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Reducing Livestock Greenhouse Gass Emissions by Forage Cultivation at Selobanteng, Situbondo, East Java, Indonesia

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ABSTRACT

Cattle is the strategic commodities in Selobanteng Village, Situbondo, East Java. Based on population monograph data, total cattle population in Selobanteng was recorded around 23.35% of total cattle population in Banyuglugur District, Situbondo Regency. The efforts to reduce greenhouse gas emissions on livestock is through the planting of forage cultivation, which has a measured area and scheduled harvest time. In this way, the age of the forage plants will continue to regenerate so that they can periodically increase carbon absorption. The aim of this research was to calculate of greenhouse gas emissions on social husbandry that implemented forage cultivation. This research was observed at Selobanteng, Banyuglugur sub-district, Situbondo district, East Java. Cattle population was converted into animal units. The ability of carbon absorption from the forage cultivation area was converted from total forage cultivated area or total dry matter production. Greenhouse gas emissions from cattle, biomass and carbon absorption from forage estimation refer to the Intergovernmental Panel on Climate Change - Agriculture, Forestry and Other Land Use by using Tier 2. Total cattle population at Selobanteng was 1,230 cows which was equivalent to 674.6 animal units. Total greenhouse gas emissions based on livestock population is 81.52 tons Gg CO_2-e/year. The forages planted in this program were calliandra, lamtoro, gmelina, corn, banana, rice and elephant grass. The absorption value of total carbon emissions from forage were 137.68 tons Gg CO_2-e/year. Surplus value of carbon absorption were 56.16 tons Gg CO_2-e/year. Planting forage provides positive benefits for the environment to increase carbon absorption.

Keywords: cattle, forage cultivation, greenhouse gas emissions, Selobanteng

ABSTRAK

Sapi merupakan komoditas strategis di Desa Selobanteng, Situbondo, Jawa Timur. Total populasi sapi di Selobanteng tercatat sekitar 23.35% dari total populasi sapi di Kecamatan Banyuglugur, Kabupaten Situbondo. Upaya penurunan emisi gas rumah kaca pada peternakan adalah melalui penanaman budidaya hijauan pakan yang mempunyai luas lahan terukur dan waktu panen terjadwal. Melalui cara ini umur tanaman hijauan akan terus mengalami regenerasi sehingga secara berkala dapat meningkatkan penyerapan karbon. Penelitian ini bertujuan untuk menghitung emisi gas rumah kaca pada peternakan rakyat dengan penanaman. Penelitian ini dilakukan di Selobanteng, Kecamatan Banyuglugur, Kabupaten Situbondo, Jawa Timur. Populasi sapi dikonversi menjadi satuan ternak. Kemampuan serapan karbon dari areal penanaman hijauan pakan ternak dikonversi dari total luas areal budidaya hijauan atau total produksi bahan kering. Estimasi emisi gas rumah kaca dari ternak, biomassa, bahan kering dan serapan karbon karbon dari hijauan pakan ternak mengacu pada *Intergovernmental Panel on Climate Change - Agriculture, Forestry and Other Land Use* dengan menggunakan *Tier 2*. Total populasi sapi di Selobanteng sebanyak 1,230 ekor sapi atau setara dengan 674.6 unit hewan. Total emisi gas rumah kaca berdasarkan populasi ternak adalah 81.52 ton Gg CO_2-e/tahun. Hijauan pakan ternak yang ditanam pada program ini adalah kaliandra, lamtoro, gmelina, jagung, pisang, padi dan rumput gajah. Nilai penyerapan total emisi karbon dari penanaman hijauan pakan ternak sebesar 137.68 ton Gg CO_2-e/tahun. Nilai lebih serapan karbon sebesar 56.16 ton Gg CO_2-e/tahun. Penanaman hijauan memberikan manfaat positif bagi lingkungan untuk meningkatkan penyerapan gas rumah kaca.

Kata kunci: sapi, penanaman hijauan pakan ternak, emisi gas rumah kaca, Selobanteng

INTRODUCTION

Cattle farming is one of the potential commodities of Selobanteng Village, Banyuglugur District, Situbondo Regency, East Java. Population monograph data shows total beef cattle population in Selobanteng Village is recorded at 1,238 heads or around 23.35% of the total beef cattle population in Banyuglugur District, Situbondo Regency. Livestock development in Selobanteng Village is faced with several technical and environmental problems.

The main environmental problem at Selobanteng Village the low water supply as a dry mountainous area so not many plants or grasses grow in the area. The average yearly rainfall is in the medium category, that occurs from November to March. This water problem has a significant impact on forage for feed availability. The main breed of cattle in Selobanteng village is dominated by the Ongol breed, which crosses with Simental and Limousine breeds with artificial insemination.

Efforts to overcome the shortage of forage for livestock feed are through the forage planting program which will begin to be implemented in February 2022. The forage planted in this program are calliandra, leucaena and gmelina. Apart from the forage for livestock, the community independently participates in planting forage for livestock feed in agricultural plants whose the waste can be used as cattle feed, including corn, bananas, rice and specifically napier grass.

Forage planting for livestock provided a solution to the availability of roughage feed. This activity also has very good benefits, especially in increasing the absorption of carbon emissions. This research was conducted to study the value of carbon absorption from planting forage on greenhouse gas emissions on livestock in Selobanteng village, Banyuglugur subdistrict, Situbondo Regency, East Java.

MATERIAL AND METHODS

This research was observed at Selobanteng, Banyuglugur sub-district, Situbondo district, East Java. Data collection on livestock populations was carried out in the second quarter. Population numbers are converted into animal units (AU) using standard calculations : calf are 0.25 AU, yearling are 0.5 AU and mature cattle are 1 AU. Total Animal Unit value was alculated by converted into conversion factor 0.72 for local beef cattle.

$$N_{(t)} \text{ in total actual Animal Unit} = N_{(x)} \times K_{(t)}$$

$N_{(x)}$ are total Animal Unit from calf, yearling and mature cattle. K(t) are convertion factor 0.72 for beef cattle (Syarifuddin *et al*. 2019).

The ability of carbon absorption from the forage cultivation area was converted from February to September 2022. Greenhouse gas emissions from cattle, biomass and carbon from forage estimation refers to the Intergovernmental Panel on Climate Change - Agriculture, Forestry and Other Land Use (IPCC-AFOLU) Tier 2 (2006).

Enterithic Fermentation Methane Emissions :
CH_4 EF emission (CO_2-e ton/AU) = cattle population (AU) × FEe (kg/AU) × 21/1000

Fecal Methane Emissions :
CH_4 FC emission (CO_2-e ton/AU) = cattle population (AU) × FEm (kg/AU) × 21/1000

Fecal N_2O Emission :
N_2O (CO_2-e ton/AU) = cattle population (AU) × (0.05 xFEn)/(1000/(453.6 × 0.72)) ×365 x 293/1000 x44/28 x /1000

Where :
FEe : Enterithic fermentation methane emissions factor (kg CH_4/AU/day)
FEm : Fecal methane emissions (kg CH_4/AU/day)
21/1000 : Conversion constant for CH_4 to CO_2 and from kg to tons
FEn : Fecal N_2O emission factor (kg N_2O/kg feces /day)
293/1000 : Conversion from N_2O to CO_2 and from kg to tons
44/28 : Conversion from N_2O-N to N_2O
0.05 : N excretion average (kg N/AU/year)

Calculation of carbon absorption is carried out using two calculation formulas, namely if the total plant dry matter is known then it will be calculated using the steps to calculate plant carbon stock using a conversion factor of 0.47 from dry matter. The results of the conversion value are then used to calculate carbon absorption with a carbon absorption conversion factor of 3.67 from the carbon stock value. If what is known is the value of plant biomass, it will be calculated using a conversion factor for the value of CO_2 gas absorption of 1.4667 from the photo synthesis equation.

$$\underset{264\ mol}{6CO_2} + \underset{108\ mol}{12\,H_2O} \rightarrow \underset{180\ mol}{C_6H_{12}O_6} + \underset{192\ mol}{6O_2} + \underset{108\ mol}{6H_2O}$$

The result was multiplied by the number of trees planted from each tree species. The total CO_2 uptake value for each tree species is then added together to obtain the total CO_2 uptake value for all planted trees.

RESULT AND DISCUSSION

The total number of livestock in Selobanteng village currently recorded is 1,230 with an adult livestock population of 839 and a population of 399 young livestock (Table 1). The livestock unit value based on the total cattle population in Selobanteng village is 674.46 ST. The breed of cattle commonly kept in Selobanteng village is the Ongol breed of cattle which may have been cross-bred with Simental and Limousine cattle through an artificial mating program so that more Simpo and Limpo cattle are found. The land requirement for livestock grazing in Selobanteng village with a silvopasture grazing pattern is estimated to require an area of 374.70 ha of forest land.

The total livestock population of 674.46 animal units apparently has a potential risk of environmental pollution, especially greenhouse gas emissions and leaching of nutrients which can cause eutrophication and acidification in waters. The livestock population in Selobanteng village

Table 1. Cattle population, animal unit and land requirement

No	Paramters	Value	Unit	Explanation
1	Mature Cattle Population	839	Head	Actual data (April-June 2022)
2	Calf Population	391	Head	Actual data (April-June 2022)
3	Total Population	1.230	Head	Actual data (April-June 2022)
4	Mature Cattle Animal Unit Value	604.08	AU	Calculated by converted of 1 AU is equal to 1 lbs
5	Calf Animal Unit Value	70.38	AU	Calf converted into 0.25 AU
6	Total Animal Unit Value	674.46	AU	Calculated by converted into conversion factor 0.72 for local beef cattle
7	Grazing Land Requirements	374.7	Ha	Calculated by Silvopasture carrying capacity 1.8 AU/ha

Table 2. Greenhouse gas emissions based on livestock population in Selobanteng

No	Parameter	Amount	Unit	Explaination
1	Enterithic Fermentation Methane Emissions	0.666	Tons Gg CO_2-e/year	IPCC-AFOLU Tier 2
2	Fecal Methane Emissions	0.014	Tons Gg CO_2-e/year	IPCC-AFOLU Tier 2
3	Fecal N_2O Emission	80.840	Tons Gg CO_2-e/year	IPCC-AFOLU Tier 2
	Total Emission	81.520	Tons Gg CO_2-e/year	IPCC-AFOLU Tier 2

Table 3. Forage planted at Selobanteng

No.	Plantation	Amount	Unit
1	Caliandra	960,00	trees
2	Leucaena	4.262,00	trees
3	Corn	19.06	hectare
4	Banana	4.906,00	trees
5	Napier Grass	3.48	hectare
6	Gmelina	7.943,00	trees
7	Rice	1.62	hectare

can cause potential greenhouse gas emissions of 81.52 Gg CO_2-e/year (Table 2). This emission value consists of enteritic fermentation methane emissions of 0.67 Gg CO_2-e/year, methane emissions from livestock manure management of 0.01 GHG CO_2-e/year, N_2O emissions from beef cattle manure management of 80.84 Gg CO_2-e/year. Greenhouse gas emissions of this magnitude certainly have a negative impact on the environment. So it is necessary to make efforts to manage livestock in a sustainable manner with an environmental perspective. One effort to reduce greenhouse gas emissions on livestock is through planting forage in a systematic manner, namely having a measurable area and having a scheduled harvest time. In this way, the age of forage plants will continue to regenerate so that they can increase carbon absorption periodically. This problem is answered in the implementation of the next activity, namely the forage planting program.

The carbon absorption capacity of the converted forage planting area from February to September 2022 is 137.68 Gg CO_2-e/year. This absorption value is greater than the carbon emissions released by the total livestock population in Selobanteng village with a surplus value of carbon absorption of 56.16 Gg CO_2-e/year, so this forage planting program provides very positive benefits for the environment.

Corn has the largest land area, namely 19.06 ha, with the largest carbon absorption, namely 88.60 Gg CO_2-e/year. Napier grass has a second carbon absorption of 16.51 Gg CO_2-e/year with a land area of 3.48 ha (Table 3). Rice is the plant with the third highest carbon absorption with an area of 1.62 ha capable of absorbing up to 16.04 Gg CO_2-e/year of carbon. Both corn and napier grass have almost the same carbon absorption value per hectare, namely 4.65 Gg CO_2-e/year/ha for corn and 4.74 Gg CO_2-e/year/ha for napier grass. Rice is a plant with the highest carbon absorption capacity per hectare with a value of 9.90 Gg CO_2-e/year/ton (Table 4). Plants with a short harvest life apparently have a higher carbon absorption value per hectare.

Table 4. Carbon emission absorption of forage area

No	Parameter	Amount	Unit
1	Caliandra Carbon Absorption	13.82	Gg CO_2-e/year
2	Leucaena Carbon Absorption	0.12	Gg CO_2-e/year
3	Corn Carbon Absorption	88.6	Gg CO_2-e/year
4	Banana Carbon Absorption	0.13	Gg CO_2-e/year
5	Napier Grass Carbon Absorption	16.51	Gg CO_2-e/year
6	Gmelina Carbon Absorption	2.46	Gg CO_2-e/year
7	Rice Carbon Absorption	16.04	Gg CO_2-e/year
8	Total Carbon Absorption	137.68	Gg CO_2-e/year
9	Carbon Absorption Value Deducting Livestock Carbon Emissions	56.16	Gg CO_2-e/year

CONCLUSION

The highest greenhouse gas emission on beef cattle farming in Selobanteng village is Fecal N_2O Emission. Planting forage for livestock provides benefits in the availability of forage sources for livestock, and has very good benefits, especially for increasing carbon emissions absorption. Plants with a short harvest life apparently have a higher carbon absorption value per hectare.

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