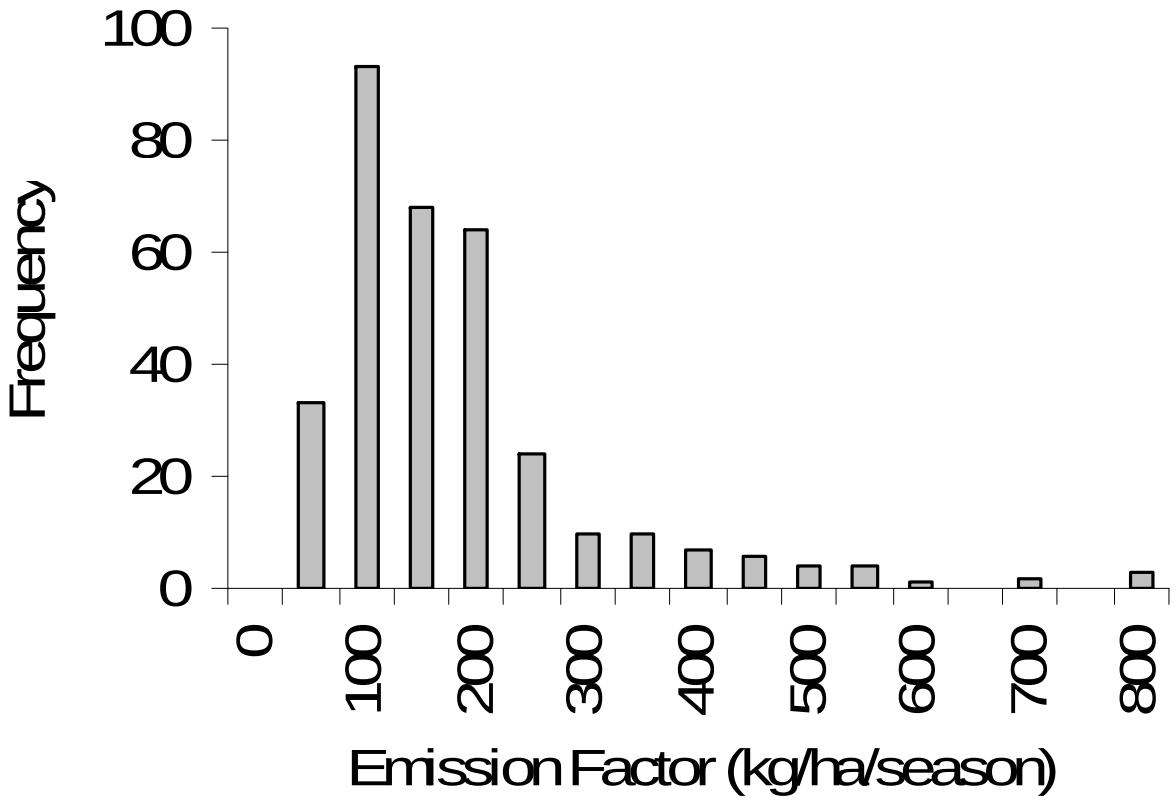
INDONESIA EXPERIENCE IN DETERMINING COUNTRY SPESIFIC EMISSION FACTOR IN AGRICULTURE SECTOR

Dr. Prihasto Setyanto
Prof. Dr. AK Makarim
Prof. Hidayat Pawitan
Prof. Iswandi Anas
Dr. Le Istiqlal Amien
Elza Sumaini

Formula for Estimating Rice CH_4 Emission

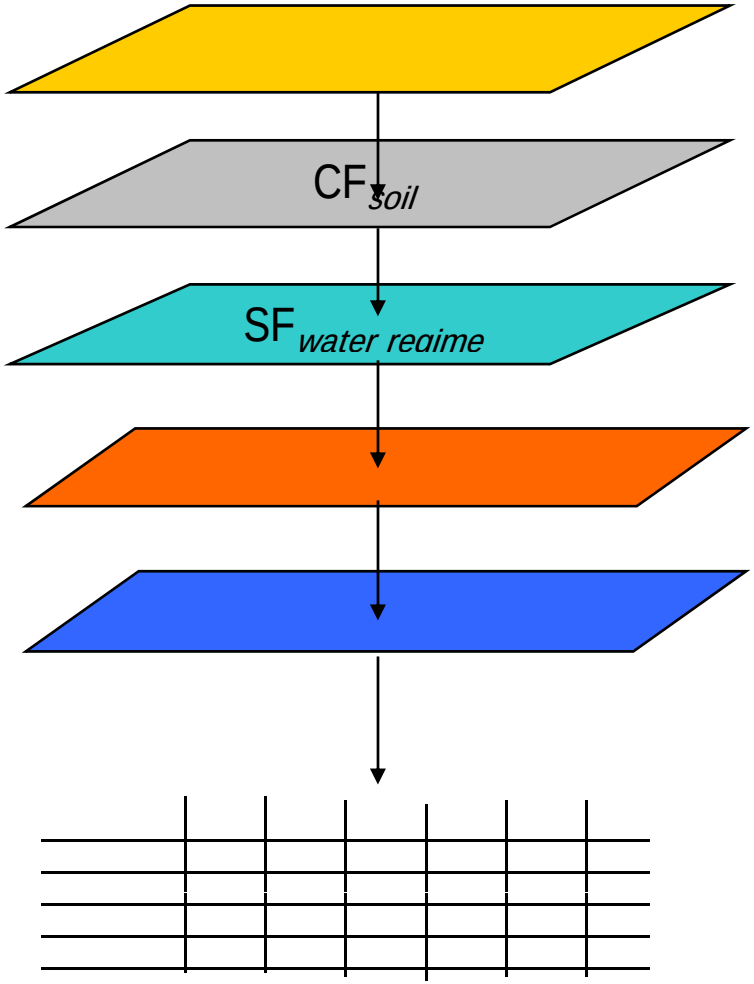
- ***CH_4 Emission$_{rice}$ = A*CF_{soil}*$SF_{water\ regime}$*EF_{rice}***
  - *CH_4 Emission$_{rice}$= annual methane emission from rice cultivation (Gg CH_4/year)*
  - *A = seasonal harvested area (ha/year)*
  - *CF_{soil} = Correction factor of different soil types*
  - *$SF_{water\ regime}$= Scaling factor of different water regime. For continuous flooded is equal to 1*
  - *EF_{rice} = Methane emission factor from rice (kg CH_4/ha)*

Rice Emission Factors



- Average of emission factor is 169.9 kg/ha/season based on 349 field experiments conducted in 10 different soil types and 3 different water management using 22 rice varieties (all in Java)

Process of Determining Rice Area by soil types and irrigation



Rice growing area based on Satellite assessment MoAg

Map of soil types from MoAg

Map of irrigated rice area from Ministry of Public Work

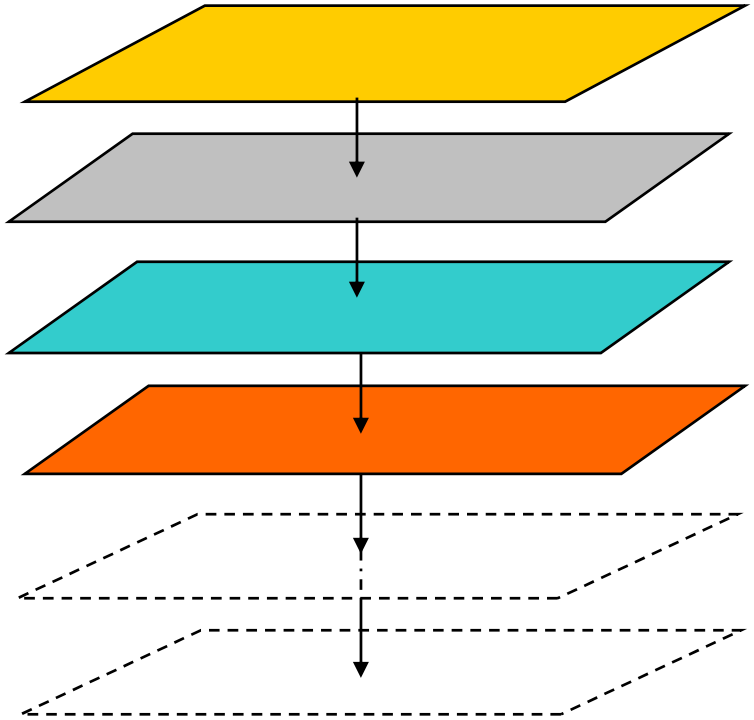
Map of district boundary

Map of rice growing area by district according to irrigation and soil types (SNC)

Data of harvesting area by season reported by district to MoAg and Bureau of Statistic based on irrigation types

Next Step

- *Introducing new scaling factor for variety (SF_v) and crop management (SF_{cm})*
- *CH_4 $Emission_{rice}$ = A*CFsoil*SFwr*SF_v*SF_{cm}*EF*



Rice growing area based on Satellite assessment MoAg

Map of soil types from MoAg

Map of irrigated rice area from Ministry of Public Work

Map of district boundary

Map of planting areas by varieties

Map of planting area by crop management

This approach can assist the sector to evaluate the effectiveness of mitigation technologies intervention by district

Rice cultivation scaling factors

1. Water regimes
2. Soil Types
3. Rice varieties
4. Organic matter
5. Establishment of herbicides
6. Crop establishment

Examples of database of various GHG emission research in Indonesia (1996-2006)

Year	Units	CH4 emission	Yield (t/ha)	Rice cultivar	Organic matter amendment	Water regime	References
1996	kg CH4/ha /season	538	6.34	Cisadane			IAERI annual report 1996/97
		440	5.15	Memberamo			
		246	4.92	IR 64			
		357	6.46	IR 36			
		412	3.25	Dodokan			
1997	kg CH4/ha /season	461	4.03	Cisadane			
		215	3.86	Memberamo			
		194	3.56	IR 64			
		282	3.11	Dodokan			
		421	4.63	IR 72			
		226	5.12	Batang anai			
1996	kg CH4/ha /season	89	3.13	IR 64	no organic amendment		IAERI annual report 1996/97
		189	6.27	IR 64	animal manure		
		170	5.51	IR 64	animal manure		
		165	5.90	IR 64	straw		
		176	4.98	IR 64	straw		
		156	4.71	IR 64	compost		
		136	4.76	IR 64	compost		
1997	kg CH4/ha /season	250	3.59	IR 64	no organic amendment		
		403	6.28	IR 64	animal manure		
		372	5.69	IR 64	animal manure		
		344	6.26	IR 64	straw		
		374	5.99	IR 64	straw		
		359	5.35	IR 64	compost		
		295	5.77	IR 64	compost		

Table continued..

RS 1997/98	kg CH4/ha /season	47.7	2.20	Cisadane			IAERI 1997/1998 annual report. Pengaruh beberapa varietas padi terhadap emisi gas metana pada lahan sawah
		40.3	2.97	Memberamo			
		30.7	3.05	Maros			
		39.0	2.85	IR 64			
		44.7	3.39	IR 36			
		65.7	3.67	Batang anai			
DS 1998	kg CH4/ha /season	147.7	4.09	Cisadane			
		121.3	3.82	Memberamo			
		117.0	4.31	Maros			
		65.8	4.20	IR 64			
		101.0	4.87	IR 36			
		168.8	4.96	Batang anai			
RS 1997/98	kg CH4/ha /season	207	3.15	Memberamo			IAERI 1997/1998 annual report. Pengaruh pemberian pupuk anorganik terhadap emisi gas metan pada lahan sawah
		188	5.81	Memberamo			
		186	5.81	Memberamo			
		181	6.63	Memberamo			
		175	6.68	Memberamo			
		197	7.62	Memberamo			
DS 1998	kg CH4/ha /season	185	3.79	Memberamo			
		176	4.46	Memberamo			
		174	4.76	Memberamo			
		168	4.47	Memberamo			
		164	5.86	Memberamo			
		184	4.83	Memberamo			
RS 1997/98	kg CH4/ha /season	99.83	6394	Memberamo		Continous flooded	IAERI 1997/1998 annual report. Emisi metan dari berbagai sistem pengaturan air pada lahan sawah
		34.54	5703	Memberamo		Intermittent irrigation	
		31.28	5439	Memberamo		Intermittent irrigation	
		93.67	6588	Memberamo		Continous flooded	
		75.04	5890	Memberamo		Saturated irrigation	
		20.70	6217	Memberamo		Intermittent irrigation	
DS 1998	kg CH4/ha /season	145.94	3201	Memberamo		Continous flooded	
		46.19	2985	Memberamo		Intermittent irrigation	
		45.92	3306	Memberamo		Intermittent irrigation	
		91.58	3346	Memberamo		Continous flooded	
		65.38	3149	Memberamo		Saturated irrigation	
		17.81	2991	Memberamo		Intermittent irrigation	

Adjusted scaling factor for water regimes and soil correction factors

Category	Sub-category		SF (adapted from IPCC Guidelines 1996)	Adjusted SF (based on current studies in Indonesia)	Adjusted CF from different soil types of Indonesia
Upland	None		0		
Lowland	Irrigated	Continuously Flooded	1.0	1.00	
		Intermittently Flooded – Single Aeration	0.5 (0.2-0.7)	0.46 (0.38-0.53)	
		Intermittently Flooded – Multiple Aeration	0.2 (0.1-0.3)		
	Rainfed	Flood Prone	0.8 (0.5-1.0)	0.49 (0.19-0.75)	
		Drought Prone	0.4 (0-0.5)		
	Deep Water	Water Depth 50-100 cm	0.8 (0.6-1.0)		
		Water Depth < 50 cm	0.6 (0.5-0.8)		

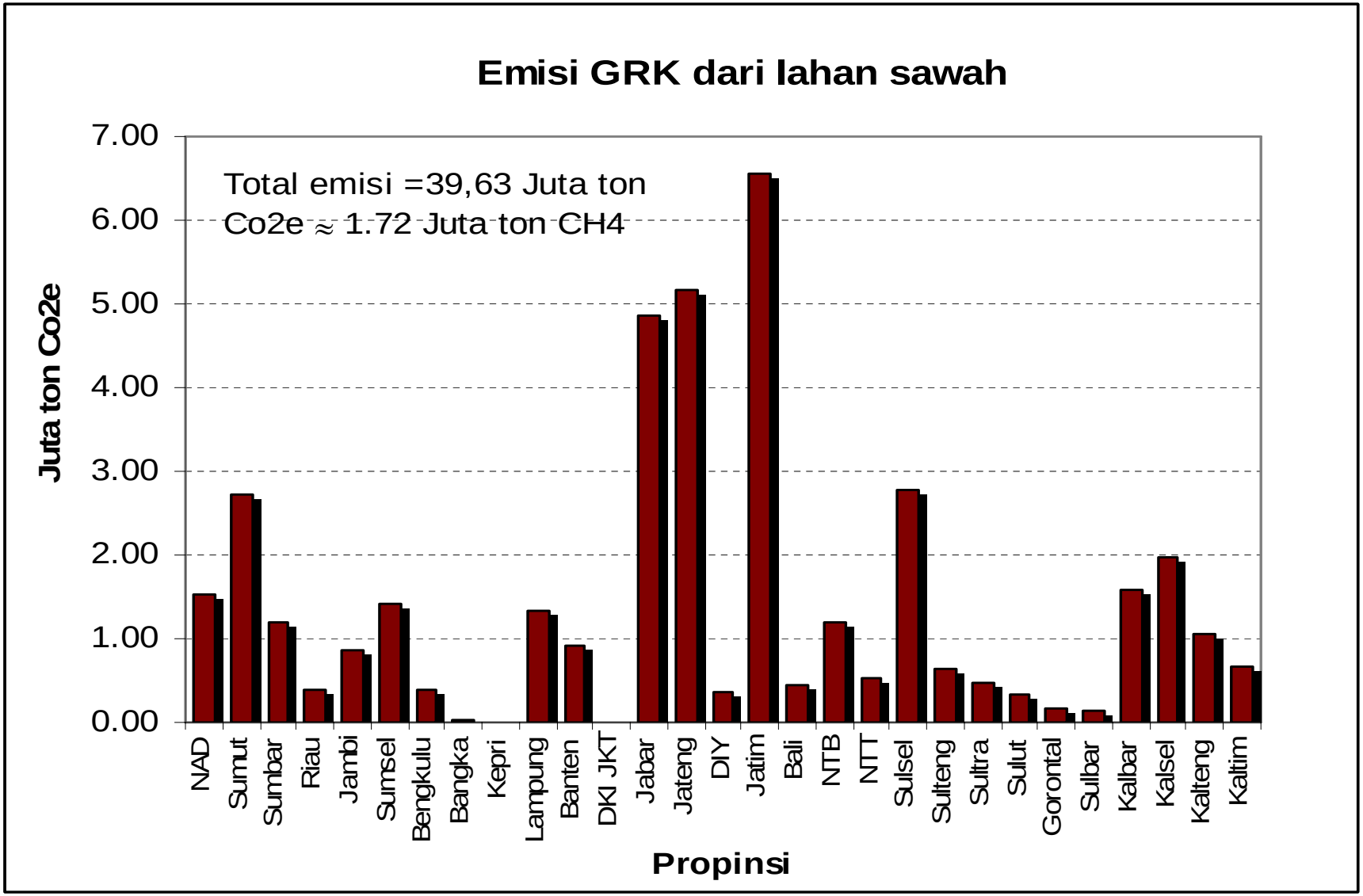
Adjusted CF from different soil types of Indonesia

Soil Types	Inceptisol	1.12 (1.0-1.23)
	Oxisol	0.29 (0.1-0.47)
	Entisol	1.02 (0.94-1.09)
	Vertisol	1.02 (0.46-1.99)
	Alfisol	0.84 (0.32-1.59)
	Histosol	2.39 (0.92-3.86)
	Mollisol	-
	Andisol	1,02**
	Ultisol	0.29*

Distribution of rice soils of Indonesia

No.	Ecosystem / rice soil types	distribution
A	Lowland	55%
	Aquept, Aquent (Alluvial and Gley soil)	
B	Highland	17%
	Udept (Latosols and Regosols)	
C	Complex (Combination between A and B)	
1	Vertisols (Grumusols) (Sub ordo Aquert, udert, and ustert)	7%
2	Ultisols and Oxisols (Red yellowish podsolic)	6%
	(Sub ordo: Aquult and Paleudult, Aquox and Kandiudox)	
3	Alfisols (Red yellowish Mediteranean)	4%
	Sub ordo udand, ustand, and aquand	
4	Newly opened rice field: Ultisols (red yellowish podsolic)	10%
5	Newlye opened rice field: Oxisols	1%
	(Latosol, lateritic)	
	Total	100%

GHG emissions from different province of Indonesia based on soil CF and adjusted SF water regimes



Scaling factors of CH4 emission under different organic amendments based on studies conducted in Indonesia

Organic matter	Mean emission (kg CH4/ha/musim)	SD	CV (%)	Number of Data	SF
No OM	65.9	39.23	59.56	13	1.00
FYM[1]	149.7	93.80	62.66	31	2.27
Straw[2]	137.1	107.47	78.36	14	2.08
Composts[3]	236.5	108.03	45.68	4	3.59
Mix FYM+straw[4]	70.5	15.33	21.74	4	1.07

Scaling factors under different rice varieties established in Indonesian rice field (based on studies at IAERI)

Rice Variety	average emission (kg CH4/ha/season)	SD	CV (%)	Number of Data	SF
Gilirang	496.9			1	**2.46**
Fatmawati	365.9			1	**1.81**
Aromatic	273.6	138.87	50.8	3	**1.35**
Tukad Unda	244.2	106.54	43.6	2	**1.21**
IR 72	223.2	133.01	59.6	5	**1.10**
Cisadane	204.6	133.85	65.4	14	**1.01**
IR 64*	202.3	165.17	81.7	164	**1.00**
Margasari	187.2	89.93	48.0	3	**0.93**
Cisantana	186.7	53.71	28.8	6	**0.92**
Tukad Petanu	157.8	32.16	20.4	2	**0.78**
Batang Anai	153.5	81.24	52.9	3	**0.76**
IR 36	147.5	121.56	82.4	5	**0.73**
Memberamo	146.2	99.49	68.1	64	**0.72**
Dodokan	145.6	144.54	99.2	6	**0.72**
Way Apoburu	145.5	84.21	57.9	36	**0.72**
Muncul	127.0	26.87	21.2	2	**0.63**
Tukad Balian	115.6	25.87	22.4	2	**0.57**
Cisanggarung	115.2	62.77	54.5	3	**0.57**
Ciherang	114.8	103.14	89.8	29	**0.57**
Limboto	99.2	40.80	41.1	6	**0.49**
Wayrarem	91.6	38.09	41.6	6	**0.45**
Maros	73.9	61.02	82.6	2	**0.37**

Scalling factors under different water regimes and herbicide application

no	Application	Average emission (kg CH4/ha/season)	SD	CV (%)	Number of Data	SF
1	cont flooding + 0 herbicide	700.7	298.88	42.7	41	1.0
2	cont flooding + herbicide	266.7	243.06	91.1	78	0.4
3	intermittent + herbicide	118.2	139.65	118.2	78	0.2
4	saturated + herbicide	65.3	52.84	81.0	78	0.1

Scaling factors of CH4 flux under different crop establishment

Crop establishment	average flux (kg/ha/hari)	SD	CV (%)	Number of data	CF
Transplanted rice*	1.067	0.75	70.0	48	**1.00**
Direct seeded rice **	1.322	0.79	60.1	48	**1.24**

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