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# THE CORRELATION BETWEEN PRODUCTION, CONSUMPTION OF LIVESTOCK AND CLIMATE CHANGE IN YOGYAKARTA, INDONESIA

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**Abstract**
This study aims to identify and predict greenhouse gas (GHG) emissions from livestock, particularly beef cattle and to analyze whether there is a relationship between its production and consumption towards climate change in Yogyakarta, Indonesia. The production of methane gas from cattle farming has been observed to cause climate change therefore, analyzes on the factors that influence these emissions is needed. This analysis was carried out descriptively by analyzing the time series. In order to identify GHG emissions from beef cattle farming, trend analysis and descriptive statistical calculations were carried out, using the Intergovernmental Panel on Climate Change guidelines and the Tier 1 method.Meanwhile, to analyze whether there is a relationship between beef production and consumption, a bivariate correlation test was carried out using the Pearson, and the factors that influence GHG emissions from beef cattle farms in Yogyakarta were also analyzed using the multiple linear regression analysis with the Ordinary Least Square (OLS) test. The results showed that GHG emissions from beef cattle increase every year with a positive trend. Furthermore, it revealed that there was a positive correlation between beef consumption and methane gas emissions from beef cattle farmsand variables of its production,consumption and the land providing forage in the form of rice fields, moor, state forests and community forests have a significant effect towards the amount of GHG emissions from beef cattle farms.
***Key words:*** *Climate Change, Emission, Livestock, Consumption,Production*

## INTRODUCTION

Climate change due to global warming in the world cannot be avoided from human life. Therefore, efforts to minimize climate change are being made, such as reducing GHG emissions, which increasingly threaten human life and biodiversity on earth [1]. Climate change impacts human life not only from the environmental aspects but also economic and social aspects. In Indonesia, it also affects all sectors, including

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agriculture. Its impact on the economic aspect is also evident in the agricultural sector although, it cannot be denied that one of the causes of climate change also comes from agricultural activities, which is a clear contradiction. After forestry, energy and waste sectors, the agricultural sector is ranked fourth in contributing to GHG emissions and causing climate change by 14% and 17% on the global and national scale, respectively. The sub-sectors, such as food crops and livestock, are the main contributors by this sector[2].

Methane ($CH_4$) is one of the most important greenhouse gases and its potential to cause global warming is 21 times more, compared to carbon dioxide [3], [4]. The livestock sub-sector contributes to GHG emissions in the form of methane gas ($CH_4$) due to inappropriate management, which triggers environmental degradation. This is due to the improper procession of the manure, which leads to the production of gas more than what is normally managed according to good procedures.

In 2018, the largest production in the livestock sub-sector after broilers was beef production, which accounted for 497,971.70tons or 13.81% of the total production of all livestock types [5], [6]. Beef is a commodity with high economic value in Indonesia and in the last ten years (2009-2018), its domestic production has increased with an average production growth rate of 2.31% [6]. However, this production capacity is not sufficient to keep up with the consumption rate of Indonesians, which also increases significantly with an average growth rate of beef consumption per capita of 18.13%. (2014-2018).

The Yogyakarta (Special Region of Yogyakarta) population increases from year to year, with an annual population growth rate of 1.18% (2010-2018). This leads to an increase in the demand for food needs, both carbohydrate and protein foods such as meat. Furthermore, the demand rate for beef in Yogyakarta has increased from year to year as seen from the consumption rate of 4% from 2001-2016. Therefore, to meet this demand, it should be made available by increasing the supply i.e. the amount of beef within and outside Yogyakarta. One of the ways to make it readily available is to increase cattle population.

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When cattle population in Yogyakarta was increased, the emission of greenhouse gases, such as methane from cow manure that was not properly managed was affected. In addition, this gas was also produced from enteric fermentation in the stomach of cows. Consequently, this increase in gas emissions destroys the ozone layer and has an impact on climate change. Cattle livestock classified as ruminants, contribute significantly to the total emissions of agricultural methane, which is not only related to environmental problems, but also associated with energy loss (Moumen, et.al., 2016). It is estimated that GHG emissions from the agricultural sector will continue to increase until 2030 in line with the rise in food demand [8]. This will certainly have an impact on the GHG concentration in the atmosphere and contribute to the destruction of the ozone layer.

Based on the background above, this study aims to identify and predict GHG emissions from beef cattle farming, to analyze whether there is a relationship between beef production and consumption and the factors which affect its emissions from beef cattle farm in Yogyakarta, Indonesia.

## RESEARCH METHOD

The basic method used in this study was descriptive quantitative, which was carried out by analyzing the time series secondary data on production and carbon emissions in Yogyakarta. The location for this study was selected by purposive sampling and thedata used was secondarybased on time series, such as data on beef cattle population and consumption. The first objective was to identify GHG from beef cattle farming using trend analysis and descriptive statistical calculations with the IPCC (Intergovernmental Panel on Climate Change) guidelines and Tier 1 method.The total $CH_4$ emissions estimation from enteric fermentation and manure was calculated using the following equation [9]:

E = $EF_T$ x $N_T$ x $1^{-3}$

Description:

E = $CH_4$ emissions from enteric fermentation or manure (tonnes/year)

$EF_T$ = $CH_4$ emission factors in certain types of livestock (kg $CH_4$/head/year)

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$N_T$= Population of certain types/categories of livestock (head)

In order to analyze whether there is a relationship between beef production and consumption, a simple correlation test (bivariate correlation) was carried out using Pearson. Furthermore, the factors that affect GHG emissions from beef cattle farms in Yogyakarta were also analyzed using multiple linear regression analysis (Ordinary Least Square).

## RESULT AND DISCUSSION

### Methane ($CH_4$) Greenhouse Gas Emissions from Beef Cattle Farming

Greenhouse gas emissions from beef cattle farming were calculated using the Intergovernmental Panel on Climate Change inventory guidelines and the Tier-1 method, which was in the form of methane gas ($CH_4$) from enteric fermentation of livestock and manure. The prediction of these emissions was carried out as an effort to overcome climate change, especially $CH_4$ from beef cattle farms. In the forestry and peatland sectors, the projected GHG emissions from 2015-2020 through a historical approach had a trend approaching a linear form [10]. Therefore, this prediction was analyzed using the linear trend of $CH_4$ emissions as shown in Figure 1.

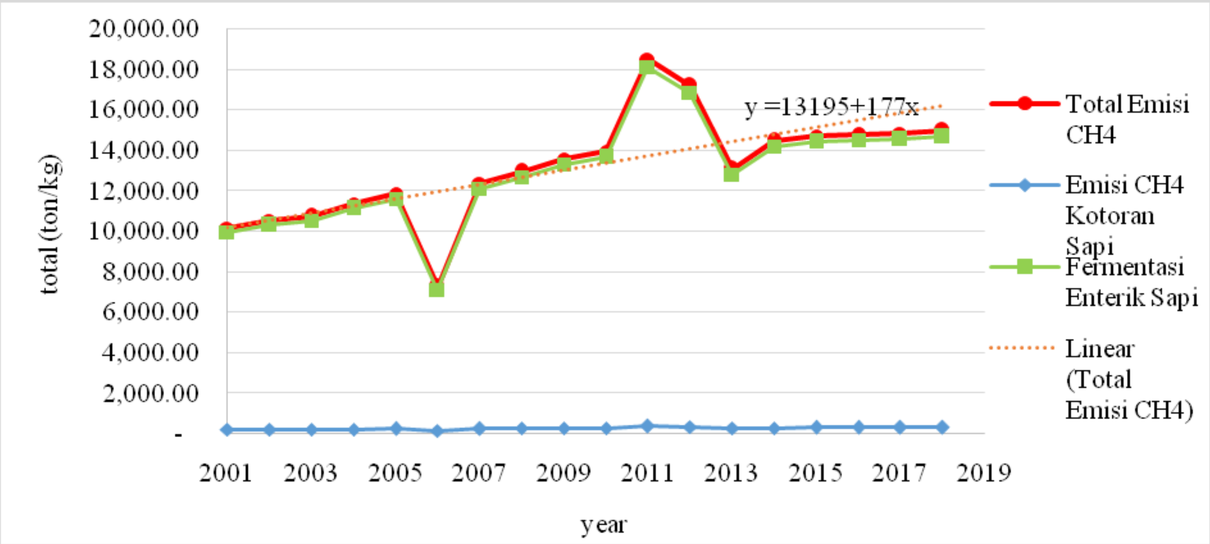


Figure 1. Trend of $CH_4$ Emissions from Beef Cattle Farming in Yogyakarta
Source: Yogyakarta Statistics Center (processed) (2002-2019)

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Based on the trend analysis in Figure 1, a linear trend equation of y = 13,195 + 177x, was obtained for $CH_4$ emissions from beef cattle farms in Yogyakarta. The positive sign in the equation indicates an increase in the emissions every year. Cattle livestock as ruminants are the highest source of anthropogenic $CH_4$ [11]. The enteric form from ruminant farms accounted for 17% and 3.3% of total $CH_4$ and GHG emissions, respectively [12]. Meanwhile, the livestock sector contributed about 37% and 89% of all anthropogenic and enteric fermentation $CH_4$ emissions [13].

The GHG load depends on the number of cattle populations and there was a linear relationship between population and $CH_4$ emissions. Based on the amount of meat produced, beef cattle contribute 41% of the total emissions on the livestock sector (Gerber et al., 2013). Furthermore, the rise in GHG is related to the increasing demand for food caused by marginal land use and meat consumption [14]. The amount of consumption affects the demand for beef which is related to the availability, increase in beef production and the totalcattle population in Yogyakarta [15]. The closeness of the relationship between methane gas emissions with production, consumption and availability of beef was analyzed using the correlation test as presented in Table 1.

Table 1. Correlation Results of Methane Gas Emissions (CH4) on Beef Production, Consumption and Availability in Yogyakarta

| Description | *Person Correlation* | Significance |
|---|---|---|
| Beef Consumption | 0.532** | 0.023 |
| Beef Production | $0.339^{ns}$ | 0.169 |
| Availability of Beef | $0.381^{ns}$ | 0.118 |

Source: Secondary Data from Various Sources (processed) (2002-2019)
Information:
**: Significant at α = 5%
ns: Not significant

Based on the results from the Pearson correlation test, it was shown that there was a significant positive relationship between methane gas emissions and beef consumption (sig $r = 0.023 < \alpha = 0.05$). Meanwhile, it did not have a significant

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relationship with beef production (sig r = 0.169 < α = 0.1) and availability (sig r = 0.118 < α = 0.1). The beef availability was influenced by its production and demand therefore, when its production does not correlate with methane gas emissions, it is possible that its availability also has no correlation (Yulastari, et.al., 2018). Meanwhile, a positive correlation between beef consumption and methane gas increases GHG emissions, considering that the consumption rate is quite large, which is by 4% (2001-2016). Therefore, the rate of beef consumption value will have an impact on increasing the population of cattle in other to meet the demand (Zulkarnainet.al., 2017). Although, the rate of increase in the beef cattle population reached 5.3%, it was not able to meet the demand due to the rate of increase in the population [18].

There are contradictions in fulfilling the demand for beef consumption and reducing methane emissions to overcome climate change. Therefore, efforts are needed in the form of creative innovation by breeders to reduce methane gas in cattle farms. Utilization of local feed ingredients containing tannins is an alternative to reduce the production of this gas. It was discovered that cattle fed with grass produced higher levels of methane than those fed with legume. This was because the addition of legume to feed increases the digestibility of organic matter and accelerates the passage rate in the rumen [19]. Furthermore, there are other methods of reducing the production of methane gas. They include improving the quality of animal feed ingredients using fermentation, raising livestock in cages, managing livestock waste or manure and providing feed which can affect the methanogenesis process for example aloe-vera waste [20]. In addition, technology development which supports environmentally friendly livestock should be a priority. Breeder knowledge towards the farming implementation with good and environmentally friendly management also needs to be increased in order to reduce the pollution.

### Factors Affecting Methane Emissions from Beef Cattle Farming in Yogyakarta

The relationship between the amount of GHG emissions, especially methane gas, and the livestock sub-sector cannot be denied. In minimizing the amount of methane

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emission in Yogyakarta, it was necessary to know the factors that influence it. These factors were analyzed and presented in table 2.

**Table 2. Factors Affecting Methane Emissions from Beef Cattle Farming in Yogyakarta**

| Variable | Expected sign | Coefficient | t statistic | Prob.t |
|---|---|---|---|---|
| Constant | +/- | 219693.439*** | 5.649 | 0.000 |
| Beef production (ton) | + | -0.002*** | -4.439 | 0.001 |
| Beef Consumption (ton) | + | 0.002*** | 4.289 | 0.001 |
| Rice fields (ha) | +/- | -1.230*** | -3.855 | 0.003 |
| Moor (ha) | +/- | -0.426** | -2.506 | 0.029 |
| State Forest (ha) | +/- | -4.853** | -2.185 | 0.051 |
| Community Forest (ha) | +/- | -0.503** | -2.445 | 0.033 |
| $R^2$/ Adj $R^2$ | | 91.4/ 86.6 | | |
| F Statistic/ Prob. F | | 19.37/ 0.00*** | | |

Source: Primary Data Analysis (2018)
Note:
*** = significant at α = 1% ; **= significant at α = 5%; *= significant at α = 10%; ns = not significant

Based on the results of the analysis in table 2, the effect of individual variables show that beef production, consumption and land forage providers in the form of rice fields, moor, state and community forests have a significant effect on methane gas emissions from beef cattle farming in Yogyakarta. Furthermore, it shows that beef production had a significant effect on the emission of this gas emissions from the farms [prob t (0.001) > α (0.01)], which was negative (ß1 = - 0.002). This was not in line with the study carried out by Dourmadet.al., 2008 [21], which stated that cattle production has a positive effect, because activities in livestock production are estimated to contribute 12% to total GHG emissions. The biggest emission from livestock manure management in Yogyakarta comes from poultry, namely broilers, domestic chickens, layer chickens and ducks by 37%, 24%, 20% and 3%, respectively. Meanwhile, those from mammals such as beef cattle, dairy cows,

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horses, buffalo, goats, sheep and pigs contribute less to total methane emissions from manure management [23]. The addition of tannins and saponins as additives in the feed, modify the fermentation process in the cattle rumen which in turn reduce energy losses, increase animal productivity and reduce methane emissions during livestock production.[24].

Beef consumption also has a significant effect on methane gas emissions from beef cattle farms [prob t (0.000)> α (0.01)], which was positive (ß2 = 0.002). Every 1% increase in consumption leads to a rise by 0.002% in the gas emissions. This consumption rate also leads to an increase in the demand for livestock to meet the needs of the consumertherefore, meat consumption continues to increase every year (Yuniarsih et.al, 2016).

The land forage providers for livestock, namely rice fields (ß3 = -1.230), moor (ß4 = -0.426), state forests (ß5 = -4.853) and community forests (ß6 = -0.503) have a significant negative effect (prob t < α (0.1)). The results from this analysis were different from the study carried out by Ikun (2018) and Tamba (2016) which stated that forage and feed availability have a positive effect on the level of livestock population. CH4 emissions from manure management are influenced by the type of feed given. Therefore, livestock manure which consumes fibrous feed will produce more CH4 compared to grain-based feed [28].

Based on the analysis, it was concluded that an increase in the land used for livestock forage will reduce methane gas emissions depending on the type of land. Apart from the land being viewed as the forage provider for livestock, it is used as green area vegetation which is able to absorb GHG [29]. Rice field management by replacing continuous with intermittent irrigation may reduce $CH_4$ emissions by 78%. Furthermore, the use of low $CH_4$ rice varieties such as Maros, Muncul, Way Apoburu and Fatmawati was able to reduce it by 66-10%. In addition, using herbicides with active ingredients of paraquat and glyphosate reduced $CH_4$ emissions by 60% compared to without herbicides [30]. Rice fields have a lower effect on reducing GHG emissions than other green vegetation areas. In this study, methane gas was reduced by1.23%, with 1hecter (ha) of rice field. The rice sub-sector causes

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greenhouse gas emissions, especially $CH_4$ and $N_2O$, which are closely related to soil oxidation-reduction conditions, created due to inundation and dry periods of cultivation. [31].

The highest reduction in methane gas emissions was influenced by state forest vegetation. In urban areas, forests have the best CO absorption capacity compared to other vegetation.  This is due to the largest area and variation of tree species that have a good level of CO absorption capacity (Fitradaet.al ,, 2020; Mulyadin&Gusti, 2013). The ability of forests to absorb and store carbon is different depending on the species, soil type and topography. Therefore, information on carbon stocks of the various forest, tree, soil types and topography in Indonesia is very important (Marispatin et.al., 2010 cit. Karizal, 2007).

## CONCLUSION AND SUGGESTION

Greenhouse gas emissions from beef cattle farming has continued to increase every year with a positive trend. There is also a positive correlation between beef consumption and methane gas emissions from beef cattle. Furthermore, variables in the form of beef production and consumption, including livestock forage providers in the form of rice fields, moor, state forests and community forests have a significant effect on the amount of GHG emissions from beef cattle farming. However, a number of policies may be taken to solve this problem. Therefore, this study suggests that the environment should be protected wisely and all activities in the livestock business should be addressed to reduce air pollution in Yogyakarta.

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