Integration of kelor (Moringa oleifera) with coffee plantation to fulfill quality forage for livestock in Samosir Island

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Abstract. Samosir Island is the location of coffee plantations especially in Pangururan subdistrict. Currently coffee farmers in Samosir are trying to utilize a protective plant for coffee tree that is Kelor. This study investigated how far the integration of Kelor with coffee plantation can support forage for Panorusan Samosir goat. This research has been conducted on a coffee plantation in Samosir Island, Parlondut Village from April to November 2017. The design was split plot design with four replications. First factor (M): starter dosage in biogas slurry, M1= 1 liter/150 kg (fresh buffalo manure+water hyacinth) and M2= 2 liters/150 kg (fresh buffalo manure+water hyacinth). Second factor (P): dosage of fertilizer which was biogas slurry (t/ha/yr), P0=0, P1=20, P2=40. Parameters observed were slurry chemical composition, fresh weight and dry weight production, Kelor production and Kelor potential for Panorusan Samosir goat feed. The results showed that interaction between M2 and P2 significantly affect (P<0.05) fresh and dry weight production of Kelor. In conclusion fresh weight production of Kelor was 10.30 t/ha/yr and by integrating Kelor with coffee plantations in Pangururan subdistrict, there would be 833 t/yr fresh Kelor while goat feed need 912.5 t/yr. As endemic goat is an endangered species, Kelor could support higher reproduction of goat.

1. Introduction

Samosir Island located in the middle of Lake Toba is famous for its beauty. Because the island is the result of volcanic eruptions, the soil is very suitable for planting coffee, so most of the people are coffee farmers. The Samosir community also keep a lot of livestock because local wisdom believes that livestock bring prosperity and health to the community. The livestock that are kept are buffalo and goat. The endemic goat called Panorusan Samosir goat can now be categorized as an endangered species, because pure goat Panorusan which local language called Siladdap only about 400 heads left. One of the caused of reduced livestock population in Samosir is the source of forage feed that become more difficult to obtain. It relates to the conversion of vacant land to plantations, especially coffee.

Coffee plant requires a protective plant. In coffee plantations such as in Takengon Aceh, the community uses legume trees namely Lamtoro (Leucaena leucocephala) as a protective tree. Utilization of the legume tree in Takengon is limited to provide benefits such as improving fruit ripening, increasing soil fertility and prolong time of coffee tree production period.

According to [9] coffee crop in Samosir island were advised to use a local legume tree called Kelor (Moringa oleifera) as protective tree. Furthermore [9] mentioned Kelor was a multi purposes...
plant because it helps to fertilize the soil, helps conservation because of the germination was about 85% and propagation can also by stacking, useful for human consumption because it used to cook with traditional recipe and is preferred by livestock namely Panorusan Samosir goat. Kelor has a complete amino acid content. It contains 18 amino acids consisting of 8 essential amino acids and 10 nonessential amino acids [16].

Related to the start of Kelor utilization by the community as a protective tree for coffee plantation, it is necessary to investigate how far the integration of Kelor with coffee plantation can support forage for Samosir endemic goat. This research was an initial research of a series of research where the next research will be a trial of Kelor utilization related to reproduction of Panorusan Samosir Goat.

In this research, fertilization using slurry from biogas installation. Renewable energy was introduced in Samosir Island, as it was in accordance with the policy of Sustainable Tourism Observatory [14] as the area designated as an international tourist Location, which pursued renewable energy to be applied. Because in Samosir there were many buffaloes, so the input of bio gas reactor was buffalo faeces and *Eichornia crassipes* which was in accordance with the policy of the Samosir Regional Government, *Eichornia crassipes* should be reduced as much as possible from Lake Toba body waters.

Slurry of bio gas is a product of organic soil material like manure [10]. Slurry is useful for the fertilization of vegetables, fruits and trees / perennials. Slurry of bio gas had an advantage when compared to manure or compost as nutrition because it could be metabolized faster by plants. For every 250 ml of slurry was equal to 2.5 g NPK [11]. [17] mentioned that bio gas slurry was rich in macro elements, N, P, and K and micro elements such as Ca, Mg, Fe, Mn, Cu and Zn.

2. Materials and Methods

The research was conducted in Parlondut Village, Pangururan subdistrict, Samosir district, Sumatera Utara and it was lasted for 7 months (April to November 2017) with 2 weeks land preparation. A survey also was conducted on coffee farmers in order to investigate the pattern of coffee cultivation on site. The materials used were legume seeds of 2-month-old Kelor, slurry of buffalo faeces and water hyacinth, water, starter. The tools used in the research were two unit installation from 20 micron plastic tubes of biogas 500 litres capacities (M1 and M2). M1 was a unit bio gas installation, filled with 75 kg buffalo faeces and 75 kg water hyacinth + 225 l of water + 1 liter starter while M2 has the same input + 2 liters starter.

The experimental design used was a split plot design using two factors, namely:
I. The first factor used as the main plot was starter dosage of slurry
   M1 = slurry with 1 liters starter
   M2 = slurry with 2 liters starter
II. As sub plot was a different dosage of slurry as of fertilizer each treatment, among others:
   P0 = Without the use of bio-slurry fertilizer
   P1 = Given a slurry gas fertilizer with a dose of 166g / plot (20 ton / ha/year)
   P2 = Given a slurry gas fertilizer with a dose of 332g / plot (40 ton / ha/year)

The data obtained were analyzed, and if the treatment was significantly different (F ≥ 0.5) or very real (F ≥ 0.1) then Duncan test was used to analysed.

The research parameters were as follows:
1. Chemical composition of slurry (50% buffalo faeces + 50% water hyacinth) with 1 and 2 litres dosage of starter. Samples were analysed in Animal Nutrition and Feed Laboratory, Faculty of Agriculture, Universitas Sumatera Utara.
2. Fresh Weight Production
Fresh weight was obtained from weighing of each treatment in fresh form. The production of fresh ingredients was calculated at the time of defoliation. Leaves and twigs were tied neatly with plastic straps, then weighed.

3. Dry Material Production
Dry matter was obtained from the production of fresh weight of legume after weighing, then oven at 60 °C for 24 hours, then weighed. Furthermore, samples was taken as much as 2 grams to know the weight of plants in 105 °C oven. Conversion was performed between the weight percentage at 60 °C and at 105 °C for the production of dry matter.

4. Moringa oleifera production on integration with coffee plantation in Samosir
Secondary data for the area of coffee cultivation was obtained from the Department of Agriculture of Samosir District. At this time the community started planting Kelor as a protective plant for coffee. It was assumed that the production of Kelor will be in accordance with the condition of the research until the coffee plant is 5 years old.

5. Moringa oleifera potential when integrating with coffee plantation used for Panorusan Samosir goat feed in Pangururan subdistrict, Samosir.
In this subsection, a calculation was done of the needs of legume for the goat population in Pangururan.

3. Results and Discussion

Table 1. Chemical composition of slurry (50% buffalo faeces + 50% water hyacinth) with 1 and 2 litres doses of starter

| No. | Parameter | Unit | Starter (liter) | 1   | 2   |
|-----|-----------|------|----------------|-----|-----|
| 1   | C-Orgnik  | %    |                | 3.82| 4.12|
| 2   | N total   | %    |                | 0.26| 0.35|
| 3   | C/N       |      |                | 17.69| 15.16|
| 4   | P2O5      | %    |                | 0.46| 0.52|
| 5   | K2O       | %    |                | 0.73| 0.54|

Table 2. Fresh weight and dry weight production; fertilized by different slurry dosage

| Fertilization Dosage (ton/ha/yr) | P0 | P1 | P2 | Average |
|----------------------------------|----|----|----|---------|
| Fresh Weight Production          |    |    |    |         |
| M1                               | 151.41 | 154.16 | 160.04 | 154.80B |
| M2                               | 152.37 | 158.54 | 170.08 | 160.33A |
| Average                          | 151.89C | 156.35B | 165.06A |   |
| Dry Material Production          |    |    |    |         |
| M1                               | 31.39 | 33.89 | 38.61 | 34.63B |
| M2                               | 32.47 | 38.40 | 43.74 | 38.20A |
| Average                          | 31.93C | 36.14B | 41.18A |   |
3.1 Chemical Composition of Slurry

Chemical composition in Table 1 showed that biogas slurry have C/N ratio with MOD 1 liter and 2 liter equal to 17.69 and 15.16 which already fulfill SNI standard. It means that the slurry was good as fertilizer due to degradation process has already taken place on buffalo feces and water hyacinth. [2] suggested C/N around 12 was good as it enabled plants to metabolized nutrients. [12] mentioned that good C/N would support a sustainable productivity and suggested for slurry that had C/N more than 20 to get maturity by keeping the slurry for at least a month which caused N value increased as population of microorganism still developed. Microorganism itself is amino acid. [4] argued that compost stability was indicated, among others, by a low C/N ratio. C/N of M2 was better than M1 and this was due to the population of microorganism which was higher in M2 than M1. The more population of microorganism especially local microorganism would cause slurry getting matured faster and subsequently would support low C/N. Associated with this phenomenon, it is suggested for farmers to make their own starter with local microorganisms such as Lactobacillus sp. According to [13] Lactobacillus sp. could be had from Dadih curd. Dadih was a specific fermented food which make from buffalo milk in a bamboo tube.

3.2 Fresh Weight Production

The highest fresh weight production of Moringa oleifera was caused by interaction between M2 and P2 which was 170.08 g/m^2 months or 10.20 ton/ha/yr. It could be caused by higher macronutrient content of M2 which are required by plants, i.e N, P, and K. Nutrient content in slurry which is in a liquid form, provides nutrition and be absorbed by plant easily. Metabolism process then produced nutrition for growing [5]. [19] also stated that the nutrient content in the slurry was complete but the quantity was small so it needs to be improved by adding other ingredients that contain macro nutrients and beneficial microorganisms such as nitrogen-fixing microbes that present in M2 or P2.

3.3 Production of dry matter

The highest value of dry weight of Moringa oleifera was caused by interaction between M2 and P2 which was 43.74 g/m^2 2 months or 2.29 t/ha/yr. It was assumed that the application of slurry with higher populations of microorganisms caused improving soil structure and the metabolic conditions in soil. [1] stated that the quality of the remaining slurry of the biogas manufacturing process was better than the cattle dung directly from the cage. This was supported by [15], the provisioned of organic fertilizers could improve soil structure, increased soil absorption of water, increased living conditions in the soil, and was as a source of food substances for plants.

3.4 Moringa oleifera production on integration with coffee plantation in Samosir

The data obtained in this study were for newly planted coffee plantation until coffee plant reaches 5 years old. In coffee that has been 5 or more, coffee canopy was very dense and affect the production of Kelor, therefore the production data processed in this study were until the coffee tree was 5 years old. In the future, new data will required as the collection of Kelor biomass for livestock feed should take for the importance of Kelor shade benefits for coffee fruit quality.
Table 3. Planting area of coffee in Pangururan Subdistrict

| No. | Sub district | Planting Area of Coffee |
|-----|--------------|-------------------------|
|     |              | TBM | TM  | TTM | TOTAL       |
| 1.  | Pangururan   | 165.00 | 476.50 | 38.00 | 679.60 |
|     | (2016)       |      |       |      |            |
| 2.  | Pangururan   | 185.14 | 457.00 | 57.50 | 699.64 |
|     | (2017)       |      |       |      |            |

Source: Samosir Agriculture Agency (15)

Note:
- TBM: Plants have not yet produced
- TM: Plants Produce
- TTM: Plants Do not Produce

Data obtained from the [6], known that in 2017 there were 185.14 TBM (plants that have not produced). Coffee planted in the field at the age of 6 months has about 4-8 leaves. In 2017 there were 457 ha of TM (plant that starts to produce fruit) from 2 years old. Well-preserved coffee crops which are cleaned and periodically fertilized caused coffee can be replanted at age 25 years. On the other hand coffee crops which are not well taken care of, at the age of 5 years only produce less fruit and replanted earlier. Therefore, a simple effort is needed to prolong the production period of coffee crops by giving them protect trees of legumes. From the TM data, it can be assumed that 15% of plant has aged up to 5 years so has the total land that can be planted with Kelor is about 245 ha. In this study, fresh material production data was based on cropping with a distance of 1x1m while in the coffee crop, the spacing was 3x3m. The production of Kelor fresh material in this study was 833 tons of 245 ha of Kelor integration coffee plantation.

Data obtained from [7], showed that the highest Panorusan Goat population was found in Pangururan District. The population of Samosir goat as pure breed or crossing were about 2500 heads. Samosir Goat reproduction was catagorised as low and it was related to feed problems. People generally tether goats on open land and bring back to the cage in the afternoon. In the cage, goats were given additional forage. In general, forage quality was equivalent to field grass. With the economic level of society in Samosir today, people are not willing to provide additional feed such as concentrate. Goat in Samosir has an average birth of 1. Goats will not have optimal reproductive performance if they are not provided with sufficient nutritional intake. [18] mentioned that ewes which grazed on legume pasture tended to have twin lambs. Heat on livestock was influenced by protein intake and one source of protein is legume like Kelor. In addition [3] mentioned that either goats or sheep which fed by plant that may supply energy and protein showed positive effect on reproduction.

According to [8] the weight of a Panorusan Samosir Goat was about 30 kg. The daily forage requirement of a goat is about 10% of body weight and the legume needs about 30% of forage. If Kelor becomes an alternative legume, it takes about 1 kg per head per day. When the population of goats in Pangururan 2,500 heads then the needs of Kelor per day were 2,500 kg or 912.5 tons per year. It is known that if Kelor is integrated with coffee plantation area of 245 ha will be obtained Kelor of 833 tons and that amount is slightly smaller than total requirement of goat found in Pangururan District. Utilization of legume will greatly affect the acceleration of reproduction. At this time Panorusan goat shows the tendency of declining in population and one of the causes is the distance of births is far and the average birth is only 1. The average number of births of goats is 2. It is expected that the use of Kelor through integration with the coffee plant in Pangururan District will increase the population of Panorusan Samosir Goat.
4. Conclusions

The higher use of slurry doses increased the production of fresh weight and dry weight of Kelor (*Moringa oleifera*). Application of 2 liters of starters every 150 kg input biogas (75 kg buffalo feces + 75 kg water hyacinth + 225 l water) interaction with slurry doses of 40 t/ha/yr resulted in higher fresh weight production of Kelor, i.e. 10.20 ton /ha/yr. Integration of Kelor with coffee plantation could supply endemic goat of Samosir, i.e., Panorusan Samosir goat with legume. It is hoped that the utilization of Kelor through integration with the coffee plant in Pangururan Subdistrict will raise the population of Panorusan Samosir Goat. From 245 ha coffee plantation with coffee aged below 5 years, could produced 833 ton fresh Kelor/year while 2,500 goat in Samosir need 912.5 ton fresh legume such as Kelor.

References

[1] Ayub SP 2004 *Organik cair aplikasi dan manfaatnya* (Jakarta: Agromedia)
[2] Badan Penelitian dan Pengkajian Pertanian Sumatera Utara 2007 *Kandungan unsur hara dalam kompos*
[3] Blache, Dominique, Maloney SK and Revell DK 2007 *Technology (Elsevier)* **147** 140
[4] Brito LM, Coutinho J and Smith SR 2008 *Bioresource Technology* **99** 8955
[5] Bougnom BP, Kofler CN, Knapp BA, Stimpfl E, Ingam H 2012 *Biomass and Bioenergy* **39** 290
[6] Dinas Pertanian Kabupaten Samosir 2018 [Annual Report]
[7] Dinas Peternakan Kabupaten Samosir 2018 [Annual Report]
[8] Doloksaribu M, Batubata A and Elieser S 2006 *Prosiding Seminar Nasional Teknologi Peternakan dan veteriner* 4-5 Agustus 2006 (Bogor: Pusat Penelitian dan Pengembangan Peternakan Bogor)
[9] Ginting, Nurzainah, Ginting N, Aulia DN, Hidayati J 2018 *Journal of Saintech Transfer* **1**
[10] Ginting N 2018 *IOP Conf. Series: Materials Science and Engineering* **309** 012053
[11] Ginting, Nurzainah, Novilda and Mustamu E 2012 *Proc. The 2nd Annual International Conference Inconjunction with The 8th IMT-GT Uninet Biosciences Conferences* (Indonesia: Syiah Kuala University. Indonesia) ISSN : 2089-208X.
[12] Ginting N 2017 *IOP Conf. Series: Materials Science and Engineering* **180** 012112
[13] Ginting, Nurzainah and E. Pase. 2018 *IOP Conf. Series: Earth and Environmental Science* **130** 012022
[14] Kementerian Pariwisata Republik Indonesia 2017 *Pedoman Observatorium Pariwisata Berkelanjutan (Sustainable Tourism Observatory)*
[15] Lingga P and Marsono 2008 *Petunjuk penggunaan pupuk* (Jakarta: Rajawali Press)
[16] Makkar H and Becker K 1996 *J. Agri. Sc. Cambridge* **128** 311
[17] Suzuki K, Takesi W and Volum 2001 *Concentration and crisatalization of ophosphate, ammonium, and mineral in the effluent of biogas digesters in the Mekong Delta* Jerean and Contho (Vietnam: University Vietnam)
[18] Vinoles C, Meikle A and Martin GB 2009 *Animal reproduction science* **113** 82
[19] Widodo and Takesi W 2007 *Konsentrasi posfat, ammonium dan mineral hasil fermentasi biogas.* (Vietnam: Vietnam University)