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Estimating the Greenhouse Gases Emission and the Most Important Factors in Dairy Farms (Case Study Iran)

[1]M. Ghorbani, [2]A.R. Koocheki and [1]M. Motallebi
[1]Department of Agricultural Economics,
[2]Department of Agronomy, Ferdowsi University of Mashhad, Mashhad, Iran

Abstract: In this study, the amount of greenhouse gases emission of some important factors was calculated using life cycle assessment. Sample was 85 dairy farms that were selected by simple random sampling method in 2007. Results showed that electricity and diesel used are the most effective parameters on greenhouse gases emissions in dairy farms, respectively and the other effective parameters are the number of other cattle, the distance of food transferring, cows manure, the No. of calves and dairy cows. It is recommended that the policy makers use some methods like environmental taxes, improving management and carbon sequestration to reduce these kinds of costs. This study results could help policy makers to decide better with considering to effective factors.

Key words: Life cycle, regression, Iran

INTRODUCTION

Greenhouse gases (GHG) emissions from different sources are one of the most important issues these days because they have being created climate changes and biodiversity damages. In this study has been tried to find the effects of some factors on greenhouse gases emissions of animal sub-sector in agriculture sector. In recent years, many treaties have been approved for managing global environment better. In 1990s, some international protocols were passed in order to control greenhouse gases emissions. One of them was Kyoto protocol, on the base of that countries should report greenhouse gas emissions of each sectors each year. With this view which that agriculture sector is one of the biggest resource of methane (CH_4) and nitrous oxide (N_2O) emission and carbon dioxide (CO_2), the necessity of control and attention to production methods in agriculture for sustainable development and conforming to international treaties in order to decrease of greenhouse gases is important.

A lot of studies have been done on this category which tried to find the best way in order to produce efficiently. Casey and Holden (2006b) used Life Cycle Assessment (LCA) to calculate the amount of greenhouse gases emissions in meat producing system in Ireland and evaluate different kinds of management methods. Results showed if a continued increase in specialization occurs in both dairy and beef sectors in Ireland it will be difficult to reduce GHG emissions. The existence of a middle-ground whereby beef can be supplied from the dairy industry while maintaining productivity within the dairy industry is perhaps the best option a shift towards very intensive milk production could see a reduction in animals crossing over to the beef industry due to lack of breed suitability for beef productivity. Lovett *et al.* (2006) calculated greenhouse gases emissions of different breeds of dairy cows with different amount of concentrate feed usage in Ireland. Results showed the least emission is related to middle dairy cows with high using concentrate in their diets. Werf *et al.* (2005) investigated the relationship between some factors like concentrate transferring distance to husbandry, kind of diet and the like on greenhouse gases emissions for pig breeding farms in France. Results have shown using fertilizer in food producing efficiently, decreasing of transferring pigs foods, using local foods for pigs diet and using more wheat than maize are the most important factors in order to decrease GHG from pigs farms. Hindrichsen *et al.* (2006) demonstrated cows diet has very crucial effect on Methane emission in order to prove their hypnosis they showed Methane emission of cows wastes went down 22% averagely with using more concentrate in their diet. Gonzalez-Avalos and Ruiz-Suarez (2001) calculated methane emission factor related to dairy and beef cows in different temperatures. They concluded that in high temperatures the rate of emissions from cows wastes increased but this rate completely depends on cows' diet, the manner which using fresh forages and cereals in cows' diet which will lead to decrease of emission. Casey and Holden (2006a) used LCA methodology to provide an objective framework for estimating emissions and evaluating emission management scenarios from the average Irish production system. Scenario testing

Corresponding Author: M. Ghorbani, Department of Agricultural Economics, Ferdowsi University of Mashhad, Mashhad, Iran

indicated that more efficient cow with extensive manure management could reduce emissions by 14-18%, elimination of non-milking animals could reduce emission by 14-26% and combination of both could reduce emission by 28-33%.

According to protocol commitments Iran should report greenhouse gases emissions of each economic sector like agriculture sector. One of the important sub agricultural sectors is animal husbandry. Cattle especially dairy cows are one of the biggest greenhouse gases emissions in agricultural sector. Data shows the number of industrial dairy farms and cattle (head) are 12667 and 1287759, respectively in Iran that there are 2683 dairy farms (first position in country) with 175117 head cattle (third position in country) in Khorasan Province. Based on agriculture ministry's information until 2006, there are 725 industrial dairy farms with 41285 head dairy cows in Khorasan Razavi Province, that Mashhad (the capital city of Khorasan Razavi Province)'s share of industrial dairy farms and head dairy cows are 176 and 15782, respectively with regarding to importance of this sub sector in greenhouse gases emissions, Iran's commitments, lack of greenhouse gases emissions estimation, ignorance of milk producers and policy makers related to greenhouse gases emissions in animal husbandry and non regarding to the effective factors which affect the greenhouse gases in milk producing, it is necessary to estimate the amount of greenhouse gases emissions, moreover finding most important factors is essential. These kinds of information are very important because they could be helpful for understanding dairy cows share and position in greenhouse gases emissions and moreover it could be effective for policy makers and managers to use encouragement tools in short run and punishment tools in long run for decreasing greenhouse gases emissions which with them, bad environmental affections of these gases could be controlled.

MATERIALS AND METHODS

In this study Life Cycle Assessment (LCA) methodology has been used in order to estimate of GHG emission. This method is one of the best one for considering a total framework to calculate of environmental problems associated with the former and the latter processes of production process.

This method in order to calculate the emission of GHG associated with 1 L milk. LCA method usually uses emission factors related to producing of a good (Table 1). Although LCA estimates GHG emissions regarded to all processes of one production process, the other methods are a bit limited and just they use one part of all production process. For using LCA, the boundaries of system should be manifested (Fig. 1).

The system boundary is defined by the GHG emissions associated with milk production from cradle to farm gate which has some parts: (i) the emissions associated with the individual ingredients of the concentrate feed production, transportation and application, (ii) emissions associated with N fertilizer

Table 1: Result of the amount of CH_4, CO_2 and N_2O related to dairy farms of the sample year^{-1}

Emission (kg)	GHG
526014.59	CH_4
26394258	CO_2
1312.1	N_2O
37847303.7	All gases emissions (Eq. CO_2 year^{-1})

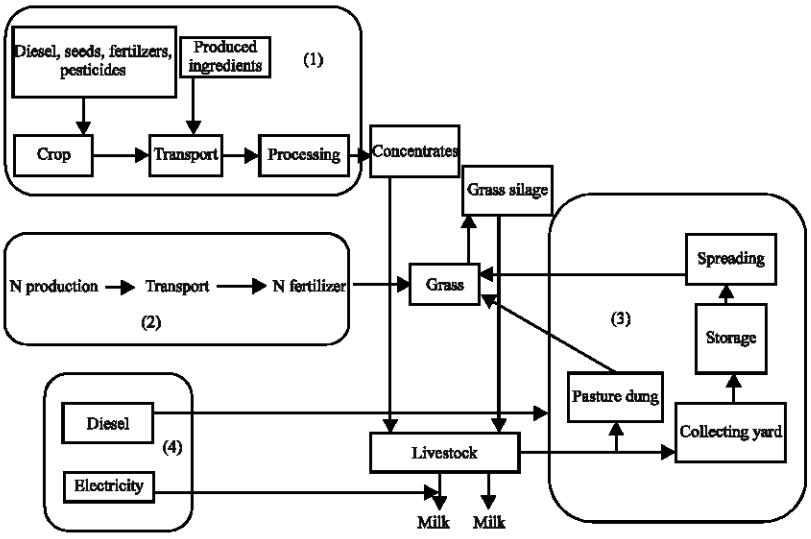

Fig. 1: The system of boundary

production, transportation and application, (iii) emissions associated with livestock and related manure management and (iv) emissions associated with electricity used for cooling milk and diesel for agricultural operations (e.g., fertilizer application, manure application and forage production).

The other effective factors have been omitted because of lack of data. Geo-political boundaries are not considered as limits to the system (Inter-Governmental Panel on Climate Changes, 1996b).

Data: The data used in this study were obtained through survey of 85 dairy farms during the year 2007. The sample was selected by simple sampling method. In order to use LCA method and GHG emission calculation, this study used the emission factors (which are different emission coefficient factors that are multiplied with the rate of GHG emissions from different resources in order to change this rate to a unique criteria like kg CO_2 eq.), that was suggested by IPCC (1993) (Tier 1).There are 2 main factors which are directly related to cows: (1) emission of enteric fermentation which produces a lot of GHG which the most important gas is CH_4 and (2) cows excreta and manure management which produce a lot of N_2O which used these parameters emission factors from IPCC data base and other emission factors for some parameters of Fig. 1 (Casey and Holden, 2006a).

RESULTS AND DISCUSSION

The amount of emissions: This study used the emission coefficient factors, that was suggested by IPCC (1996a, b, 2000) (Tier 1) and using life cycle assessment (LCA) method to estimate the amount of CH_4, CO_2 and N_2O related to dairy farms of present sample annually (Table 1).

Estimation of GHG emission functions in dairy farms: In this part dependent factor is emission factor of each dairy farm and some factors like electricity (kWh year^{-1}), cows manure each year (m^3), the distance of food transferring till dairy farm (km), the No. of cows in milk (head), the No. of calves (head), the No. of other cattle (head), the amount of used diesel in year (L) are dependent factors on emission from dairy farms. After calculating a lot of functions formats and testing by econometric methods, finally Cobb-Douglas function has been elected. The most important criterion for choosing of the desirable method was the minimization of the differences between the real and the calculated amount of real and calculated emissions. The result of estimation is shown in Table 2.

Table 2: GHG emission function in Mashhad dairy farms

Variables	Coefficient	t-test
Constant	5.36	12.1*
Electricity (kWh year^{-1})	0.38	15.01*
Cows manure each year (m^3)	0.069	1.9*
The distance of food transferring till dairy farm (km)	0.083	2.48*
The No. of cows in milk (head)	0.054	0.75^{ns}
The No. of calves (head)	0.078	1.34^{ns}
The No. of other cattle (head)	0.118	2.33*
The amount of used diesel in year (L)	0.13	4.07*
R^2	0.85	
F	60.7*	

*Significant at 1% level and ^{ns}Non-significant

According to Table 2, the coefficients of electricity and diesel used are 0.38 and 0.13, respectively which are the most effective parameters on greenhouse gases emissions in dairy farms and the other effective parameters are the No. of other cattle, the distance of food transferring, cows manure, the No. of calves and dairy cows, respectively. R^2 shows 85% of dependent variation is explained by significant factors in present model in one hand and on the other hand F shows that present model is completely significant.

It is recommended that the policy makers use some methods like environmental taxes, improving management and carbon sequestration to reduce these kinds of costs. This study results could help policy makers to decide better with considering to effective factors.

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