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Methane Emissions from Beef Cattle in South Sulawesi, Indonesia: An Inventory and Trend Analysis

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ABSTRACT

Methane (CH_4) emissions from cattle are significant but they can be reduced. The beef cattle industry is vital for providing protein to humans. However, the higher number of cattle populations influence the higher amount of methane emissions. This study was conducted to establish an inventory of methane emissions from cattle in the districts of the Regency of Bone (27 districts) and Barru (7 districts), Province of South Sulawesi, Indonesia. The estimation of CH_4 emissions (Gg/year) was calculated using Tier 1 method (IPCC). Tier 1 method is a simplified approach that is typically used when more detailed data and resources are not available. The location of the study was in the regency of Bone and Barru because Bone is the center of cattle fattening and Barru is the breeding center of local cattle in South Sulawesi. Methane emissions from enteric fermentation in the regency of Barru decreased by 14.5% similarly from manure, in 2019-2020 compared to the previous year. Of all the districts in Barru regency, the lowest contributor to CH_4 emissions was Balusu district. The trend of methane emissions from enteric fermentation similar to manure in the regency of Bone showed a gradual increase (around 31%) from 2013 to 2020. District Tanete Riattang and Amali in Bone Regency produced the least amount of enteric and manure CH_4 emissions. It requires more data on the age group categories and body weight to establish inventory of the correlation of emissions to the age group from cattle's industry in those regencies to further decide the actions of mitigation, because the latest Tier method requires the detail record of age group and body weight which may reflects closest to the real amount of the emissions. This study supports the policy of establishing more complete record from the regency and the strategy of reducing the amount of methane emissions whilst increasing the number of cattle population in Indonesia particularly in South Sulawesi.

1. INTRODUCTION

Reducing methane emissions has been a big effort for countries since this past 10 years including the countries that focused on their agricultural production, such as Indonesia. Methane is a potent greenhouse gas that has a much higher heat-trapping potential than carbon dioxide (CO_2) over a short timeframe. While CO_2 is the most abundant greenhouse gas emitted by human activities, methane emissions from agriculture are the second-largest source of methane globally, after the fossil fuel sector. These emissions significantly contribute to global warming. The Province of South Sulawesi is the main beef cattle supplier for eastern Indonesia. The regency of Bone is the center for cattle's production in South Sulawesi with the total of local cattle's population in 2020 was 437,115 cattle. The total area of Bone Regency is about 4,559 km^2 with the population density around 162 people/ km^2 [1]. The other regency, Barru is on the developing process as a breeding center of Bali cattle, with the total population of Bali cattle in 2020 was 117,991 cattle. The total area of Barru regency is 1,175 km^2 with the population density 139 people/ km^2 [2].

Beef meat is still people's favorite choice compares to the other type of red meat in Indonesia. Having been populated by mostly Moslem community, emerging beef meat as a common protein source for people in Indonesia. Beef meat nonfat provides 60% of daily protein in 100g meat, vitamin B12 and vitamin B6 and iron as the component of cell metabolism, protect the neuron system and involve in the production of red blood cell in human [3]. Even though the regency of Bone and Barru are highly prospective in Bali cattle's industry, there is still no report of its methane emissions as the 'side effect' of ruminant industry. Bali cattle, also known as Bali cows, are a unique breed of cattle native to the Indonesian island of Bali. Bali cattle are small to medium-sized animals, with adult cows weighing around 250-300 kg (550-660 lbs) and bulls weighing slightly more [4]. It is primarily raised in small-scale farming systems by local farmers.

The main agricultural commodity from the regency of Barru and the regency of Bone is horticultural products such as: cassava, sweet potato, corn, peanut, and banana. The harvest waste of those horticultural products is potential as the feed component in ruminant's diet. However, most local farmers in those regencies still rely on using the conventional forages and the unprocessed straws for their cattle, that eventually might increase the amount of methane (CH_4) released to the atmosphere. Methane is a potent greenhouse gas, and its impact on climate change can indirectly affect agriculture in several ways such as shifts in precipitation patterns, temperature extremes, and more frequent and severe weather events like droughts, floods, and storms [5] and impact on livestock production [6, 7].

Methane (CH_4) is an odorless gas emitted from ruminants as a 'side effect result' from ruminal fermentation. The more slowly digested fiber gets into rumen, the more amount of CH_4 eructed to the environment. It is concerning because CH_4 has 21 times potentially warmer the earth's temperature compares to carbon dioxide-CO_2 [8] and the amount of methane emitted to the environment means energy loss for the animals [9]. So, if we could capture this energy to convert it to more meat and milk, then why we let it go?

This study aimed to record the inventory of methane emissions from two regencies in South Sulawesi, the main regencies for beef cattle production in Eastern Indonesia. Tier 1 methods are relatively simple and easy to implement, making them accessible for a wide range of organizations and countries. They often rely on basic activity data and emission factors, which can be readily available or estimated without extensive resources, providing a quick initial assessment of methane emissions [10]. In the future, this study will be useful to further decide the regional policy in methane mitigation actions from the livestock sector in South Sulawesi in general and particularly for the regency of Barru and Bone as the center of cattle's development and to support their role as the beef cattle supplier for Eastern Indonesia.

2. MATERIALS AND METHODS

The parameters measured in this study were methane production from cattle's enteric fermentation and methane production from cattle's manure.

Primary data was collected through interviewing the key respondents: The staff of the Livestock and Veterinary Section, at the Department of Agriculture and Horticulture, The regency of Bone and Barru, and also the leader of the farmers groups. Secondary data was collected from the website of statistical board of the Province of South Sulawesi and from statistical report of the Department of Agriculture and Horticulture, The regency of Bone and Barru. The method of measurement of CH_4 emissions from cattle's enteric fermentation and from manure was Tier 1, because data provided was only about the total population (Appendix). The emission factor is based on the information from IPCC [11] for cattle in the Asian countries for warm area. Tier 1 methods are the simplest and least data-intensive compare to the higher Tier and beneficial for developing countries and smaller-scale agricultural operations that may not have the resources for more complex assessments. They can provide a starting point for understanding the magnitude of methane emissions from this sector, which can be important for policy and decision-making. The guidelines and recommendations from IPCC [11] may evolve over time as new scientific knowledge emerges. However, in the Province of South Sulawesi, the emission factor (FE) for the local condition has not been studied yet, and there is very limited information on the livestock production. Whilst it is essential to have the background information on the emissions from this sector.

Methane emission factor (EF) for enteric fermentation beef cattle in Asia Tier 1= 56 [3]

Methane emission factor (EF) for cattle manure in Asia for warm area = 1 [3]

The estimation of total CH_4 emissions from enteric fermentation (Gg CH_4 yr^{-1}) is based on the equation below:

$$E_T = \Sigma_{(P)} EF_{(T,P)} \bullet \left(\frac{N_{(T,P)}}{10^6} \right)$$

E_T = methane emissions from Enteric Fermentation in animal category T, Gg CH_4 yr^{-1}

$EF_{(T,P)}$ = emission factor for the defined livestock population T and the productivity system P, in kg CH_4 $head^{-1}$ yr^{-1}

$N_{(T,P)}$ = the number of head of livestock species / category T in the country classified as productivity system P

T = species/category of livestock

P = productivity system, either high or low productivity for use in advanced Tier 1a

$$\text{Total } CH_{4\ \text{Enteric}} = \sum_{i,P} E_{i,P}$$

Total $CH_{4\ \text{Enteric}}$ = total methane emissions from Enteric Fermentation, Gg CH_4 yr^{-1}

$E_{i,P}$ = is the emissions for the livestock categories and subcategories based on production systems (P)

3. RESULTS

3.1 Methane emissions from enteric fermentation

Emissions from enteric fermentation is the gases resulted from the fermentation process in rumen that is erupted out of the ruminant's mouth. Methane emissions from enteric fermentation in cattle in the Regency of Barru, South Sulawesi, Indonesia, from 2013 to 2020 is presented in the Table 1.

Table 1. Methane emissions from enteric fermentation in the Regency of Barru, South Sulawesi, Indonesia

District	CH_4 Emissions from Enteric Fermentation (GgCO_2-e yr^{-1})							
	2013	2014	2015	2016	2017	2018	2019	2020
Pujananting	12.93	11.59	12.15	12.51	12.69	12.75	10.87	10.91
Tanete Riaja	13.97	13.90	14.57	15.00	15.22	15.29	13.04	13.08
Tanete Rilau	8.84	10.80	11.32	11.66	11.83	11.88	10.13	10.17
Barru	14.34	14.66	15.37	15.83	16.05	16.13	13.75	13.80
Soppeng Riaja	7.28	9.26	9.71	9.99	10.14	10.19	8.68	8.71
Mallusettasi	8.75	10.03	10.52	10.83	10.98	11.03	9.41	9.44
Balusu	6.85	6.95	7.28	7.50	7.60	7.64	6.51	6.54

The lowest amount of methane released to the atmosphere was from district Balusu which was the opposite of district Barru with the amount of CH_4 produced averagely more than double. It appeared that it was related to the total population of beef cattle in the district of Balusu which was the least of all districts. The total of cattle's population in Balusu was averagely 5.923 head for the past five years whereas in the district of Barru, it was more than double, which was averagely 12.506 head. However, the trend shows that CH_4 production was gradually declined in each district in 2019 to 2020, along with the reduction in the number of the cattle. The number of the ruminant's population is one of the factors that trigger the increasing amount of the emissions. There are some other factors such as: the type of the diet, the fiber content of the diet, the feed intake, the size and the breed of the animal [12-14].

Mostly farmers in the regency of Barru feed their ruminants with Elephant Grass (70%) as the basal diet, then they mix it with natural grass, rice straw, corn stove and peanut straw as the fiber source. For the non-fiber source, the local farmers purchase their concentrate from local agricultural store. All the type of straws that were fed to the ruminants in the district of Barru, were unprocessed, so this might not modulate the H transfer during the fermentation process in rumen resulted in more methanogenesis [15, 16]. It is likely that the high lignin content on the unprocessed straws increased the number of protozoa population, in which methanogens were attached to. Consequently, methane production is highly possible to escalate [17]. This is exacerbated by the number of cattle's population. However, to prove this, further study in investigating the rumen microbial variation is required.

Diets high in fibrous material result in higher methane emissions compared to diets with more easily digestible feed. For example, cattle on a diet of high-quality forage produce less methane than those fed high-grain diets. Additionally, the varieties and the age of forage and the types of forage also influence the amount of methane emissions from cattle. For example, feeding Leucaena reduced methane yield 17%-40% at the various level of inclusion in the heifer's diet [5] compared to grass that was probably due to the presence of the anti-methanogenic compounds in legume [2]. Other studies indicated that there was significant difference in methane emissions from cattle fed corn silage-based diet which was lower 11% to 45% compared to grass silage-based diet [18].

Recent study in calculating methane emissions from livestock in Java, Indonesia [19] and in Western Australia [20] reported that the amount of methane emissions from livestock mainly depends on the number of the livestock population. The amount of methane emissions might have been reduced if the agricultural waste was processed prior to given to the ruminants. Turning any straw to the silage could ease the fiber degradation process in the rumen and altering the hydrogen (H) pathway during the ruminal fermentation. Thus, more H will be 'captured' by fiber degrading bacteria to convert it to VFA particularly propionate than to use it to form CH_4. It means more gross energy is available to produce meat and milk as the final product from ruminants. It was reported in many studies that CH_4 represents energy loss about 2-12% [8, 14, 21].

Table 2. Methane emissions from enteric fermentation in the Regency of Bone, South Sulawesi, Indonesia

District	CH_4 Emissions from Enteric Fermentation ($GgCO_2$-e yr^{-1})							
	2013	2014	2015	2016	2017	2018	2019	2020
Ajangale	.00	8.11	9.51	9.12	8.71	11.68	11.41	12.75
Amali	2.33	2.66	3.90	4.94	5.72	6.42	7.78	8.76
Awangpone	18.92	20.58	22.83	24.87	22.39	15.93	14.26	15.26
Barebbo	12.49	13.47	15.15	16.91	18.26	20.13	16.95	18.31
Bengo	10.33	10.96	12.28	13.52	15.23	15.31	16.79	17.97
Bontocani	13.74	15.73	17.77	19.58	21.16	21.22	21.38	22.52
Cenrana	11.22	10.89	12.21	13.83	14.93	15.31	15.63	16.72
Cina	15.70	14.98	16.58	18.28	19.76	18.48	18.82	19.96
Dua Boccoe	4.36	4.91	5.74	7.75	10.18	18.11	15.52	16.65
Kahu	33.87	32.15	33.61	31.05	39.12	45.28	47.25	44.19
Kajuara	15.38	15.72	16.44	17.84	22.96	18.93	19.18	20.47
Lamuru	10.85	11.67	13.03	14.16	15.73	17.27	16.49	17.84
Lappariaja	11.94	12.18	13.57	14.91	16.23	17.73	20.33	20.64
Libureng	46.64	50.86	56.24	58.29	42.32	49.72	50.47	46.67
Mare	19.75	20.98	23.06	25.22	27.79	24.58	24.76	26.13
Palakka	13.89	15.14	16.98	18.57	19.17	18.80	18.90	20.06
Patimpeng	16.00	15.24	16.93	17.72	23.92	28.12	28.44	28.89
Ponre	14.72	16.75	19.12	21.92	16.33	16.41	16.55	16.94
Salomekko	11.12	10.59	10.75	11.13	12.24	12.90	13.11	14.08
Sibulue	19.78	22.09	24.89	27.56	33.16	24.93	25.23	26.10
Tanete Riattang	2.53	2.40	3.22	3.31	7.79	7.80	7.88	6.15
Tanete Riattang Barat	6.73	7.41	8.60	10.33	16.27	8.90	8.86	9.68
Tanete Riattang Timur	7.42	8.43	10.05	12.08	13.71	8.05	8.00	8.90
Tellu Limpoe	10.77	12.57	14.35	16.64	18.69	16.41	16.36	17.42
Tellu Siattinge	10.23	11.44	13.17	14.80	10.74	12.51	12.85	14.03
Tonra	8.47	9.50	10.64	13.27	14.49	15.91	15.75	16.76
Ulaweng	4.89	5.27	6.03	7.29	6.70	9.51	9.41	10.19

Data on Table 2 shows that the highest amount of enteric CH_4 was emitted from the district of Libureng, then followed by the district of Kahu. There are only 2 districts (Tanete Riattang and Amali) that produce the least amount of CH_4. This might closely relate to the total population of cattle in those districts. As the trend of the total population of cattle increased, the rate of CH_4 emissions was also going up. Similarly, when the cattle's population reduced. For example, in the district of Tanete Riattang Timur, the cattle's population reduced 41,7% in 2019 compared to that in 2017. This triggers the reduction in the enteric CH_4 emission and manure CH_4 emission to 41% in the same year. The trend of the data indicated that the reduction in methane emissions is mainly due to the reduction in the total of cattle population, whilst the amount of methane in manure and enteric methane showed the similar trend. As has been reported in a very recent study that there was no difference in enteric methane and methane in manure [18].

Similar to the local farmers in the district of Barru, mainly the local farmers in district of Bone fed their cattle with rice straw and corn straw and any available forage nearby. Consequently, the ruminal fermentation process of structural carbohydrates may not be effective, hence influence the ratio of acetate to propionate in rumen that is beneficial to the animal host [22]. Cellulose from fiber source and starch from non-fiber source diet for ruminants will all be converted to glucose then will be furtherly converted to VFA. The conversion occurs in different pathways. It is preferred that 93% of glucose energy is degraded to form VFA particularly propionate, that can be achieved through ruminal microbial population [23]. From the context of local farmers in Indonesia, the manipulation of rumen microorganism is practically done through diet manipulation either through the inclusion of tannin containing plants or flavonoid containing plant or ensilage of the agricultural by-products. Converting the straw in to silage will provide more degradable fiber that will be advantageous for ruminal fiber degrading bacteria, providing more VFA that is essential for the animal host and possibly reduce methane production compare to unprocessed straw. However, it should be considered that the ensilage of the unstructured carbohydrate or non-fiber source will eventually produce less amount of methane than the structural based [2, 10]. Similarly, legume ensilage produced less amount of methane compared to grass ensilage because legume basically contains less structural carbohydrate than grass [24]. It is considerably important to find the right proportions of such feed component in the complete ration in order to achieve the target of the weight gain and the total population of cattle whilst reducing the environmental footprints.

There are national rules in reducing the emissions in all sectors. However, until recently, there has no local government policy about the strategies in reducing methane emissions from agricultural sector in regency of Bone and Barru whilst keep increasing the total population of cattle.

3.2 Methane emissions from manure

The source of methane emissions from livestock is from enteric fermentation (80-90%) and the rest is from manure. There is more amount of CH_4 emitted to the environment when ruminant eructates. Gas that is trapped in the rumen is released in big amount and directly from mouth. Methane contained in manure is from the rest of the fermentation process in colon which cause only very few amounts of CH_4 is found in manure [4]. Data below presents the amount of CH_4 in manure in Cattle's farm in the Regency of Barru (Table 3) and Bone (Table 4).

Methane from ruminants is emitted through enteric fermentation (80-90%) and through feces (10-20%) due to the different amount of methane produced in foregut fermentation compared to that in hindgut fermentation [25].

Even though there is less methane emitted in feces, it may give significant environmental footprint if there are less mitigations of actions in further processing the feces.

Data shows that in the regency of Barru (Table 3), the amount of CH_4 released in manure is much less than that was released from enteric fermentation. The district of Barru contributed the biggest amount of manure CH_4 from 2013 - 2020 followed by Tanete Riaja district then Pujananting district and the least was from district Balusu. The interesting trend is that there was a reduction 13,4% in CH_4 manure from 2018 to 2019 until 2020. It requires further investigation about the cause of the trend, even though it is a satisfying signal, however the total population of cattle was also decline in those years. Whereas on the other side, it is compulsory to increase the total population of the cattle to fulfil the market demand.

In the regency of Bone, the trend showed that the amount of manure CH_4 emission continued to increase from year to year (Table 4). In 2020, manure CH_4 emission was going up 31,12% from 2013. It is concerning, because there could be a prevention by converting manure to biogas and using the solid waste of the slurry as organic fertilizer. Processing manure to become an energy source or a heat source requires proper installation.

It has been introduced three units of the biogas installation in the districts in the regency of Bone. However, to keep the installations operating properly and sustainable requires a continuous supply of slurry as well as continuous collection of the solid waste from the installation to be further processed to become fertilizer. If this run efficiently, it is possible that it will benefit the farmers for their daily use as well as for their income. In the future, it requires a strong commitment from the farmers and the livestock field officer from the government and most importantly the sponsor fund either from the local government or the private investors to implement best management practice in cattle industry in the regency of Bone and Barru to increase the total of cattle population whilst reducing methane emissions.

Table 3. Methane emissions from manure in the Regency of Barru in 2013-2020

District	CH_4 Emissions from Manure ($GgCO_2$-e yr^{-1})							
	2013	2014	2015	2016	2017	2018	2019	2020
Pujananting	.23	.21	.22	.22	.23	.23	.19	.19
Tanete Riaja	.25	.25	.26	.27	.27	.27	.23	.23
Tanete Rilau	.16	.19	.20	.21	.21	.21	.18	.18
Barru	.26	.26	.27	.28	.29	.29	.25	.25
Soppeng Riaja	.13	.17	.17	.18	.18	.18	.16	.16
Mallusettasi	.16	.18	.19	.19	.20	.20	.17	.17
Balusu	.12	.12	.13	.13	.14	.14	.12	.12

Table 4. Methane emissions from manure in the Regency of Bone in 2013-2020

District	CH_4 Emissions from Manure ($GgCO_2$-e yr^{-1})							
	2013	2014	2015	2016	2017	2018	2019	2020
Ajangale	.00	.14	.17	.16	.16	.21	.20	.23
Amali	.04	.05	.07	.09	.10	.11	.14	.16
Awangpone	.34	.37	.41	.44	.40	.28	.25	.27
Barebbo	.22	.24	.27	.30	.33	.36	.30	.33
Bengo	.18	.20	.22	.24	.27	.27	.30	.32
Bontocani	.25	.28	.32	.35	.38	.38	.38	.40
Cenrana	.20	.19	.22	.25	.27	.27	.28	.30
Cina	.28	.27	.30	.33	.35	.33	.34	.36
Dua Boccoe	.08	.09	.10	.14	.18	.32	.28	.30
Kahu	.60	.57	.60	.55	.70	.81	.84	.79
Kajuara	.27	.28	.29	.32	.41	.34	.34	.37
Lamuru	.19	.21	.23	.25	.28	.31	.29	.32
Lappariaja	.21	.22	.24	.27	.29	.32	.36	.37
Libureng	.83	.91	1.00	1.04	.76	.89	.90	.83
Mare	.35	.37	.41	.45	.50	.44	.44	.47
Palakka	.25	.27	.30	.33	.34	.34	.34	.36
Patimpeng	.29	.27	.30	.32	.43	.50	.51	.52
Ponre	.26	.30	.34	.39	.29	.29	.30	.30
Salomekko	.20	.19	.19	.20	.22	.23	.23	.25
Sibulue	.35	.39	.44	.49	.59	.45	.45	.47
Tanete Riattang	.05	.04	.06	.06	.14	.14	.14	.11
Tanete Riattang Barat	.12	.13	.15	.18	.29	.16	.16	.17
Tanete Riattang Timur	.13	.15	.18	.22	.24	.14	.14	.16
Tellu Limpoe	.19	.22	.26	.30	.33	.29	.29	.31
Tellu Siattinge	.18	.20	.24	.26	.19	.22	.23	.25
Tonra	.15	.17	.19	.24	.26	.28	.28	.30
Ulaweng	.09	.09	.11	.13	.12	.17	.17	.18

4. CONCLUSIONS

The trend of methane emissions from enteric fermentation in the regency of Barru and Bone, Province of South Sulawesi is in line with the trend of methane emissions in manure. The amount of methane emissions in manure is around 10-15% than CH_4 emitted from enteric fermentation. There is only district Balusu that produced the least amount of CH_4 emissions in the Regency of Barru and there are only two districts in the Regency of Bone (Tanete Riattang and Amali) that produced the least amount of methane emissions. However, as this study used Tier 1 method due to the very limited data sources available, the estimation of methane emissions can only be used as the baseline to rethink about the possible strategies in achieving the sustainability in cattle production in Barru and Bone.

Reducing methane emissions from cattle while increasing their population is a complex challenge, but it is essential for addressing climate change and ensuring sustainable food production. There are some potential mitigation strategies that could be considered for the regency of Bone and Barru such as: improving the livestock record on the age groups and types of feed, improving feeding practices by using high quality forage or processed feed, introducing feed additives, using methane inhibitor supplementation, promote alternative forage protein sources; supporting research in breeding and genetic selection; Implement policies that put a price on carbon emissions, creating financial incentives for emissions reduction; educate cattle farmers about methane emissions and sustainable practices.

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APPENDIX

Tables A1 and A2 below are the additional information about the data of the total cattle population in the Regency of Barru and Bone from 2013-2020.

Tabel A1. Total of the cattle's population in the Regency of Barru, South Sulawesi, Indonesia, from 2013 - 2020

Districts	Total of Cattle's Population (head)							
	2013	2014	2015	2016	2017	2018	2019	2020
Pujananting	10,994	9,856	10,330	10,636	10,787	10,838	9,243	9,276
Tanete Riaja	11,878	11,819	12,388	12,756	12,938	12,998	11,086	11,123
Tanete Rilau	7,514	9,187	9,629	9,915	10,057	10,105	8,616	8,646
Barru	12,194	12,469	13,069	13,457	13,649	13,713	11,693	11,734
Soppeng Riaja	6,187	7,875	8,253	8,499	8,621	8,662	7,385	7,410
Mallusettasi	7,441	8,532	8,942	9,208	9,338	9,383	8,001	8,028
Balusu	5,828	5,906	6,191	6,375	6,465	6,496	5,538	5,557

Source: BPS Barru, 2021

Tabel A2. Total of the cattle's population in the Regency of Bone, South Sulawesi, Indonesia, from 2013 - 2020

Districts	Total of Cattle's Population (head)							
	2013	2014	2015	2016	2017	2018	2019	2020
Ajangale	-	6,895	8,084	7,756	7,410	9,928	9,701	10,843
Amali	1,983	2,265	3,318	4,202	4,867	5,461	6,614	7,446
Awangpone	16,091	17,504	19,417	21,144	19,043	13,542	12,128	12,974
Barebbo	10,619	11,455	12,885	14,375	15,530	17,118	14,413	15,567
Bengo	8,787	9,320	10,445	11,499	12,950	13,016	14,275	15.280
Bontocani	11,680	13,376	15,110	16,648	17,992	18,045	18,177	19,148
Cenrana	9,538	9,260	10,384	11,760	12,697	13,017	13,292	14,220
Cina	13,353	12,735	14,098	15,546	16,806	15,713	16,001	16,972
Dua Boccoe	3,711	4,174	4,882	6,588	8,656	15,403	13,201	14,161
Kahu	28,800	27,342	28,581	26,405	33,267	38,500	40,177	37,575
Kajuara	13,077	13,371	13,979	15,167	19,526	16,095	16,308	17,410
Lamuru	9,227	9,926	11,080	12,040	13,373	14,685	14,021	15,170
Lappariaja	10,154	10,359	11,539	12,679	13,798	15,077	17,286	17,553
Libureng	39,656	43,250	47,826	49,565	35,983	42,279	42,914	39,687
Mare	16,794	17,837	19,609	21,448	23,634	20,905	21,056	22,220
Palakka	11,812	12,875	14,438	15,794	16,301	15,989	16,074	17,059
Patimpeng	13,608	12,955	14,396	15,066	20,336	23,910	24,185	24,566
Ponre	12,517	14,247	16,261	18,643	13,885	13,957	14,073	14,408
Salomekko	9,455	9,005	9,142	9,466	10,404	10,969	11,144	11,971
Sibulue	16,822	18,784	21,163	23,434	28,196	21,201	21,458	22,193
Tanete Riattang	2,148	2,039	2,738	2,812	6,625	6,631	6,698	5,226
Tanete Riattang Barat	5,723	6,299	7,310	8,780	13,831	7,564	7,534	8,230
Tanete Riattang Timur	6,311	7,172	8,548	10,272	11,662	6,847	6,803	7,571
Tellu Limpoe	9,161	10,688	12,204	14,148	15,897	13,953	13,912	14,816
Tellu Siattinge	8,700	9,731	11,203	12,586	9,132	10,641	10,929	11,934
Tonra	7,206	8,082	9,048	11,284	12,320	13,530	13,395	14,249
Ulaweng	4,159	4,478	5,131	6,201	5,697	8,083	8,001	8,666

Source: BPS Bone 2021