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MITIGATION OPTIONS OF GREEN-HOUSE GASES (GHG) FOR AGRICULTURE

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ABSTRACT

Inventory of greenhouse gases (GHG) of Indonesia has been conducted in the ALGAS Study. Estimates and observations of various emission sources were used as the basis of mitigation analysis in the current study. The important GHG in the agriculture are particularly methane (CH_4) and N_2O, while emitted CO_2 considered to be taken up during crop growth via photosynthesis. Methane emission contributes significantly from agricultural sector. Major sources are rice field farming (76%) and large animal farming (23%).

Mitigation options to reduce methane emission for rice cultivation based on cost effectiveness can be ranked as follows: (1) no tillage 12%; (2) intermittent irrigation 30%; (3) direct seeding (Tabela) 20%; (4) substitution of other rice varieties with IR64 62%; (5) substitution of prilled urea with tablet urea 5%; and (6) substitution urea with ammonium sulfate (ZA) for S deficient soils 9.6%. Ranked mitigation options for livestock are (1) artificial insemination 15%; (2) use of crop residues as feeding substitution 30%; (3) construction of biogas plant 70%; (4) mineral block supplies 40%; (5) rumen modifier agent supplies 25%; and (6) improved digestibility 15%. The most potential options for methane emission reduction are rice variety substitution with IR64, followed with intermittent irrigation at technical irrigation land. These options can be implemented with least cost of emission reduction and still giving positive benefit.

Keywords : green-house gases, mitigation options, ricefield, and livestock.

ABSTRAK

Inventori gas-gas rumah kaca (GRK) di Indonesia telah dilakukan melalui studi ALGAS. Pendugaan dan pengamatan terhadap berbagai sumber emisi dilakukan sebagai dasar dalam analisis mitigasi. Gas rumah kaca yang penting dari kegiatan pertanian adalah CH_4 dan N_2O, sedangkan CO_2 dianggap termanfaatkan melalui fotosintesis. Emisi CH_4 memberikan kontribusi yang nyata dari sektor pertanian terutama dari kegiatan pertanian padi lahan sawah (76%) dan peternakan (23%).

Pilihan mitigasi untuk mengurangi emisi dari pertanaman padi sawah didasarkan atas efektivitas biaya yang tersusun sebagai berikut : (1) tanpa olah tanah 12%, (2) irigasi berselang 30%, (3) tanam benih langsung (tabela) 20%, (4) penggantian varietas padi dengan IR64, 62%, (5) penggantian Urea butiran dengan Urea tablet 5%, dan (6) penggantian Urea dengan Zauntuk lahan defitisit S, 10%. Urutan untuk mitigasi dari kegiatan peternakan antara lain: (1) inseminasi buatan, 15%, (2) pemanfaatan limbah tanaman sebagai makanan pengganti, 30%, (3) membuat tungku biogas, 70%, (4) pemberian blok mineral, 40%, (5) pemberian zat pemodifikasi rumen, 25%, dan (6) meningkatkan pencernaan, 15%. Pilihan yang paling potnsian untuk mengurangi emisi metana adalah pemakaian varietas IR64 dan irigasi berselang. Pilihan tersebut dianggap dapat diterapkan dengan biaya rendah tapi tetap berdampak positif terhadap pengurangan emisi.

Kata kunci : gas rumah kaca, pilihan mitigasi, padi sawah dan peternakan.

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INTRODUCTION

Based on the inventory study of GHG, rice fields in Indonesia emit the highest CH4, namely 2.57 Tg/year. Therefore, mitigation options for GHG are to be focused on CH4 emission on rice cultivation system. Since CH_4 emission is the resultant of CH_4 production, oxidation, transport and emission, so mitigation of CH_4 emission is aimed to suppress one or more of those processes. Each process is also dependent on several conditions such as soil Eh, pH, temperature, microbial activity, CH_4 sources, and pathway. Mitigation should be able to alter one or more conditions to become unfavourable for CH_4 production and transport. In order to cover as many as possible options of mitigation orderly, the taxonomy of GHG arranged.

TAXONOMY OF GHG's MITIGATION OPTIONS FOR AGRICULTURE

Rice Field

The taxonomy of GHG mitigation options in rice cultivation is based on the major components of agricultural practices which are directly or indirectly affecting GHG production, oxidation, transportation, and emission. Those components are (1) water managements, (2) soil management, (3) crop management, and (4) cultural practices. Each component is subdivided into more specific technologies applicable for the specific situation as follows:

a. Water Management

Water management, separated into irrigation and drainage, are mostly affecting GHG production, oxidation, transportation and emission. Soil water condition affects soil redox potential (Eh), soil pH and control microbial activities. Those factors are substantial for GHG production, and oxidation. On the other hand, standing water layer may inhibit, GHG transportation, emission and oxidation.

- Controlled irrigation; it may regulate the physico-chemical properties of soils, such as pH and Eh, which are very important in determining the rates of several chemical reactions and processes, and microbial activities in the soils related to GHG emission. The shortest flooding period of dry-seeded rice consistent with high yields of grain is 30 days from 75 to 105 days after seeding (Sass *et al.*, 1992). This requires high control of soil moisture because a stress slightly above field capacity may reduce grain yield by 20-25% compared with continually flooded treatments (De Datta, 1981).
- Drainage system in many poor drain soils is required for healthy growth of crops.

This system increases O_2 into the soil, increases CH_4 oxidation, increases soil Eh, increases methanotrophic bacteria, while decreases methanogens, and resulting decreases in CH_4 emission. However, it may increase N_2O emission due to increase denitrification, when reflooding the soil. Mid drying depends of physiological condition of plant, decrease methane by 13%. A single midseason drainage may reduce seasonal emission rates by about 50% (Sass *et al.*, 1992); Kimura, 1992). Multiple aeration for 2-3 days at 3, 6, 9 weeks after initial flooding reduced methane emission by 88% and did not reduce rice yields compared with the normal irrigation (Sass, *et al*, 1992).

b. Soil Management

Soil tillage and soil conditioners are mostly affecting GHG production, oxidation, and transportation.

- Soil tillage (dry and wet tillage) is very much affecting GHG production, oxidation, and transportation. Dry tillage may not cause CH_4 emission, because organic matters will decompose aerobically, and methanogens could not survive. However, denitrification that leads to emit N_2O may occur when the soil is reflooded. Wet tillage, on the other hand, emits N_2O at the beginning of soil is reflooded. Wet tillage, on the other hand, emits N_2O at the beginning of flooding. Methane emission may or may not occur which depend on soil Eh, but usually it occurs when the soil is completely flooded. Minimum tillage is possible when the soil hardness and weed are not the problem to the crop. Zero tillage plus herbicide could be practiced mainly for the second crops.
- Organic amendments contribute carbon sources (substrates) fro CH_4 production. The degree of increasing CH_4 due to addition of organic materials depends on the chemical composition (the amount of easily degradable substrates, C/N ratio) and their physical properties (fresh or composted). Time of organic amendments, whether the soil is wet or dry, may have different effect on GHG emission. Aerobic decomposition produces NO_3 and no CH_4, where as wet decomposition or fermentation produces substrates for CH_4 production. Application of 12 ton/ha composted material, that has a higher degree of humification, to a Gleysol and Andosol resulted in 62 and 40% lower CH_4 emission rates, respectively, when compared with incorporation of 6 ton/ha rice straw. In China, the incorporation of sludge from biogas generators into ricefields reduce, CH_4 emission by 60% compared with the application of unfermented manure (Wassmann *et al.*, 1994). The recycling of crop residues in rice fields through fermentation in biogas generators limits increases in CH_4 emissions as well as aerobic composting and provides an additional energy source for household. Straw application 1-2 months before inundation reduce CH_4 emission by 15-50% in comparison to that incorporated at inundation time. Aerobic decomposition of straw occurs under upland condition.

c. Crop management

There are many varietal differences of rice in morphology (height, tiller number, leaf area, aerenchyma diameter, biomass, grain/straw ratio, shoot/root ratio), in physiology (growing period, photoperiodic sensitivity, root oxidizing power, root decay, root exudation) that may or may not related to their potential yields, but may affect GHG emission.

- Crop diversification and cropping intensity may determine the agricultural production and profit. Meanwhile, this system may also affect the total GHG emission due to different in water requirement/soil water condition and crop duration in the field. Lowland rice required long period of flooding, where as upland rice and palawija crops do not need flooding. Flood condition may couse CH_4 emission.
- Varieties of rice plant differ in morphology and physiology that may affect GHG emission as well as yield level. Good rice varieties have characteristics as follows: high yields and relatively stable, short growth duration, high grain/straw ratio, high

oxidizing power, small percentage of root decay, of root exudates). Selecting and breeding for this type of rice varieties are possible in the future.

The CH_4 concentration in the growth medium and the number of tillers per plant positively correlates with CH_4 emissioin rates (Marik *et al.*, 1991). Older tillers within a single plant hill show higher CH_4 fluxes (Kimura, 1992). Positive correlations are found between root biomass and CH_4 production and between above ground biomass (Sass *et al.*, 1990) or grain yield (Neue and Roger 1993) and CH_4 emission.

Cultivar differences in root exudation and root senescence. Rice roots become the major carbon sources for CH_4 production at later growth stages. Oxydation. Large cultivar differences in root oxidation power (Neue and Roger, 1993) and in emission rates (Parashar *et al.*, 1990; Makarim *et al.*, 1996). The pronounced diversity of morphological and metabolical traits of rice cultivars provides the possibility to develop high-yielding cultivars with lower potential for CH_4 emissions.

4. Cultural Practices

Agricultural practices by farmers may affect the rates of GHG emission and oxidatioin, due to the difference in crop growth duration and soil disturbance. Those practices may be subdivided into planting method, fertilizer application, weeding, and soil microorganisms and retardants.

- Planting methods (transplanting vs direct seeding) may affect the duration of crops in the field and the soil disturbance, by which the GHG emission rate will change. Dry seeded rice is flooded 4-5 weeks after seedling emergence until 10-14 days before harvest, reduce methane emission in southern United States as high as 88% compared with the normal flooding (Sass *et al.*, 1992).
- Fertilizer application (kinds and methods) may affect microbial activity, soil condition, and plant growth, so that directly and/or indirectly affects GHG production and oxidation. Addition of ammonium to flooded water can inhibit CH_4 oxidation in the soil-flood water interface and reversibly increased the CH_4 flux (Conrad and Rothfuss, 1991). Application of nitrate-containing fertilizer increases the soil Eh and results in a decrease in both the rate and the total amount of CH_4 produced. Sulfate containing fertilizer decreases CH_4 production, especially when applied in large amounts. Schutz *et al.* (1989b) reported a decrease of 6% in CH_4 emissions when ammonium sulfate was applied to the surface and up to 62% when incorporated into the soil. Sodium sulfate was more effective than ammonium sulfate in reducing methane emissions (Lindau *et al.*, 1993). Suppression of methanogens by sulfate reducers in fresh-water sediments at in situ concentration of as low as 60 uM has been found (Lovely and Klug, 1983). Application of 100 kg/ha ammonium sulfate will provide sulfate concentrations in the soil solution that may reduce CH_4 production. Slow release of acetylene from calcium carbide, encapsulated in fertilizer granules greatly reduced CH_4 emissions (Bronson and Mosier, 1991).
- Weeding (hand weeding vs herbicide) may affect GHG emission. The grequent weeding may disturb soil condition and couse the release of entrapped CH_4. Herbicide application may reduce the soil disturbance and so reduce emission.
- Soil microorganisms and retardants, control GHG production and oxidation. Methanogenic bacteria produces CH_4 gas, while the other microbia, such as

> denitrification, chemolithotropich nitrification, heterotrophic nitrification produce N2O. Naturally alternate electron acceptors (O_2, NO_3-, Fe_3+, Mn_4+ and SO_{42}-) inhibit methanogenesis in mixed microbial ecosystems by channeling electron flow to microorganisms that are thermodynamically more efficient than methanogens (e.g. denitrifiers or sulfate reducers).

Application of soil microorganisms (methanothroph) or chemical retardant (denitrification inhibitors) may reduce GHG emission. Nitrification inhibitor (wax-coated calcium carbide) reduced N_2O emission as well as N_2 and CH_4. Applications of some chemical inhibitors, such as 2- bromoethanesulfonic acids, chlorinated CH_4 (e.g. chloroform and methylene chloride) inhibit methanogenic bacteria and so CH_4 production. Metals ions such as Cu and Cd, may also inhibit methanogenesis. However, this technique is still uncommonly practiced.

Areas of mitigation options for agriculture are influenced by complex factors such as geographycal distribution, soil characteristics, weather variables, plant and animal types and agronomic practices as well as social economic considerations could be selected based on identification of important GHG sources, spatial distribution of those sources and technology options that are feasible for applications. The latter should take social and economics consideration into account prior for application by most subsistent farmers in the country.

Although agriculture emits various GHG's, namely CH_4, CO, N_2O and NO_x, but only certain GHG's are potentially mitigated for Indonesian agriculture. The most important GHG from agriculture was identified to be CH_4 from rice fields and less important from livestock management by enteric fermentation. Burning of agricultural residue could be significant source of CO that may also be the concern of local government for other reasons other than climate change issue. The use of nitrogen fertilizer could be considered as important source but the accuracy of prediction and hence mitigation options would be less certain.

MATERIAL AND METHOD

1. Ricefield

The year 1990 was used as the base year in the prediction of GHG emission assessments and the construction of baseline scenario. The baseline would then be the basis for the prediction of GHG emissions response on mitigation options by which mitigation strategy could be developed.

Base line of methane emission from Indonesian rice field was constructed based on the projected harvested area over time and total CH_4 emission in 1990, assuming that the methane emission is proportionally related with the area. The increase of the harvested area in Indonesia was calculated from 1981-1993 data, and the rate was 161,718 ha/annum (r^2=0.889). It was assumed that the rate of increase population, while suitable land for rice field is limited and, hence, in the relative terms increasing rice field could be less than that of population growth in the long run. Figure 1 presents projected harvested area of rice in Indonesia during 1990 to 2020.

2. Livestocks

Baseline data that was constructed based on the increase rates of methane emissions from enteric fermentation and manure management as shown in Figure. This increase is related with increasing demand of food by Indonesian population that also increases in terms of number and the economic growth (7.34% GDB per annum).

Assuming the demand increase of meat and eggs remains constant as represented by population growth, thus, the current increase in methane emission (2% per annum) could be used to construct the baseline data for the livestock. In mitigation option assessment, all possible technologies available in each aspect are analyzed in during their effects on crop yields, profits, and GHG emission.

RESULTS AND DISCUSSION

1. Base scenario of GHG Emission from Agricultural Sector up to 2020

Projection of GHG emission from agricultural sector up to 2020 mainly characterized by methane emission from rice field and cattle farming, as shown in Figure 1. The projection of methane emission from rice field in Indonesia is based on projection of harvest areas up to 2020, using base year 1990. The rate of increase of harvest areas was calculated from data of 1981-1993, which indicate a rate of 161,718 ha/year. It was assumed in the projection to 2020 at fixed rate, with consideration that the increase of rice demand due to population increase is conditioned by limited land available. While methane emission from cattle farming was calculated from projection of cattle population and average methane emission per cattle. And the projection of cattle population was based on the estimated increase of meat and dairy demand, and average productivity per cattle for the period 1990-2020. The growth rate of cattle productivity was estimated at 0.3%. The growth rate of meat and milk demand followed the growth of population and to be fulfilled by cows, buffaloes, goats, sheep, pigs, and chickens. The growth rate of cattle population was estimated at 7.0% for dairy cows, 2.4% for meat cattle, and 0.9% for buffaloes, with average methane emission levels at 63; 49; 46; 40 and 57 kg/head/year, respectively. The growth of this cattle population is not sufficient to meet the demand of animal products, where the rest is fulfilled from import. Figure 1 showed the projection of methane emission from agricultural sector up to 2020, and Table 1 provides the details. Using 1990 as base year, projection of methane emission from rice field increases from 1.977 million ton CH_4 at the base year and reach 3.051 million tons CH_4 at year 2020, while from large cattle farming's methane emission increases from 0.678 million tons CH_4 at year 1990 to become 1.407 million tons at year 2020. This means that total methane emission from agricultural sector increases almost a hundred percent in this coming thirty years.

Table 1. Projected area under rice, livestock population and methane emission

	Year			
	Base year	2000	2010	2020
Rice area (ha)	10,500,000	12,032,250	13,963,917	16,205,696
Methane emission (ton CH_4)	1,976,625	2,265,071	2,628,707	3,050,722
Livestock population (head)				
Dairy	293,900	628,657	1,344,710	2,876,358
Non-dairy	10,410,200	13,196,496	16,728,546	21,205,952
Buffaloes	3,322,600	3,634,040	3,974,673	4,347,234
Methane emission (ton CH_4)	687,344	854,634	770,199	1,406,756

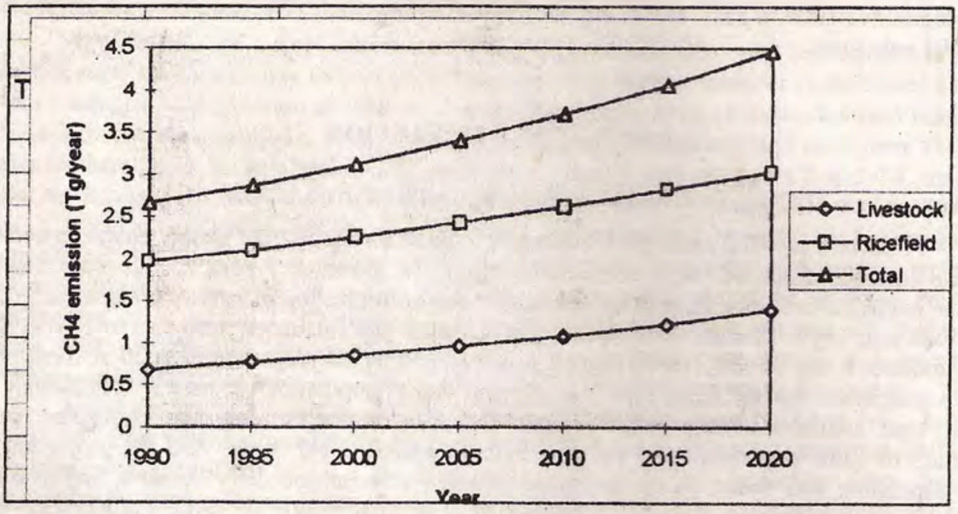

Figure 1. Baseline of methane emission from agricultural sector overtime.

2. GHG Mitigation Options and Opportunities

Indonesian agricultural sector will continue to play a dominant role in the national economy eventhough our agricultural production system is still being characterized by traditional farming's with small scale enterprises and being executed by a large number of small farmers and farm workers, especially for two agricultural subsectors as major GHG emitters that are rice field and large animal farming. Therefore, mitigation options and opportunities of GHG emission need to consider technologies that can ensure sustainability of existing farming systems, acceptable by farming community in its implementation, do not reduce production inputs. Another imposing aspect in choosing technology of GHG emission mitigation options for agricultural sector is the dependence of agricultural activities to climate, soil, and technical and cultural factors that require site specific selections. For these, it is proposed a selection of technologies for several rice ecosystems such as rice field irrigation, rainfed, wamp, and for large animal farming as given on Appendix 1 and for action plan also prepared on Appendix 2 that indicate potential reduction of methane emissioin, impacts to production, and areal targets for every technology selection.

CONCLUSIONS

1. Methane emission contributes significantly from agricultural sector. Major sources are rice field farming (76%) and large animal farming (23%).

2. Mitigation options to reduce methane emission for rice cultivation can be ranked as follows :
    1) No tillage
    2) Intermittent irrigation
    3) Direct seeding (Tabela)
    4) Substitution of other rice varieties with IR-64
    5) Substitution of prilled urea with tablet urea
    6) Substitution urea with ammonium sulfate (ZA) for S deficient soils.

3. Ranked mitigation options effective for large animal farming are :
    1) Artificial insemination
    2) Use of crop residues as feeding substitution
    3) Construction of biogas plant
    4) Mineral block supplies
    5) Rumen modifier agent supplies
    6) Improved digestibility.

4. Most potential options for methane emission reduction are variety substitution with IR-64, followed with intermittent irrigation at technical irrigation land. These options can be implemented with least cost of emission reduction and still giving positive beneift.

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Appendix 1. Feature of mitigation options from agricultural sector

No.	Mitigation Options	Featurs	Methane Emission Reduction % from Baseline
	Livestock		
L1	Providing mineral block	Providing mineral block as feed additive. So there is added cost to buy mineral blocks (1 block/month/head).	40 (Howden and Munro, 1994)
L2	Use local crop residue	Using local crop residues as supplement of grass (79.20 ton/year/farm of local crop residues are replaced by 14.4 ton/year/farm of grass).	30 (Leng, 1991)
L3	Building biogas plant	Building biogas plant to reduce methane emission from manure management. It needs investment to build the plant so there is addition depreciation of fixed asset and also need more labor to operate the plant.	70 (Sathaye and Meyer, 1995)
L4	Artificial insemination	Replacing of natural insemination by artificial insemination. To conduct this action needs semen and inseminator.	15 (Nugraha *et al.*, 1996)
L5	Modified rumen	Addition rumen modifier agents to feed in order to reduce methane emission and increase digestibility.	25 (Howden and Munro, 1994)
L6	Increased digestibility	Chopping grass, so there are cost additions for depreciation of chopper machine and labor for operation.	15 (Moss et al., 1994)
	Ricefield		
R1	No Tillage	There is no land preparation for no tillage cultivation scenario and replaced by herbicide application.	12.2
R2	Substitution of urea by AS	Reducing application of urea (-23kg) and increasing application of AS (50 kg).	9.6
R3	Substitution prill urea by tablet urea	In the baseline uses prill urea and this scenario uses tablet urea. The quantities of fertilizer are not different but it needs more labours (5 Mondays/ha).	5.3
R4	Direct seeding	In the baseline scenario the seed is broadcasted first in nursery and then transplanted to field. In this scenario the seed is broadcasted directly to field. The need of seed is not different, but this scenario use less labour (4 Mondays/ha).	19.7
R5	Intermittent irrigation	In the baseline filed is flooded continuously, in this scenario filed is flooded interuptly. This method can save water 50% from usual method, but need more labour (6 Mondays/ha).	29.8
R6	Substitution of variety by IR64	In the baseline, it uses Cisadane variety and in this scenario uses IR64 variety.	62.2

Appendix 1. *Continued*

No.	**Mitigation Options**	**Featurs**	**N_2O Emission Reduction (% from Baseline)**
	Lowland rice		
S1	Split urea application	More frequent urea application from twice to three times with the same rate (250 kg/ha).	8.1 (Zaini, *et al.*, 1997)
S2	Reduce urea application	The amount of urea applied to lowland rice is reduced from 250kg/ha to 200 kg/ha.	19.8 (BPS and by calculation)
S3	Reduce Ammon. Sulphate (AS)	In baseline 250 kg urea/ha is applied; In option, 227 kg urea/ha and 50 kg AS.	5.2 (Freeney *et al.*, 1981)
S4	No fertilizer	Omit the application of 150 kg urea/ha as the option.	5.3 (BPS and by calculation)
S5	Without organic matter	In baseline 5 ton organic matter/ha was used as mulch; In option no organic matter applied to the field.	41.1 (BPS and by calculation)
	Corn		
S6	Reduce urea application	In baseline 200 kg urea/ha is applied; In option urea is applied as much as 130 kg/urea/ha.	50.4 (BPS and by calculation)
	Cassava		
S7	Adira IV variety	In baseline cassava variety use is Malang 1, while the option is Adira IV.	1.4 (Bronson *et al.*, 1993) (Mosier *et al.*, 1990)
S8	Reduce urea application	In baseline 130 kg urea/ha is applied; In the option it is only 67 kg urea/ha.	30.2 (BPS and by calculation)
	Fallow period		
S9	Natural weedy fallow	In baseline the line is cleared by light cultivation; In the option, the land is kept weedy.	10.1 (Buresh *et al.*, 1989) (George *et al.*, 1993)

Appendix 2. Mitigation options in agricultural production

No.	Mitigation Options	Methane Emission Reduction Potential	Impact on Yield (% Change)	Feasible Target Area
	Livestock	**Kg/animal/yr**	**Meat or milk**	
L1	Providing mineral block	22.2	+ 30% milk in 2 years + (16-50%) milk	East Java, Central Java
L2	Use local crop residue	16.7	+ 21.6% milk + 35% milk fat	South Sulawesi, West Java
L3	Build Biogas Plant	38.9	Source of energy, biofertilizer and other purposes	Java, Nusa Tenggara
L4	Artificial insemination	8.3	+ 157% milk	East Java
L5	Modified rumen	13.9	+ (5-8%) meat	Java, South Sulawesi
L6	Increased digestibility	8.3	+ 5% meat	Java, South Sulawesi
	Irrigated Ricefield	**Kg/ha**	**Rice**	
R1	No Tillage	22.9	-10.8	West Java, Sumatra, Kalimantan
R2	Ammonium Sulfate (AS)	10.0	6.5	East Java, Bali, Nusa Tenggara
R3	Tablet Urea	18.1	20.5	Java, Bali
R4	Direct Seeded	37.0	4.3	Java, Sumatra, South Sulawesi, Bali
R5	Intermittent irrigation	55.5	5.4	Java, South Sulawesi, Bali
R6	Variety (IR64)	-90.0	-15.6	West Java
	Rainfed Ricefield			
R1	No Tillage	42.0	-8.4	West Java, Sumatra, Kalimantan
R2	Ammonium Sulfate (AS)	29.8	6.7	East Java, Bali, Nusa Tenggara
R3	Tablet Urea	20.0	10.8	Java, Bali
R4	Variety (IR64)	33.0	40	West Java
S1	Split N application	0.14	6.7	All Indonesia
S2	Reduce N fertilizer (Urea)	0.34	-8.6	East Java
S3	Reduce Ammon. Sulphate	0.09	-7.6	West Java, Sumatra, Bali
	Upland rice			
S4	No N fertilizer	0.09	-0.09	Kalimantan, Sumatra, Java
S5	Without Organic matter	0.70	-15	Sumatra, Java
	Corn			
S6	Reduce N fertilizer (urea)	0.70	-8	East Java
	Cassava			
S7	Adira IV variety	0.02	-12	Java, Sumatra, Kalimantan
S8	Reduce N fertilizer (urea)	0.42	-7.2	East Java
	Fallow period			
S9	Natural weedy fallow	0.14	0	Java, Sumatra, Kalimantan