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The Implementation of *Eco-Techno Farming System* to Increase Farmer's Income and Reduce Green House Gases Emission

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Abstract. Maintenance of beef cattle at the farm level is still done traditionally without technological touch, especially for the waste produced. Likewise, food crops such as sweet corn (*Zea Mays L. Saccarata*) dependence of farmers on subsidized fertilizers is quite high, the availability of which is not in accordance with the time farmers need. The impact of all this is not optimal plant productivity, greenhouse gas (GHG) emissions in the form of N2O and CH4 increased due to the accumulation of solid and liquid beef cattle waste and the use of chemical fertilizers intensively**.** Therefore, it is necessary to implement a techno-ecological agricultural system to increase income and reduce greenhouse gas (GHG) emissions. Methods of activities include (1) processing beef cattle solid and liquid waste into organic fertilizer "Trichokompos" in various formulas by adding banana stem waste (LBP), feed forage (HSP), and rice straw (JP) (2) processing liquid waste beef cattle into Liquid Organic Fertilizer (POC) Biourin E2P (3) Processing corn into SIPROMO (Probiotic Molasses Silage) as feed supplement for beef cattle. The results of the activity show that various solid waste products (Trichokompos) and liquid waste (Biourine E2P) beef cattle and supplement feed in the form of SIPROMO (silage probiotic molasses) corn waste can reduce production costs, and can be a business opportunity to increase revenue and reduce glass gas emissions (GHG).

Keywords: Organic fertilizer, Silage, Emissions, Greenhouse gases, Income

Abstrak. *Pemeliharaan sapi potong ditingkat petani masih dilakukan secara tradisional tanpa sentuhan teknologi terutama terhadap limbah yang dihasilkan. Begitu juga halnya usaha tani tanaman pangan seperti tanaman jagung manis (Zea Mays L. Saccarata) ketergantungan petani terhadap pupuk subsidi cukup tinggi, yang ketersediaannya tidak sesuai dengan waktu kebutuhan petani. Dampak semua ini produktivitas tanaman tidak optimal, emisi gas rumah kaca (GRK) berupa N2O dan CH4 meningkat karena penumpukan limbah padat dan cair sapi potong dan*

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penggunaan pupuk kimia secara intensif. Oleh karena itu perlu implementasi sistem pertanian tekno-ekologis guna meningkatkan pendapatan dan mengurangi emisi gas rumah kaca (GRK). Metode kegiatan berupa (1) Mengolah limbah padat dan cair sapi potong menjadi pupuk organik "Trichokompos" dalam berbagai formula dengan menambahkan limbah batang pisang (LBP), Hijauan sisa pakan (HSP), dan jerami padi (JP) (2) Mengolah limbah cair sapi potong menjadi Pupuk Organik Cair (POC) Biourin E2P (3) Mengolah jagung menjadi SIPROMO (Silase Probiotik Molasses) sebagaifeed suplemen sapi potong. Hasil kegiatan menunjukkan produk berbagai limbah padat (Trichokompos) dan limbah cair (Biourine E2P) sapi potong serta feed suplemen berupa SIPROMO (silase probiotik molasses) limbah jagung dapat mengurangi biaya produksi, serta dapat menjadi peluang usaha untuk menambah peningkatan pendapatan serta mengurangi emisi gas kaca (GRK).

Kata Kunci*: Pupuk organik, Silase, Emisi, Gas rumah kaca, Pendapatan*

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1. Introduction

In general, farming carried out by farmers is still traditional in nature, both for beef cattle cultivation and food crop farming. The condition is caused by limited knowledge of the farmers and the technology for implementing the farming is not yet optimal. In the beef cattle raised, farmers usually only rely on forage in the form of grass as a source of cattle feed. In rainy season the forage availability will not be a problem. However, the availability decreases during dry season, so that it would lesses the forages supply and then affect the productivity of beef cattle. Moreover, in terms of waste generated from cattle, farmers have not treated them properly: beef cattle manure is discarded or piled around the cage, as well as liquid waste in the form of urine is also not used optimally. This maintenance system will clearly affect the environment especially on greenhouse gas (GHG) emissions produced in the form of methane (CH_4). Beef cattle manure that is not utilized will contribute to global warming due to methane (CH_4) emissions. The accumulation of beef cattle manure has the potential to increase the production of methane (CH4) if not utilized [1], as the methane gas (CH_4) has a great influence on geothermal energy. It was reported before that livestock manure 51% plays a role in the presence of greenhouse gases (GHG) [2].

In food crop farming, farmers' dependency on chemical fertilizers is very high. Due to the high price of chemical fertilizer, the farmers are forced to replace the fertilizer from the subsidiary fertilizer. However, the availability of subsidized fertilizer is not continuous and it also difficult to obtain by the farmers. This condition also leads to greatly impact on the productivity of the farming business. In addition, the high use of

N fertilizer by farmers also rises the production of greenhouse gases (GHG) in the form of N_2O. The N_2O has an effect 298 times more powerful influence compare tothe heavy elementof CO_2[2]. Farmers are also unable to process food waste into products that can be used, and by farmers after harvesting is allowed to accumulate, usually will be burned at the time of replanting.

The behavior of farmers in implementing traditional system obviously will affect the productivity of the business undertaken. Production costs become high as a result of farmers' dependency on subsidized fertilizers, and burning plant wasteduring harvest season can trigger land fires (Karhutla). Therefore, it is necessary to minimize the behavior of these farmers, by starting to implement a "*eco-techno farming system*". The system is an integration of livestock and plants by implementing technology that considering the environment, so that environmentally friendly agriculture can be applied [3]. In this system there is a synergistic system between livestock and plants, especially in the use of waste, where livestock waste can be given to plants and plant waste can be given to livestock. The synergy between livestock and plants cause no waste that can be potentially damaged the environment especially due to greenhouse emissions (GHG) production. In addition, the use of reduce the production costs incurred because they can utilize the waste generated between livestock and plants. The global warming itself would significantly affect the farming. [1] stated the accumulation of beef cattle manure has the potential to increase. Therefore, it is necessary to have a good technology so that the waste can be transformed to a product that has economic value resulting in the increase in farming productivity.

With the integration of livestock and plants in *eco-techno farming system*, solid and liquid beef cattle waste canbe processed into organic fertilizer "***trichocompost***" and liquid fertilizer "***biourine Empon-Empon***". The application of processed cattle cattle waste when combined in the field will be a source of organic fertilizer which is expected to reduce the use of chemical fertilizers. For plant, rice or corn, waste, it can be processed into a feed Supplement Product with Molasses (**SIPROMO)** products.

Utilizing various waste both from livestock and plants into an efficient product meant that the farmers have also played an important role in reducing greenhouse gas (GHG) emissions and global warming. The increase in farming productivity encourages the creation of economically independent farmers because it can drive the rural economy. In addition, the high productivity will greatly affect the lives of farmers themselves, so that a whole a more prosperous, safe and peaceful community is created. Therefore, the application of *eco-techno farming systems* should be implemented in farmer groups, because the system has many advantages. The eco-techno system can increase farmers' income, reduce greenhouse gas (GHG) emissions in the form of N_2O, CH_4 and CO_2, improve productivity and management of farming and be environmentally friendly agriculture.

2. Methods

Based on the stated problems above, several activities were carried out in the form of outreach and direct application in the field. Activities undertaken include:

1. Introduction of the *eco-techno farming system*, so that the farmers can understand the benefits of this system when it is implemented in farming.
2. Making a demonstration plot, in this case making 4 (four) boxes, to process beef cattle solid waste and other waste surounding the area to be used as organic fertilizer "Trichokompos". For this purpose, banana trunk waste is used as a result of banana thinning (LBP). Forage residual waste (HSP) and rice straw (JP)
3. Making liquid organic fertilizer (POC) biourine empon-empon (E2P), which was made from urine waste which was fermented with empon-empon extracts and EM4 bioactivators
4. Making SIPROMO rice straw with ingredients: rice straw waste, rice bran, probiotics produced from EM4, yogurt, pineapple and molasses.

1. Implementation of Eco-Techno Farming System

Cattle's Solid and Liquid Waste Utilization Method and SIPROMO

Banana Thinning (LBP) Trihochompost, Forage Residual Waste (HSP) Trichokompos and Rice Straw Trichocompost

Trichokompos Formula made from banana stems, residual feed waste are shown in Tabel 1. Application of Beef Cattle Solid Waste Processing Technology are shown in Figure 1.

Success Indicator in Creating Trichocompost are the physical performance and a measured indicator.

a. Physically the trichompost should be not smelly, have blackish brown color and be crumbs and not sticking in the hand.

b. For a measurable indicator the data need to be measured with a thermometer, a moisture meter and a pH meter. If fermentation process has been done, the temperature of compost must achieve 30° C, with moisture content of 45-55% and pH 6-8.

Table 1. Formula Trichocompost LBP, HSP and JP

Material	Trichocompost	Trichocompost LBP	Trichocompost HSP	Trichocompost JP
	----------	---------- %	----------	----------
Feces	85	75	75	75
Banana Stem Waste (LBP)	-	10	-	-
Forage Feed Leftover Waste (HSP)	-	-	10	-
Paddy Straw (JP)	-	-	-	10
Sawdust	5	5	5	5
Husk Charcoal	5	5	5	5
Rice Bran	5	5	5	5
Trichoderma	1 kg	1 kg	1 kg	1 kg

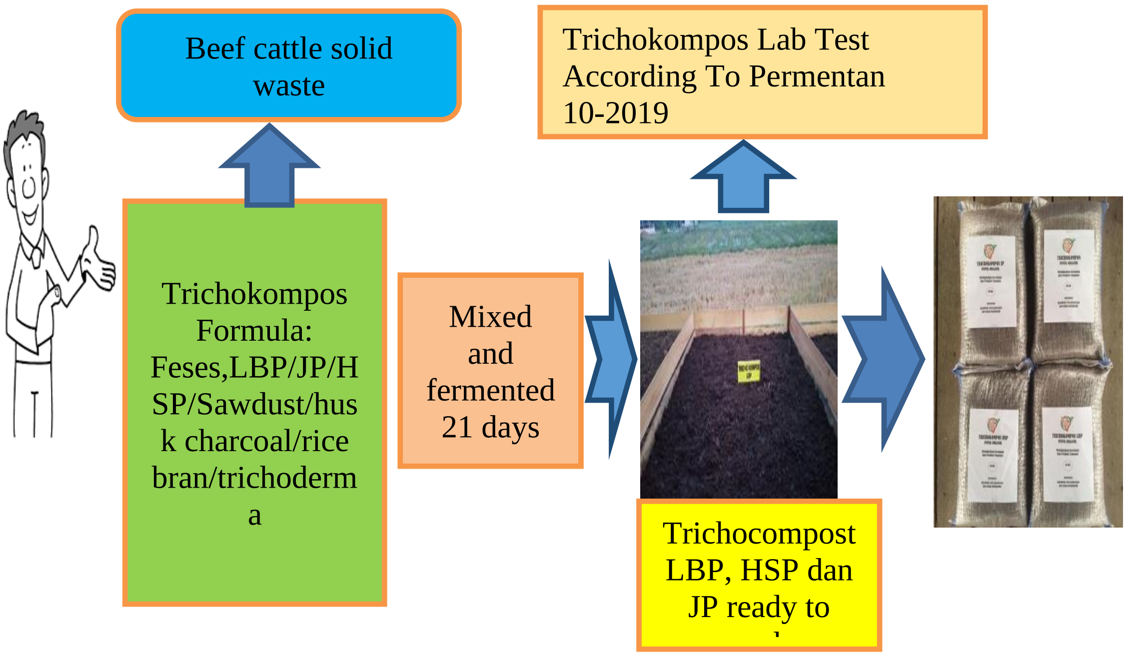

Figure 1. Application of Beef Cattle Solid Waste Processing Technology

If the indicator mentioned above has been fulfilled, compost is ready to pack and sell to the market. This marketing process will be better if it is accompanied by laboratory analysis on compost nutrition value. The composition must be in accordance to the regulation mandated by Permentan 01-2019 or Indonesian National Standard (SNI) for solid inorganic fertilizer.

2. Cattle's Liquid Waste Utilization (Biourine)

Required materials used for castle liquid waste utilization were 100-130 L cattle's urine, 750 mL molasses, 5 kg empon-Empon, 250 mL EM4 bioactivator and 10 L clean water.

Production Step:

There are steps that can be used to create liquid organic fertilizer (POC) from cattle's biourine, which are:

a. Empon-empon that has been mashed directly poured into urine and add EM4.
b. After empon-empon has been mashed,then create a new extract to be added to urine solution
c. These materials later poured into a drum which has been closed tightly in order to prevent the intrusion of air in order to keep the fermentation process running perfectly.
d. Stir the mixture around 15 minutes then close the drum tightly. The stirring process need to be done everyday for 21 days.
e. After 21 days, directly filter the urine and do the aeration by utilizing aerator for three hours. The purpose of this process is to reduce ammonia content in the solution.
f. Biourine is ready to use.

Preparation in using POC from this cattle's urinewas by mixing or diluting it with water with 10% comparison (1 litre of urine: 10 litre of water)

Producing *Feed Supplement* of Silage Probiotic Molasses (SIPROMO) rice straw and corn

a. Feed Supplemen of SIPROMO rice straw and corn can be produced with the mixture of some materials including rice straw or corns, rice bran, salt and probiotic (*blended 25 kg Molasses and 5 pineapple fruits , 1 bottle EM4, ½ kg milk powder, 3 bottles of Yakult and a drum with 150 L capacity*).
b. Silage Probiotic Molasses (SIPROMO) of Paddy Strawcan be produced by firstly prepare 250 kg rice straw and corn. Put it in a layer of drums and each layer is watered with rice bran and probiotics, layer again with rice straw/corn. Do it until the drum is full and compacted so that no air is left. After full and solid in the drum, cover with rice bran and flush again with probiotics. Cover tightly, until 2-3 weeks.

Open the drum lid after 2-3 weeks. g. Smell the aroma of SIPROMO if it produces good smells.

c. Before being given to beef cattle it is aerated first.

The schematic diagram of rice straw Sipromo technology shown in Figure 2.

Figure 2. The Process of processing rice straw into SIPROMO rice Straw

3. Results and Discussion

Profile of Farmers in the Community Economic Zone of Pudak Village, Kumpeh Ulu District, Muaro Jambi Regency

In general, the pattern of farming cultivation and raising beef cattle were still traditional, farmers only relied on field grass as the mainstay of the cattle. The remaining forage was wasted and was not utilized properly. From beef cattle manure produced, either solid or liquid, was also not utilized properly, and the wastes were only allowed to accumulate around the cage. Even though if it was utilized, the potency has not been maximized. This accumulation of beef cattle waste would obviously pollute the environment, especially by producing methane gas (CH_4), so that it became a contributor to *global warming*. This behavior was a cultivation behavior practiced by almost all rural farmers. This condition was happening due to the current business was not correctly applicable in a business manner, they had no productivity target to be achieved. Furthermore, low motivation and innovation made business productivity was not optimal. Farmers had not read the business opportunity by utilizing waste generated from raising livestock. In food crop cultivation, the need for fertilizer subsidies was very high, however, the availability of this fertilizer was not continuous. Using commercial fertilizer was costly, therefore it is expected to use subsidized fertilizers. However, the availability of subsidized fertilizer was also very limited that lead to low farming productivity. Subsequent behavior in conducting livestock or crop cultivation in rural areas did not consider the environment. Plant waste was a source of the increase in greenhouse gas (GHG) emissions because it was burned when the plant returns. In the dry season, burning on land often triggered land fires. Therefore, it was necessary to implement *aneco-techno farming system* to prevent environmental damage and to reduce production costs. The aim of this activity, of course there was a need for synergistic activities between livestock and plants, so that all waste generated by livestock and plants could be mutually beneficial. If this being applied, it would produce environmentally friendly or sustainable agriculture.

Implementation of *Eco-TechnoFarming Systems*

The techno-ecological agricultural system, also known as "*eco-techno farming*", was an agricultural system that implemented technology and considered the ecological (environment). According to [2], the characteristics and factors forming the techno-ecological agricultural system included:

a) **the diversity (diversification) of commodities,** there must be at least two commodities or species cultivated that had a functional relationship with the first commodity

b) **there was an integrative pattern**, without integration or functional diversification between two or more commodities. Integrative pattern was a pattern in farming that emphasized commodities that were endeavored to have a functional relationship in the utilization of food substances, so that commodities did not compete, but substituted each other in meeting nutrient needs. In this case, the chain of food substances was formed mainly by the utilization of waste. Plant waste was processed for animal feed, while livestock waste was processed for plant fertilizer and this agricultural model would create a waste free area (zero waste)

c) **Local resources utilization oriented**, because the *eco-techno* agricultural model encouraged the formation of a closed production cycle, it would naturally be oriented to the utilization of local resources and suppressed the entry of external inputs. This was in accordance with the principle of low external input and sustainable agriculture (LEISA), because there was a chain of utilization of food substances from plants to livestock in the form of plant waste for feed and from livestock to plants in the form of waste (feces and urine) for fertilizer. Through the process and the addition of certain ingredients from local resources, biopesticides and bioenergy were also produced. With the orientation on the utilization of local resources, *the eco-techno agricultural model*, besides being more efficient, would also reduce the dependence of farmers on external inputs so that it would further ensure the sustainability of farming activities

d**) environmentally friendly**, the application of environmentally friendly technology was a feature as well as a supporter of strengthening the techno-ecological. In addition, the reduction of using inorganic materials (fertilizers, pesticides, feed) and increasing the use of organic materials, was also oriented to maintain a balance between ecosystem components. This was done to maintain the diversity of species (commodities) and ensured the preservation of agricultural resources, such as land, water and the organisms that lived in them that were beneficial to the stability of the ecosystem. Moreover, environmentally friendly technologies could reduce GHG emissions.

(e) **The existence of yield processing**, this was a very important support in addition to being able to add value to agricultural products. The application of yield processing technology would also support the formation of production cycles.

In this activity a variety of wastes, such as cattle waste in the form of solid and liquid, banana stem waste, forage feed leftover waste and rice straw, could be used as a compiler for organic fertilizer. This material was used to produce trichocompost organic fertilizer. This trichocompost product itself could be produced in various products such as LBP trichocompost (banana stem waste), HSP trichocompost (forage feed leftover) and JP trichocompost (rice straw). By producing this product, it indirectly showed or disseminated to farmers that there were many business opportunities that could be make to be used as a source of additional income besides raising livestock or farming. At least the organic fertilizer produced could be used for their own needs, so that the dependence on chemical fertilizers could be reduced. Moreover, the use of organic fertilizer made by themselves would reduce production costs. The direct impact of the fertilizer innovation would reduce the potential for environmental pollution, especially reducing the potential for an increase in greenhouse gases (GHG) in the form of methane (CH_4) and nitrogen in oxides (N_2O). [1] reported that the application of *a eco-techno* farming system in the form of an integration model between beef cattle and food crops (PAJALE) could increase productivity, livestock farmers' income, and reduced greenhouse gas (GHG) production. Furthermore, it was stated, that the pile of beef cattle manure had the potential to increase methane gas (CH_4) and (CO_2) which contributed to the increase of Greenhouse Gas (GHG) and global warming. The effect of methane gas (CH_4) was 23 times stronger than CO_2 and contributed to filling the atmosphere which caused the earth's temperature to get warmer. Likewise, the liquid waste of beef cattle in the form of urine could also potentially be used as additional income. Fermentation the liquid waste using empon-empon and EM4 could be use as liquid organic fertilizer (POC) for plants. This POC product was expected to replace chemical liquid N fertilizer, because excessive used of N fertilizer would trigger N_2O emissions.

In the traditional system, rice straw would usually be piled on the ground and burned at the time of replantingMeanwhile, agricultural waste, like rice and corn, can also be processed. In this activity farmers were trained to make beef cattle feeding from agriculturalwaste by transferring (*Silage Probiotic Molasses*) SIPROMO technology. It wasexpected that SIPROMO could substitute forage needs during the dry season. SIPROMO technology wasalso supposed to encourage farmers for not buring the waste. [4] stated that feed which has been preserved and processed as raw material in the form of forage fodder that had been fermented by lactic acid bacteria in acidic and aerobic conditions (without oxygen) to stimulate the formation of acidic atmosphere could be added additives in the form of digestible carbohydrates such as drops of carbohydrate fermented by lactic acid bacteria in an acidic and aerobic atmosphere (to process without oxygen). Sugar cane and bran. It was further stated that the purpose of making silage was to anticipate animal feed supplies in the dry season, to accommodate excess forage in the rainy season, and to utilize agricultural waste such as rice straw and corn.

By utilizing various wastes from both livestock and plants, farmers were expected to maintain thesustainable agriculture. I tis believed that the implementation of *eco-techno farming system* would be able to increase farmers' income and reduced greenhouse gas (GHG) emissions.

The Impact of Various Waste Utilization (Livestock and Crops)

The impact of processing cattle waste (solid and liquid) into trichocompost and biourine can be a good source of income to the farmers. Calculation analysis using traditional and techno-ecological farming systems is presented in Table 2.

Table 2. Analysis of Farming Enterprises Traditional Agricultural Systems and Agricultural Systems Techno-ecological

No	Labor and Production Costs	Traditional System	Tech-Echo System
I.	Corn		
a.	Labor (OH)	4.140.000	4.140.000
b.	Saprodi	7.600.000	4.380.000
c.	Total Cost (1)	11.740.000	8.520.000
d.	Harvest		
	Revenue	20.000.000	25.200.000
f.	Income (1)	8.260.000	16.680.000
II.	Cow	11.582.500	10.697.500
	Harvest		
	B. Final Price of Cattle (Unit)	16.000.000	19.600.000
	Income (2)	4.417.500	8.902.500
III.	Compost	0	1.274.000
	Revenue	162.000	4.035.000
	Income (3)	162.000	2.761.000
IV.	Biourine	0	17.952.000
	Revenue	0	37.900
	Income		19.948.000
	Total Production Cost	23.322.500	38.443.500
	Total Income	36.162.000	66.787.000
	Income	12.839.500	28.343.500
	R/C	1,55	1,74

Tabel 2. showed that the implementation of *eco-techno farming system* given higher income than traditional system. This was due to the implementation of *eco-techno farming system*, opened business opportunities to increase income for farmers.

In addition to increasing revenue, the impact that would be seen was environmental pollution in the form of the potential for an increase in greenhouse gas (GHG) emissions that could be reduced, because all waste was processed into products that had a sale value.Strategies so that this system could motivate other farmers, activities implemented in the form of demonstration plots, in one area of farm business must be carried out continuously, so that demonstration plots in this area would become a model for other farmer groups and farmer groups that are fostered will become *pioneers* for these farmer groups.

4. Conclusions

The implementation of *eco-techno farming system*could increase farmers' incomes and had a positive impact on reducing greenhouse gas (GHG) emissions. Processing various wastes in a farming area would be a source of income for farmers and the realization of sustainable agriculture.

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