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Farmer Behavior in Rice Local Cultivation As A Mitigation Approach in Global Warming Reduction

*Sidharta Adyatma[1],Soemarno[2],Sukoso[3],Akhmad Rizali Saidy[4]
[1]*Faculty Teaching and Education, Lambung Mangkurat University, Banjarmasin Indonesia;*
[2]*Faculty of Agriculture, Brawijaya University, Malang Indonesia;*
[3]*Faculty of Fisheries and Marine Science, Brawijaya University, Malang Indonesia;*
[4]*Faculty of Agriculture, Lambung Mangkurat University, Banjarmasin Indonesia*
*Corresponding Author: * Sidharta Adyatma*

Abstract : *The aim of the research is to identify the concordance value of farmer behavior and green house emission reduction in rice cultivation in swamp ecosystem in Barito Kuala in South Kalimantan, Indonesia. In order to identify the concordance level, the questionnaire distributed to 375 respondent in Tamban and Marabahan sub-regency. Data was analyzed descriptively. Result of the study shows that farmer behaviors has high level concordance to the green houses gases emission reduction. The level of concordance in Tamban was calculated about 55.3%, while in Marabahan it is recorded about 55.8%. The very high level of concordance was calculated about 44.7% in Tamban and 44,2% in Marabahan. The traditional farming practices in Tamban and Marabahan is important in the effort to minimize green house emission, and therefore it is important for global warming reduction*.

Keywords : *green houses gases mitigation, rice cultivation, local rice variety, peat swamp ecosystem*

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I. Introduction

Peat swamp is important ecosystem in the earth. In natural condirion, peat swamp ecosystem is a carbon *source* and *sink*, in which ait is important in global climates regulation. Peat swap ecosystem is the bigest sources of CH_4 emission and contributes to the 255 of CH_4 in athmosprere [1] [2] [3]. The conversion of peat swap as agricultural land, especially for rice cultivation, is source of CH_4 [4] [5]. The rapid development of rice filed in peat swamp forest has been contribute to the wild habitat disturbance, and therefore there is important to manage peat swamp ecosystem sustainably [6] [7].

Farming has been identified contribute to the global warming. Agricultural activity contributes significantly in global warming through CH_4 production [8] [9]. Rice field has contribute to the CH_4 emision about 10%, between 26-61Tg per year (terra gram = 10^{12} gram) or equal to 6-29% total emisi of CH_4 per year [10] [11] [12]. In Indonesia, there are about 7,748,840 Ha rice field in 2002. In 2011, however, rice field decrease to 6,758,840 Ha [13]. It is equal to 6,8% of total global rice field. In the worlds, there totally about 3.2-5.8 Tg of CH_4 was released yearly [14]. In East Kalimantan, the amjority of rice field was located at the Barito Kuala Regency. There are about 99,695 Ha of rice field, in which about 78,209 Ha was used as local rice sites cultivation. There are about 38 local rice cultivated in south Kalimantan [15] [16].

The opening of rice field in swamp ecosystem requires numerous techniques of land preparation and management, ranging from preparation, fertilization, weeding, irrigation and adding compost which are contributes to the green houses emission to atmosphere [17]. The opening of rice field in peat swamp ecosystem was addressed to increase rice productivity and food stability. In such practice however, the proper management of land conversion to rice land require proper management and sustainable practices, which the objectives is minimizing green houses emission from peat swamp ecosystem. It is especially important because rice land contributes to the 70.9% of green house emission [18]. Green houses emission from agricultural lands was influced by farmer behaviour in rice culivation, ranging from rice field management, fertilizing lands, irigationn, and types of rice variety which area cultivated. Water quality and soil characteritics also contributes to the green houses rate emission in agricultural lands. The aims of the study is to describes and identify the farmer behaviour in rica cultivation in South Kalimantan and its concordanec levet to the green houses emission.

II. Methodology

Study site

Studi site for observation was located at Barito Kuala Regency, South Kalimantan Province n Klaimantan Island, Indonesia. Geographcally, it is located at 2°29'50" to 3°30'18" south latitude and

144°20'50" to 114°50'18" East Longitude. Study area located at peat swamp land with brackish water (Zone I) and peat swamp land with freshwater (Zone II). These lands has been intensively used by local people as land for rice cultivation. Farming is common activity in Barito Kuala. There are 9,364 farmer registered in Tamban sub-district and 6,673 farmer in Marabahan sub-district. Totally, there are about 16, 037 registered in Barito Kuala.

III. Methods

In order to to identify the farmer behavior and its concordance to the effort to minimize green houses gasses emission, this study employ observation and questionnaire techniques. In this study, the respondent consist of local farmer who cultivate local rice in Barito Kuala. The sample size for respondent was calculated following Morgan principles, with assuming that farmer is homogenous. Following the Morgan methods, there are 373 farmer selected in this study. It is consist of 219 farmer from Tamban and 156 farmer from Marabahan district. Questionnaire was constructed by involving some key questions to identify the concordance levels of farmer behaviors, namely land preparation, water management, rice variety usage, seeds selection, seedling techniques, transplanting, transplanting techniques, weeding, fertilizing, plant protection, and harvesting –post harvesting Data was analyzed descriptively. The concordance level between farmer behaviors and green house gasses emission was evaluated using questionnaire analysis, in which respondent's answer in interval score was calculated using formula [19]:

$$I = \frac{R}{K} \dots\dots\dots (1)$$

In which:
I = interval length
R = range (higest score minus lowest score)
K = number of category

Based on the calculation, the highest score was = 93 and the lowest score was = 31, therefore R value was 62. Number of category was (K) 5, and the interval score was I = 62/5 or 12.4. Based on the calculation, the concordance levels using 5 category and interval 12.4 was given in Table 1.

Table 1. The score interval and the concordance level between farmer behavior and green house emission

No.	Score interval	Concordance level
1.	80.7 – 93.0	Very high
2.	68.3 – 80.6	High
3.	55.9 – 68.2	Medium
4.	43.5 – 55.8	Low
5.	31.0 – 43.4	Very low

IV. Result and Discussion

Based on the questionnaire data, the concordance levels between farmer behavior and green house gasses emission reduction was given in Table 2.

Table 2.Level of concordance between farmer behavior in local rice cultivation in green house gasses emission reduction

No.	Interval score	Concordance	Tamban		Marabahan	
			Number of respondent	Percentage (%)	Number of respondent	Percentage (%)
1.	80.7 – 93.0	Very high	98	44.7	69	44.2
2.	68.3 – 80.6	High	121	55.3	87	55.8
3.	55.9 – 68.2	Medium	0	0.0	0	0.0
4.	43.5 – 55.8	Low	0	0.0	0	0.0
5.	31.0 – 43.4	Very low	0	0.0	0	0.0
Total			219	100	156	100

Based on the analysis of concordance level between farmer behaviors and green houses gasses emission reduction it is clear that the majority of farmer has high rate number of concordance. It means that farmer behavior potentially contribute to the effort to mitigate global warming from agricultural sector. The high level of farmer behavior concordance to the green houses emission reduction can be related to the farmer behaviors and practices in rice cultivation. From the systematic observation in the field, the farmer practices can be considered as traditional practices, in which it is important in sustainable agriculture. The practices includes:

1. Land preparation

In Both study area, land preparation was initiated by shrubs and weed clearing. The clearing was done using traditional equipment called *tajak*. The reason for using *tajak* in land preparation was simple, equipment availability and easy in operation. *Tajak* is suitable cutter equipment in water dominated area. This traditional equipment represents the ability of local people to build and modify farming equipment to meet effective works in flooding rice lands, including peat swamp lands. Slashing shrubs and grasses in water dominated area effective using long cutter equipment, like *Tajak*. The use of long cutter equipment able to cut the basal area of weeds and therefore reduce the ability of plant to grows. About 219 respondent (100%) state that there are no herbicide application to combat shrubs and grasses. Only few farmer in Marabahan (37 respondents, 24%), used herbicide in low intensity due to some technical aspect. The majority of respondent to use traditional equipment is related to the cost of slashing and cutting shrubs and grasses. The rest of shrubs and grasses contain organic matter which are traditionally used as mulch and increase organic matter availability in soil. About 156 respondent (100%) in Tamban and 219 in Marabahan state that organic matter is important and keep the biomass for at least two weeks for further processing. In land management practices, 184 respondent (84%) in Tamban and 127 respondent (81.4%) in Marabahan state there are less and no further land further treatment; while 35 respondent (16%) in Tamban and 29 respondent (18,6%) in Marabahan state there is still some land treatment before rice planting. Farmer's behaviors consistent with the research result that state the management of land without intensive treatment able to reduce methane emission about 10,8Kg/Ha [18] [20].

2. Water management

Respondent state that irrigation is important and all respondent use irrigation system for rice cultivation. The water comes from Barito Rivers through main canals and secondary canals to the rice field. About 155 respondent (70.8%) respondent in Tamban watering rice field continuously, while 64 respondent (29.2%) using intermiten techniques. In Marabahan, 83 respondent (53%) using intermiten techniques, while 42 (26.9%) continuously watering the rice field. Farmer argues that inundation is significant step in rice cultivation and increasing grain productivity. The inundation of rice field contribute to the methane emission about 55.5Kg/Ha [18] [20], and therefore it is contradictive with the effort to minimize green houses emission.

3. Rice variety

All of the respondent uses local rice as a min rice variety in swamp ecosystem. The reason behind the use of local rice includes: the local rice easy to plant and grow in swamp environment, local rice has good taste, and local rice has high price in market. Local rice was cultivated one time per year, while superior rice variety was cultivated two to three times per year. Therefore, compare to the local rice, superior rice produce higher methane emission. According to Budiastuti (2008) rice variety with high grain productivity contributes to the higher methane emission compared to the rice with low grain productivity[21]. Planting two times contribute lower methane emission compared to the three times planting in one year. The uses of local rice therefore potentials to reduce green hoses emission.

4. Seeds selection

There are two techniques in seeds selection. In Tamban, 188 respondent (85.8%) use salt solution to select seeds, while in Marabahan about 125 respondent (80.1%) used salt solution 3%. About 31 respondent (14.2%) in Tamban and 31 (19.9%) in Marabahan use ZA solution to select seeds. ZA solution is poisonous solution to environment [22]. but used to select seeds because low cost, effective to separate good and bad seeds, and there is also government subsidy to get ZA. The majority of farmer in using salt solution is arguably relevant with the effort in green houses gases reduction from agricultural sectors.

5. Seedlings

There two techniques in seedling, wet and dry seedling techniques. Most of the respondent state that the seedling done without chemical fertilizer applications. Mostly report that uses of compost is the common techniques in seedling. Wet seedling was done in dry season. About 184 respondent (84%) in Tamban and 136 respondent (87.2%) in Marabahan report that soil for seedling has rich organic matter, and therefore chemical fertilizer application was not needed. Few respondent reports the application of chemical fertilizer during seedling process. About 19 or (8.7%) respondents in Tamban use few amount of fertilizer, including 10gr urea, 10gr TSP (14gr SP 36) and 10 gr KCl per m^2 while in Marabahan 20 respondent (12.8%) use 10gr urea, 10gr TSP (14gr SP 36) and 10 gr KCl per m^2 and 16 respondent (7.3%) use fertilizer and compost. Dried seedlingw was done during rainy season. There are also few application of chemical fertilizer.

6. Transplanting

All of the respondents state that planting done using manual techniques, and in many occasion it is done by involving community member. The reason behind planting techniques is preserving cultural

togetherness among community in rice transplanting. Such practices is low emission and free from pollution. In transplanting, the distance of seedling was vary from 30-40 cm to >40 cm. About 123 respondent (56.2%) in Tamban and 97 respondent (62.2%) in Marabahan use transplanting distance >40cm (locally known *sadapa lima*); while 96 respondent (43.8%) in Tamban and 59 (37.8%) in Marabahan use transplanting seedling 30 – 40 cm (locally called *sadapa anam*). The reason for the majority of respondent to use *sadapa lima* is related to the rice grain productivity and famer accessibility to control rice population grows using traditional small boat called *jukung*. It is especially important during regular pest control, rice maintained and harvesting. The *sadapa lima* lead the number of rice clump relative few and therefore correlates with the effort to minimize green house emission. Low clump number will produce low methane emission. About 39 respondent (17.8%) in Tamban and 55 respondent (35.3%) Marabahan put one seed in one hole, while180 petani (82.2%) in Tamban and 101 (64.7%) Marabahan put two seed in one hole. It is depend on the rice variety. One seed in one hole was applied for rice with high number of tiller, while two to three seeds in one hole was applied for rice seed with few tiller number. Overall such practice relevant with the effort to minimize green house emission in rice farming in swamp lands.

7. Transplanting time

All of the respondent state that only one time planting was permitted in one year. This is significantly different with the superior rice cultivar, in which there are opportunities to three times planting in one year. The local rice has age 9 to 11 month. There are also opportunities to plan two time in one year using local rice with shorter ages, but the number was few. It was reported by only 45 respondent (28.8%) in Marabahan. One time transplanting in one year has significant contribution to reduce green houses gases emission.

8. Weeding

All of the farmer in Tamban and Marabahan practicing weeding manually using traditional equipment. Weeding is important step is farming [23]. Removing weed often done directly using hand because only few number weed able to grow in inundated rice field in swamp ecosystem. Under the high level of flooding, only few number of weed able to grow. There are no herbicides used, and such practice is relevant with the effort to minimize green house emission to environment. Some low quality of seedling was replaced by new seedling. However, it is rarely done because number of died seedling was low in Tamban (22 respondent, 10%) and in Marabahan (103 respondent, 66%). The replanting of low quality of seedling was done by 29 respondent (13.2%) in Tamban and 19 respondent (12.2%) in Marabahan.

9. Fertilizing

About 164 respondent (74,9%) in Tamban and 89 respondent (57.1%) in Marabahan use organic fertilizer from past rice straw biomass that were spread in paddy field. About 55 respondent (25.1%) in Tamban and 67 respondent (42.9%) in Marabahan add chemical fertilizer to increase rice grain productivity. The uses of organic fertilizer has been reconvened to minimize green house emission, while the use of chemical fertilizer such as Urea per ton contributes to the NO_2 emission 0,2 Ton per year [18]. As far, 219 respondent (100%) in Tamban and 130 petani (83.3%) in Marabahan uses of chemical fertilizer reported bellow than recommended chemical fertilizer application. Respondents argues that the uses of large number of fertilizer is not effective because many of fertilizer will be dissolved in river water. Fertilizing was done at 07.00 to 09.00 by 166 respondent (75.8%) in Tamban and 91 (58.3%) in Marabahan. Fertilizing plant in the early morning relevant with the effort to decrease green house gases emission because in the morning time soil still cold and the microbes activity still low. Scholar point out that the optimum condition for methane formation occurs in soil with temperature 30-40 ^oC [9] [24]. Increse of soil temperature from 20^oC to 25^oC lead to CH_4 increse two times [25] [26]. About 197 respondent (90%) in Tamban and 123 respondent (78.8%) in Marabahan not practicing liming because the cultivated rice cultivar was acid resistance and therefore relatively able to grows in acid environment. Only few farmer practicing liming to decrease soil acidity (< 1Ton/Ha) in Tambang (22 respondent, 10%) and in Marabahan (33 respondent, 21.2%). Liming was not applied among the majority of farmer in Tamban and Marabahan. This practices contributes significantly in green house emission reduction because most of the methanogens bacteria is neutrophilic that live in pH ranging from 6 to 8 and the formation of CH_4 maximum occurs in pH 6.9 – 7.1 [27].

10. Plant protection

Plant protection from pest and diseases is important aspect in rice cultivation in Barito Kuala. Respondents argues that the uses of biological control is suitable to countermeasure pest and plant diseases. All of the respondents (219 farmer, 100%) in Tamban and 119 respondent 76.3) in Marabahan use organic patricides because low cost and effective to reduce pest. Only 37 respondent (23.7%) in Marabahan uses

chemical pesticides. Sathpaty et al. (1998) argues that application of organochlorin and hexachloro-siklohexan (HCH) pesticides in 2Kg active compound ha^{-1} able to stress methanogenic bacterial grows [28].

11. Harvesting and post harvest

All of the respondent state that harvesting rice uses traditional equipment called *sabit* or *ani-ani*. The main reason is such equipment is easily used and no cost for operations. The uses of traditional equipment without cutting machine contribute to the reducing green house impact which are release to environment. About 173 respondent (79%) in Tamban and 127 respondent (81.4%) in Marabahan state that harvest time take place after 90% rice grain has yellow color, indicate the rice grain maturity. To separate rice grain, all of the farmer using rice tresher machine. The reason for use machine is effective, fast and easy in application. Rice grain drying was done under sun rise. Rice grains left to dry in the field before threshing. After drying, rice grain was packaged in plastic sack and stored in *lumbung* or warehouse. All of the respondent state that rice milling was done using rice milling machine. The rice straw was burned by farmer in Tamban (156 respondent, 71.2%) and in Marabahan (100 respondents, 64.1%). Straw burn practice has been viewed as cheap methods. Some straw was remain in field and decompose in wet environment. This practices was implemented by 63 respondent in Tamban (28.8%) and 56 respondent (35.9%) in Marabahan. Farmer behavior to burn rice straw was not relevant with the effort to minimize green houses emission. Burning rice straw is producing high level of CO_2 [18].

Indigenous practice in farming represent the sustainable agricultural activity, in which it is common in developing countries with abundance bio-cultural resources. The uses of local rice cultivar among local community represent the ethnobotanical knowledge of local community, in which it has been recognized contributes significantly in the sustainable development [29]. There are some efforts needed to increase farmer capacity to preserve best practices in traditional farming.

V. Conclusion

The concordance level analysis of farmer behavior to the effort to green houses gases emission shows that the rice farming practices in swamp land in Barito Kuala is significant in reducing green houses emission. About 55.3% respondents in Tamban dan and 55.8% in Marabahan shows very high concordance level to the green houses gases emission, while 44.7% respondents in Tamban and 44.2% in Marabahan shows high concordance levels. The traditional farming practices in Tamban and Marabahan is important in the effort to minimize green house emission, and therefore it is important for global warming reduction.

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