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# POTENT OF INDONESIAN'S AGRICULTURAL AS GREEN HOUSE GASES SOURCES

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## ABSTRACT

Over supplied of N will produces more GHG and this phenomenon has been intensive discussing to find out the solution. Relate to the loss of N Rolston et al. (1978) reported 73% N will loss after applying of manure and Ryden and Lund (1980) stated that 95-293 kg N/ha annually loss as N2O gas. Indonesia's farmer/crops growers have been fertilizing their crops with N by using recommendation dosage. That mean N fertilization executes without take the soil N into account. This method tend to have less efficiency, that is way this method since 1980s not recommended in developed countries (such as European countries, USA, Japan) because they want reduce the production of GHG from agriculture that according to Bacon (1995) 44% of 1.5 Mio. Ton/year of atmospheric N2O originated from agricultural ecosystem. Indonesia has record as inefficient country in N use, N loss in maize production 50-58% (N loss in USA only 14-41%), N loss in rice production 77-89% of applied N. Efficient N fertilizing method will reduces N fertilizer production and reduces CO2 emission, and at the same time will reduces N loss through denitrification procces in form of N2O gas. That mean efficient method can be a solution to reduce GHG production. Due to inefficient of N fertilization-method loss of N in 4 main crops (rice, maize, vegetables, sugarcane, tobacco) can be predicted as follows: from 8.000.000 hectare of paddy rice will occur N loss of 1.600.000 tones, from 3.300.000 hectare of maize field will occur N loss of 150.000 tones, from 1.000.000 hectare of vegetables field will occur N loss of 138.000 tones, from 500.000 hectare of Sugarcane plantation will occur N loss of 84.000 tones and from 200.000 hectare of tobacco plantation will occur N loss of 18.000 tones. The total loss of N from those crops are 1.990.000 tones. According to Bacon (1995) 0.1-1.5% of applied N will loss as N2O gas. 1.990-29.850 tones of N2O gas produced by cultivation of rice, maize, vegetables, sugarcane and tobacco annually in Indonesia.

*Keywords : Nitrogen, crops, agriculture, gas, greenhouse.*

## INTRODUCTION

Nitrogen supplied to crop in big quantity for maintain their growth and development, but crop able to take up it not more than 50% of supplied N through fertilization (Raun and Johnson, 1999; Schjoerring et al., 1995). Some quantity of the nitrogen in the soil will transform to $N_2O$ and $NH_3$ gases. The gases will accumulate in the earth atmosphere as green house gas (GHG) caused global warming.

Over supplied of N potentially contaminate environment that recently frequently discus and try to find out the solution because it can be treat human health and even treat life on the Earth.

Rolston *et al.* (1978) reported that, 73% of N loss from manure applied on field, Ryden and Lund (1980) said 95-293 kg N/ha/year loss in form of $N_2O$ gas. N loss in form of $N_2O$ gas estimated round 0.1-1.5% of applied N (Eichner, 1990).

Fertilization's method that apply a fix rate of N fertilizer at any condition of soils (without take the N content of soil into account) show less efficiency. In developed countries especially European countries fix N rate method is not recommended anymore since 1980s.

N fertilizer productions process and their distribution produces $CO_2$ gas, that means increase of N fertilizer consumption through high input crop culture cultivation and inefficiency in N use, increase world $CO_2$ gas emission. Combustion of each 1 kg of *fossil fuel produces 2.3 kg of* $CO_2$ gas to atmosphere (www.engineeringtoolbox.com).

N loss from agriculture ecosystem in form of $N_2O$, $NH_3$ and $NO_3$. Each year amount of $N_2O$ gas emission estimated around 1.5 mio tons source from applied N fertilizer in agriculture through denitrification. Acording to Bacon (1995), 44% of total $N_2O$ gas input to the atmosphere originated from agriculture ecosystem. $NH_3$ gas on other hand produced each year around 8.4 mio tones from N fertilizer production and applied N on the field.

Indonesia has noticed as a less efficient country in N fertilizer use. N loss in maize cultivation 50-58% (as comparation: in USA 14-41%), N loss in flooded rice cultivation 77-89% of applied N (Bacon, 1995). Why? Because N is applied by unaccurate/inefficient method (fix rate method). Due to this unaccurate application method the N national consume is high and the N fertilizer producers increase their production to supply the required N.

There are 8 mio hectars of rice fild, 3.3 million hectars of maize fild, 1 million vegetable field, 500 thausand hectars of sugarcane field and 200 thausand hectars of tobacco field to supplay each year.

*N Fertilizer Consumsion*

*1. Rice*

Total harvest area of rice was 6 million hectars. Urea recommendation was 300 kg/ha. Total applied urea: 300 kg x 12,000,000 hectars (2 x crops/year) = million tons of urea. Equal to 1.6 million tons pure N.

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2. *Maize*

Total harvest area of maize was 3.3 million hectars. Urea recommendation level is 200 kg/ha. Total applied urea 200 kg x 3,300,000 ha = 660,000,000 kg Urea, equal to 300,000,000 kg pure N (300,000 tons of pure N).

3. *Vegetable*

Total harvest area of vegetable crops was 1 million hectars. Urea recommendation is 300 kg/ha. Total applied urea 300 kg x 1,000,000 ha = 300,000,000 kg (300,000 tons Urea). Equal to 138,000 tons of pure N.

4. *Sugar Cane*

Total harvested area of sugar cane was 500,000 hectars. Urea recommendation is 400 kg ZA at planting and 400 kg ZA a month after planting (800 kg ZA/ha). Total applied ZA was 400,000 tons (500,000 x 800 kg). Equal to 84,000 tons of pure N.

5. *Tobacco*

Total harvested area of tobacco was 200,000 hectars. Urea level as high as 500 kg/ha. Total applied urea was 100,000 tons. Equal to 46,000 tons of pure N. Total N applied to supply rice, maize, vegetable, sugar cane and tobacco was 2.16 million tons.

*The potential of N loss*

N loss in rice cultivation in Indonesia indicated 77-89%, N loss in maize 50-58%, N loss in vegetable 50%, and N loss in sugar cane 47-61% of applied N (Bacon, 1995). N loss in tobacco asume as high as 40%.

The potential N loss from 1.6 million applied N in rice, 300,000 tones applied N in maize, 138,000 tones applied N in vegetable, 84,000 tons applied N in sugar cane, 46,000 tons applied N in tobacco, respectively as high as 1.4 million tons, 174,000 tons, 69,000 tons, 51,000 tons, and 18,400 tons. Total N loss as high as 1.7 million tons.

*The Potential $CO_2$, $N_2O$ and $NH_3$ Gases Emission*

1. *Rice*

$CO_2$ gas produced by fossil fuel combustion to produce 1.6 million tons of N as high as 1.6 million tons x 2.3 →3.7 million tons of $CO_2$ gas.

Some publications such as Mikkelsen et al., 1978; Vlek and Craswell, 1981; Freney et al., 1983; Leuning et al., 1984; Jayaweera and Mikkelsen, 1990) reported that as high as 60% of applied ammonium in rice cultivation transform to $NH_3$ gas.

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1.5% of applied N loss as $N_2O$ gas to the atmosphere. It is possible from 3.6 million tons applied urea produce 24,000 tons of $N_2O$ and 960,000 tons of $NH_3$ gas.

2. *Maize*

$CO_2$ gas production by maize was 690,000 tons (300,000 tons N x 2.3). $N_2O$ gas production was 4,500 tons (1.5% of 300,000 tons), whereas $NH_3$ gas was 90,000 tons (30% of 300,000 tons).

3. *Vegetable*

$CO_2$ gas production by maize cultivation was 300,000 tons (138,000 tons x 2.3). $N_2O$ was 2,000 tons (1.5% of 138,000), $NH_3$ gas was 41,400 tons (30% of 138,000 tons).

4. *Sugar cane*

$CO_2$ gas production by sugar cane plantation was 193,200 tons (84,000 tons x 2.3). $N_2O$ gas production was 1,260 tons (1.5% of 84,000 tons), while $NH_3$ gas production was 25,200 tons (30% of 84,000 tons).

5. *Tobacco*

$CO_2$ production by tobacco cultivation was 105,800 tons (46,000 tons x 2.3). $N_2O$ production was 690 tons (1.5% of 46,000 tons), while $NH_3$ gas was 13,800 tons (30% of 46,000 tons).

Total production of $CO_2$ gas of rice, maize, vegetable, sugar cane and tobacco cultivation was 4.9 million tons.

Total production of $N_2O$ gas of rice, maize, vegetable, sugar cane and tobacco cultivation was 32,450 tons (2.16% of annual World's $N_2O$ emission originated from agriculture ecosystem).

Total production of $NH_3$ gas of rice, maize, vegetable, sugar cane and tobacco cultivation was 1.1 million tons.

## RESULTS AND DISCUSSION

Focus of discussion is to answer the question why nitrogen supply in agriculture has low efficiency, so the potential of N loss and GHG ($N_2O$, $NH_3$, $CO_2$) emission from it is high.

*Method of N supply*

N fertilization by using fix rate of N level has some disadventages such as:

1) Impossible to match required N of cultivated crop,
2) N content of soil not to be taken into acount to match N need of

cultivated crop

3) has high potential in N loss in form of GHG,

4) has high potential in inacurate supply (to high or to low).

$N_{min}$ Method (Wehrmann and Scharf, 1986) is the method that able to supply N fertilizer in acurate quantity to crop. The $N_{min}$ Method is based upon the finding that different quantities of mineral nitrogen are available in soil at the beginning of growth (20-567 kg N/ha) or at any required fertilization date. The quantity of mineral nitrogen in the rootable soil layer of cultivated crop is measured at the date of application. N fertilizaion is calculated as the difference between optimum N quantity and N mineral content of the soil (Scharpf, 1977).

$N_{min}$ Method resulted in a decrease of nitrogen fertilization by 30 kg N/ha on sugar beet, in vegetable production, N fertilization could be reduce even more (75-429 kg N/ha). In general, resulted a decrease of N fertilization by 50% (Wehrmann and Scharfp, 1986). When the $N_{min}$ Metod on rice, maize, vegetable, sugar cane and tobacco to be applied, will result a decrease of nitrogen use by 1 million tones of pure N, equal to 2 million tones of urea. That mean will reduce fossil fuel combustion of 1 million tone. World $CO_2$ production from N fertilizer production will reduce as much as 2.3 million tones.

To slowdown global warming, N use efficiency in crop production one of nessesary effort have to be done, therefore, an efficient method to supply N required.

*Soil N-mineral*

Researchers found that among agriculture's land showed a big variation of N-mineral (nitrate and ammonium) content. From 415 different location of wheat field Scharpf and Wehrmann (1979) found variation ranged 18-283 kg/ha, on 703 different location of sugar beet field ranged 22-324 kg/ha, and on 38 different location of vegetable field 64-335 kg/ha of N mineral. Soil samples was taken at harvest time. From 4 different location of rice field in Ambulu, Jember indicated different content of N mineral (sampling depth 40 cm), as follow:

Table 1. N mineral Content of Different Rice Field in Ambulu, Jember

| Location | Nitrate (kg/ha) | Ammonium (kg/ha) | N-mineral (kg/ha) | Equal to Urea (kg) |
|---|---|---|---|---|
| Sumberejo | 368 | 568 | 936 | 2,034 |
| Sabrang | 369 | 622 | 991 | 2,154 |
| Karanganyar | 400 | 639 | 1,039 | 2,258 |
| Ambulu | 400 | 578 | 978 | 2,126 |

Source: Wijaya (2004)→ data unpublished

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Those big variations of N mineral content of the soil caused N supplied with fix rate (recommendation rate of N) resulted low efficiency of N fertilizer use in agriculture. On different cropping patterns found different quantity of N mineral (Table 2):

Table 2. N-mineral Content of Different Cropping Pattern in Ambulu, Jember

| Cropping Pattern | N-Nitrate (kg/ha) | N- Ammonium (kg/ha) | N-mineral (kg/ha) | Equal to Urea (kg) |
|---|---|---|---|---|
| Rice-Maize-Soybean | 355 | 560 | 915 | 1,989 |
| Rice-Maize -Tobacco | 392 | 635 | 1,027 | 2,232 |
| Rice-Maize -Vegetable | 401 | 611 | 1,011 | 2,197 |

Source: Wijaya (2004) → data unpublished

N mineral content in the soil of 7 different sugar cane fields in Semboro, Jember ranged 217-532 kg/ha (Wijaya, 2005 → data unpublished). On the other hand, sugar cane needs 150 kg N/ha (FAO, 1996). N mineral found in the soil (217-532 kg/ha) actually more than enough to supply sugar cane without any application of N fertilizer, but in fact, sugar cane growers in Semboro, Jember add N fertilizer as much as 400 kg Urea + 400 kg ZA at time of planting and 30 days after planting. This excessive N supply leads to N loss in form of gases ($N_2O$, $NH_3$) and leached nitrate. Excessive supply of N on sugar cane decrease the sugar content of cane.

*Uptake of N*

Precision agriculture is a quality oriented crop cultivation such as nitrate content, sugar content, vitamin C content, protein content, fat content of crop yield. Base on N uptake, the optimum supply of N can be calculated. The quality of crop yield and N loss to the environment affected by N supply.

Table 3. N Uptake and Rooting Depth of Sugar Cane, Maize, Tobacco and Cabbage

| Crop | N Uptake (kg/ha) | Rooting Depth (cm) |
|---|---|---|
| Sugar Cane | 140 | 60 |
| Maize | 165 | 75 |
| Cabbage | 108 | 60 |
| Tobacco | 108 | 45 |

Source: Wijaya (1998)

N fertilization on sugar cane is inefficient because of two reasons are 1) N of soil do not take into account to fertilization (use fix rate of N at any soil fertility), 2) date of N application is too early (at planting and 30 days after planting), in fact, sugar cane uptake N only about 2 kg N/ha after 30 days. N uptake increase after 75 days. According to the N uptake-curve of sugar cane, the first N fertilization must be applied at 65 days after planting, and the 2nd application must be at 120 days after planting (Figure 1).

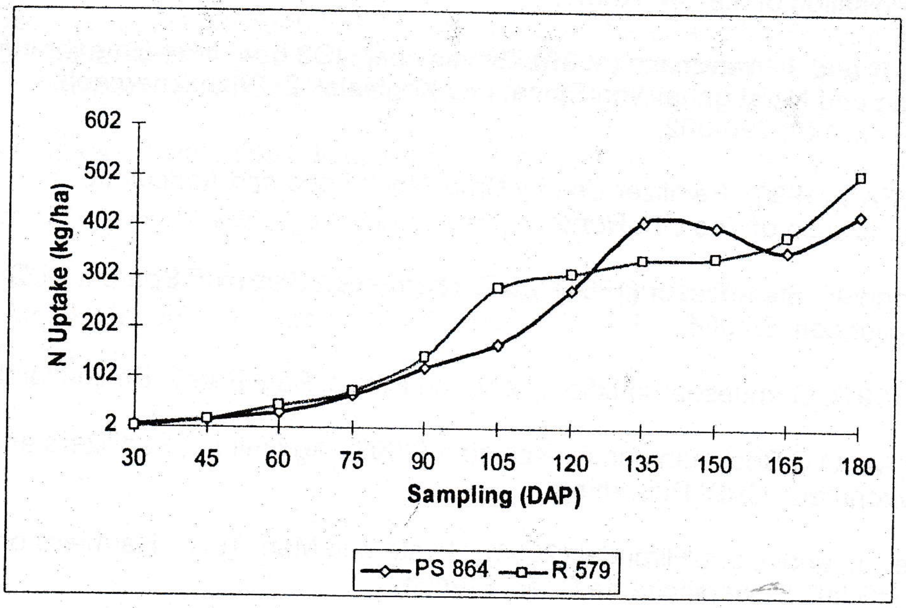


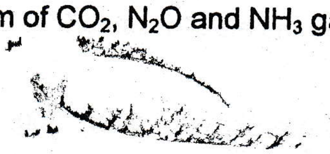

Figure 1. N Uptake Curve of Two Cultivars of Sugar Cane (Wijaya, 1998)

## CONCLUSION

1. Rice, maize, sugar cane, vegetable crop and tobacco cultivation produced

| Crop | $CO_2$ Gas (ton) | $NH_3$ Gas (ton) | $N_2O$ (ton) |
|---|---|---|---|
| Rice | 3,700,000 | 960,000 | 24,000 |
| Maize | 690,000 | 90,000 | 4,500 |
| Vegetable Crop | 300,000 | 41,400 | 2,000 |
| Sugar Cane | 193,200 | 25,200 | 1,260 |
| Tobacco | 105,800 | 13,800 | 690 |

2. Supply of nitrogen conducts base on recommendation dosage which cause inaccurate supply.
3. Indonesia's agriculture needs a method to supply N that can reduce N loss in form of $CO_2$, $N_2O$ and $NH_3$ gases to the atmosphere.



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