken have been genetically developed for commercialization [4, 5] and Thai cross breed native chicken are the cross breeds of Thai male indigenous fighting cocks and female broilers. In general, they are the so-called Gai Baan Thai, meaning Thai domestic chicken. Among Thai consumers, meat of the Thai cross breed native chicken is more preferable and recognized as lean, tasty, not so tough and chewy, and has higher economic values compared to commercial broiler meat [7]. Gai Baan Thai are promoted as a commercial product for exporting and the Livestock Development Department and the Exporting Promotion Department have been working closely to develop the breeds with higher meat quality. Although, the livestock productions meet the requirement of government sectors, private sectors, and farmers, the environmental impact from the production should be considered [7, 8, 4]. Therefore, Thailand has attempted to be the leadership in trade of livestock production exports to the ASEAN Economic Community (AEC). Thailand needs to investigate the basic data of carbon massflow and carbon footprint of the livestock production as well as to develop the process in achieving the least environmental impact [2, 9 -13]. The aim of the present work focused on Thai cross breed chicken 8-10 weeks of age or 1.0-1.2 kg. body weight to prepare as raw materials for grilled chicken.

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II. Materials and Methods

A. Study Site

Based on the data obtained from the Agricultural Information Center, Office of Agricultural Economics, Nakhon Ratchasima was the selected province, which represented the production of native Thai cross breed chicken [14]. This province is the largest area and provides many Thai cross breed chicken farms as shown in the distribution of production areas within Thailand (Fig. 1A) and the province of Nakhon Ratchasima (Fig. 1B) [15].

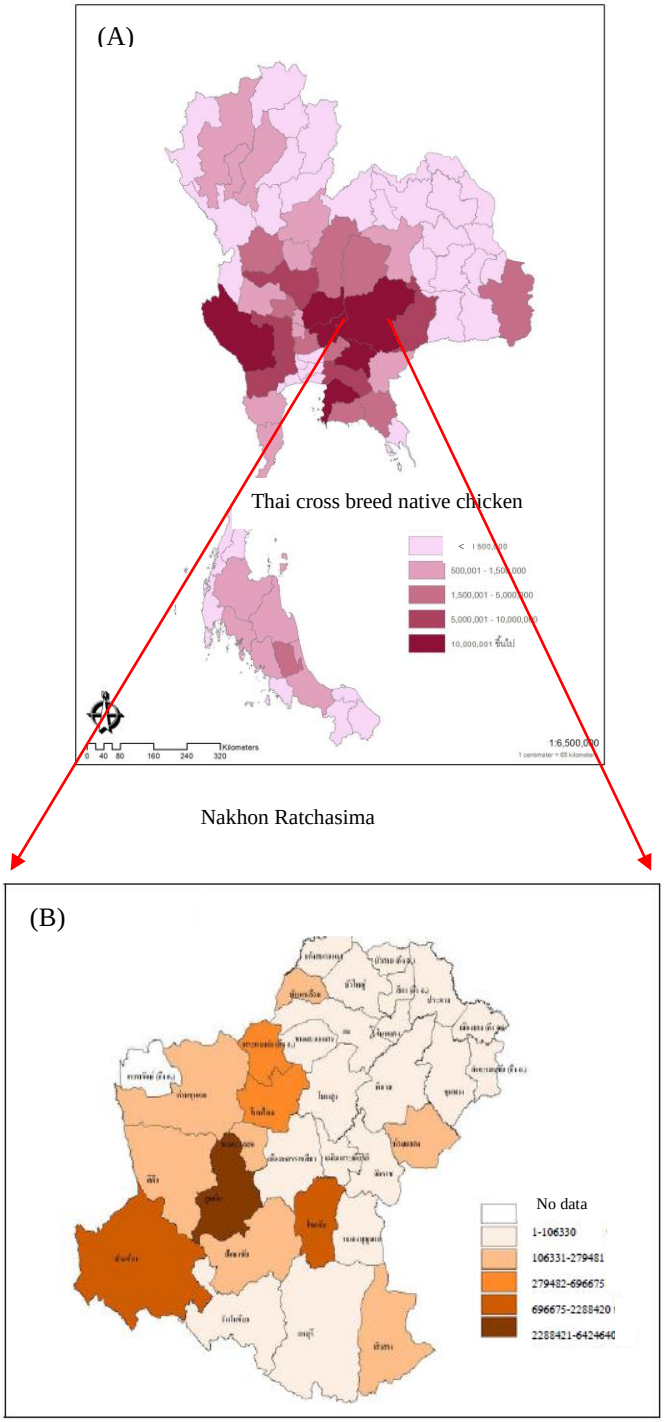

Fig. 1 Density number of Thai cross breed native chicken in Thailand (A) and in Nakhon Ratchasima province (B)

B. Size of Samples

The formula of Taro Yamane was applied to calculate the number of farms and Thai cross breed native chicken in Nakhon Ratchasima province [15]. The formula is:

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

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

For example, the sample size of Thai cross breed native chicken farms in Nakhon Ratchasima province for the study was calculated according to the recommendation as follow:

$n = 2437/[1+2437x(0.05)^2] = 344$ Thai cross breed native chicken farms

At 95% confident level, the number of studied Thai cross breed native chicken farms were 344 farms and 344 Thai cross breed native chicken in Nakhon Ratchasima province. Animal feed, cross native chicken and faeces samples were collected from state and private farms and transferred to the laboratory at Suranaree University of Technology. CO_2 was detected by Gas Analyzer from living cross native chicken at the farms [9, 3]. Percentage of moisture, and carbon content were analyzed following the methods of Manlay et al. [16-18], while the volatile solid, fixed solid and weight were investigated by the techniques of APHA, AWWA, WEF, [19, 20].

III. Results

The carbon content as the unit of kilogramme carbon per kilogramme of chicken weight per day (kg.C/individual/day) was used to study the carbon massflow from animal feed to the biomass of Thai cross breed native chicken (C-input). The carbon transference and fixation rates were determined from the state and private farms in Nakhon Ratchasima province. The rate of carbon transference from animal feed to Thai cross breed chicken for state and private farms were 1.030±0.032 and 1.049±0.026 kg.C/individual/day, respectively. Carbon fixation of Thai cross breed chicken were 0.853±0.013 and 0.868±0.03 kg.C/individual/day, respectively. The C-output minus the carbon contents emitted in faeces, enteric fermentation, and respiration (C-emission) was the carbon mass fixed in the body (C-fixation). The carbon emission for the two groups were 0.180±0.006 and 0.181±0.037 kg.C/individual/day, respectively. These results are summarized in Tables 1 and 2. The value of carbon massflow C-input, C-output and C-emission between state and private farms were not significantly different ($P \leq 0.05$). The results revealed that the carbon massflow were different from Thanee et al. [3], while the values of young layer production was not significantly different ($P \leq 0.05$).

TABLE I
COMPARISON OF CARBON INPUT, CARBON FIXATION AND CARBON EMISSION OF THAI CROSS BREED NATIVE CHICKEN BETWEEN STATE AND PRIVATE FARMS IN NAKHON RATCHASIMA PROVINCE; MEAN±S.D

Parameters	State farm	Private farms
C_{input} (kg.C/individual/day)	1.030±0.032	1.049±0.026
$C_{fixation}$ (kg.C/individual/day)	0.853±0.013	0.868±0.034
$C_{emission}$ (kg.C/individual/day)	0.180±0.006	0.181±0.037
$C_{emission}/C_{input}$(%)	17.51	17.28
$C_{emission}/C_{fixation}$(%)	21.14	20.88
Fixation efficiency, C = (C_{input} - $C_{emission}$)/C_{input} (%)	82.49	82.72

TABLE II
CARBON EMISSION PER INDIVIDUAL PER DAY AND CARBON EMISSION PER DAY COMPARING FROM SAME WEIGHT OF ANIMAL; MEAN ± S.D.

Animal	Fresh faeces wt (kg./ind/day)	% Faeces per ind. wieght	Carbon emission (kg.C/ind/day)	Mean live animal weight in farm (kg./ind)	Carbon emission comparing from same weight (kg.C/kgind.wt/day) x 10^{-3}
State farm	0.080 ± 0.41	3.32	0.180□0.006	1.24 ± 0.05	14.60□0.005
Private farms	0.067 ± 0.37	3.54	0.181□0.037	1.39 ± 0.63	13.02□0.040

The carbon footprint (CFP) of Thai cross breed native chicken both from state and private farms was 15.883 kg.$C0_2$.eq./1 kg.individual. Most carbon footprint from energy was 15.123 kg.$C0_2$.eq./1 kg.individual but carbon footprint form faeces and respiration was 0.767 kg.$C0_2$.eq./1 kg.individual (Fig. 2). The results showed that the carbon footprint (CPF) was the highest in the use of energy especially during the transportation of the production as shown in Table 3. Then the farmers should develop and manage the use of energy in Thai cross breed native chicken.

TABLE III
RATIO OF CARBON EMISSION FROM LIVESTOCK AND ENERGY USE OF FARMS AND SLAUGHTERHOUSES IN THAI CROSS BREED NATIVE CHICKEN MEAT PRODUCTION

Ratio of carbon emitted form	State farm	Private farms
Animal (%)	3.63	7.39
Energy use (%)	96.47	92.71

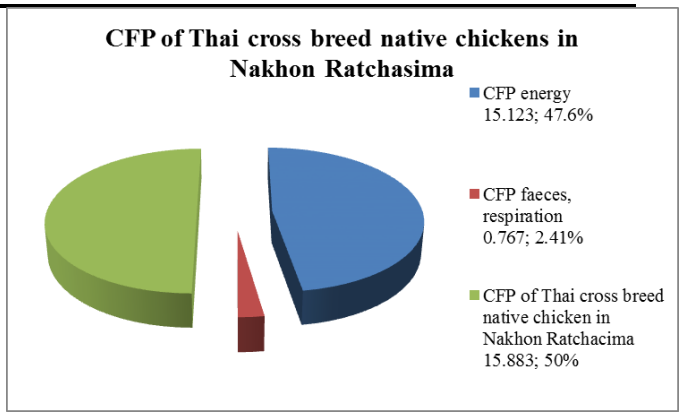

Fig. 2 The composition of CFP in the production of Thai cross breed native chicken in Nakhon Ratchasima province

The carbon footprints (CFP) of meat production of Thai cross breed native chicken of state and private farms were 0.760 and 0.774 kg.$C0_2$.eq./1 individual, respectively which were not different (P≤ 0.05). However, the carbon footprint of state farm and private farms in the use of energy were 20.580 and 9.536 kg.$C0_2$.eq./1 kg.chicken, respectively and the values differed significantly (P≤ 0.05) as shown in Fig. 3 This result was similar to Thanee and Keeratiurai [22], who found that the carbon footprint of commercial broiler meat production and private company Thai cross breed native meat production were not significantly different (P≤ 0.05).

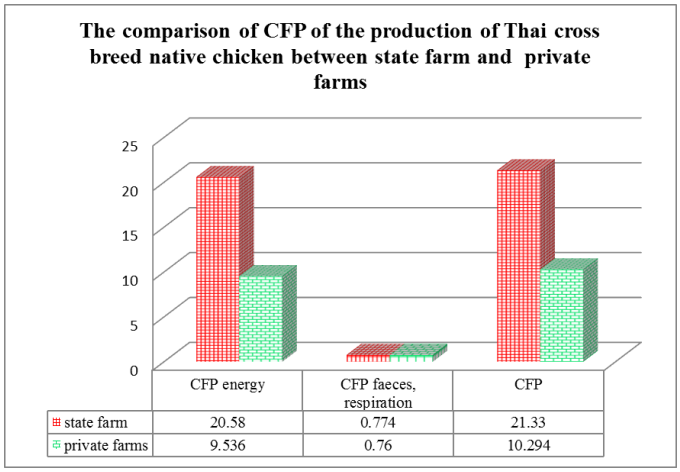

Fig. 3 The comparison of CFP of the production of Thai cross breed native chicken between state and private farms

The production of Thai cross breed native chicken of state farm should increase the number of animal per experiment to reduce the carbon footprint especially in the use of energy. In particular, the Department of Livestock Development has to promote the production process of Thai cross breed native chicken to farmers. Moreover, they should expand the markets and provide useful information to the farmers, especially, for exporting this product to the ASEAN Economic Community (AEC). For the reduction of the carbon footprint, The effective way to reduce the use of energy is to reduce the transportation distance of chicken food. In addition, Thailand aims to be the leader in the trade of livestock production exports within the ASEAN Economic Community (AEC). Therefore, the Thailand government should put a research programme into place to investigate and quantify carbon massflow of the livestock productions and to develop a process to measure and minimize the environmental impacts.

IV. Discussion

The carbon massflow of Thai cross breed native chickens between of state and private farms showed that carbon input (C-input) were 1.0298±0.032 and 1.0487±0.026 kg.C/individual/day, carbon fixation (C-fixation) were 0.8531±0.013 and 0.8678±0.034 kg.C/individual/day, and carbon output (C-output) were 0.1803±0.006 and 0.1812±0.037 kg.C/individual/day, respectively. The values of carbon massflow of Thai cross breed native chicken between state and private farms were not significantly different ($P \leq 0.05$). The carbon footprints (CFP) of Thai cross breed native chicken of state and private farms were 0.760 kg.$C0_2$.eq./1 kg.individual and 0.774 kg.$C0_2$.eq./1 kg.individual, respectively. Furthermore, the carbon footprint from the use of energy were 20.580 kg.$C0_2$.eq./1 kg.individual and 9.536 kg.$C0_2$.eq./1 kg.individual. It can be concluded that the carbon footprints (CFP) are almost from the transportation, so it should be considered to reduce of the energy in the production.

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