PENGELOLAAN PIRIT PADA LAHAN SAWAH PASANG SURUT

Oleh :

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Disajikan pada :

SEMINAR NASIONAL DAN MINI EXPO
" PENGENDALIAN PIRIT, WERENG BATANG COKELAT, DAN LAYU FUSARIUM DENGAN TEKNOLOGI ORGANIK DAN HAYATI"
Menara 165, Jakarta
28 Agustus 2018

Soil sampling in the acid sulphate soil

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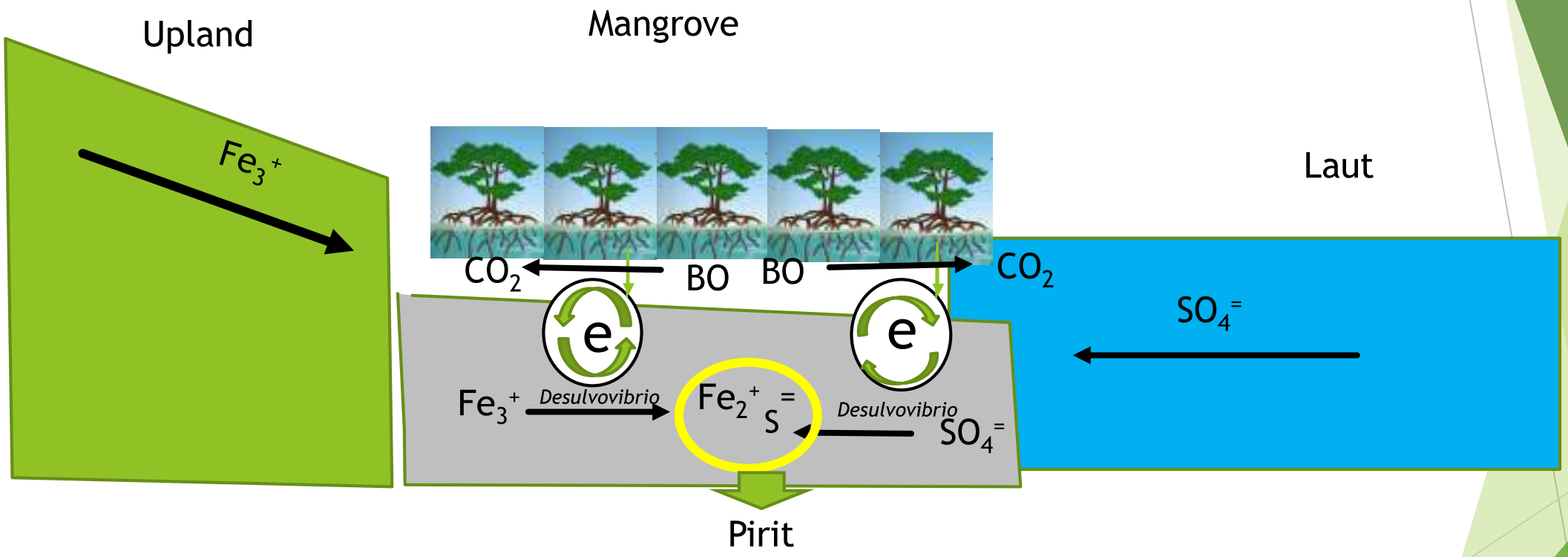
- Mineral Pirit: FeS2
- Terbentuk : 1. hasil proses pembekuan magma, dan 2. Hasil rekristalisasi mineral FeS2 pada lingkungan mangrove

Mineral Pirit

Lingkungan Mangrove



Pembentukan mineral pirit pada lingkungan mangrove sebagai reaksi biokimia antar a: ion sulfat pada air laut dengan ion besi (ferri) dari pada sedimen sungai terjadi pada lingkungan mangrove yang banyak bahan organik oleh bakteri *Desulvovibrio sp*

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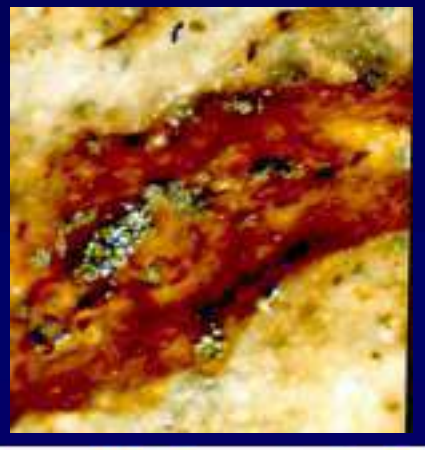
Problems in Acid Sulphate Soil Management:

1. Low pH
2. Low content of macro and micro nutrients
3. High concentration of soluble toxic materials
4. Lack of fresh water for flushing the toxic materials



Acid sulphate soil:

1. The soil pH is extremely low (pH 2-3)
2. Oxidation of pyrite

   $FeS_2 + 8H_2O \rightarrow Fe^{3+} + 2SO_4^{2-} + 16H^+ 15e^-$
3. Some location near river can be used for rice field with low production (< 3 ton/ha).

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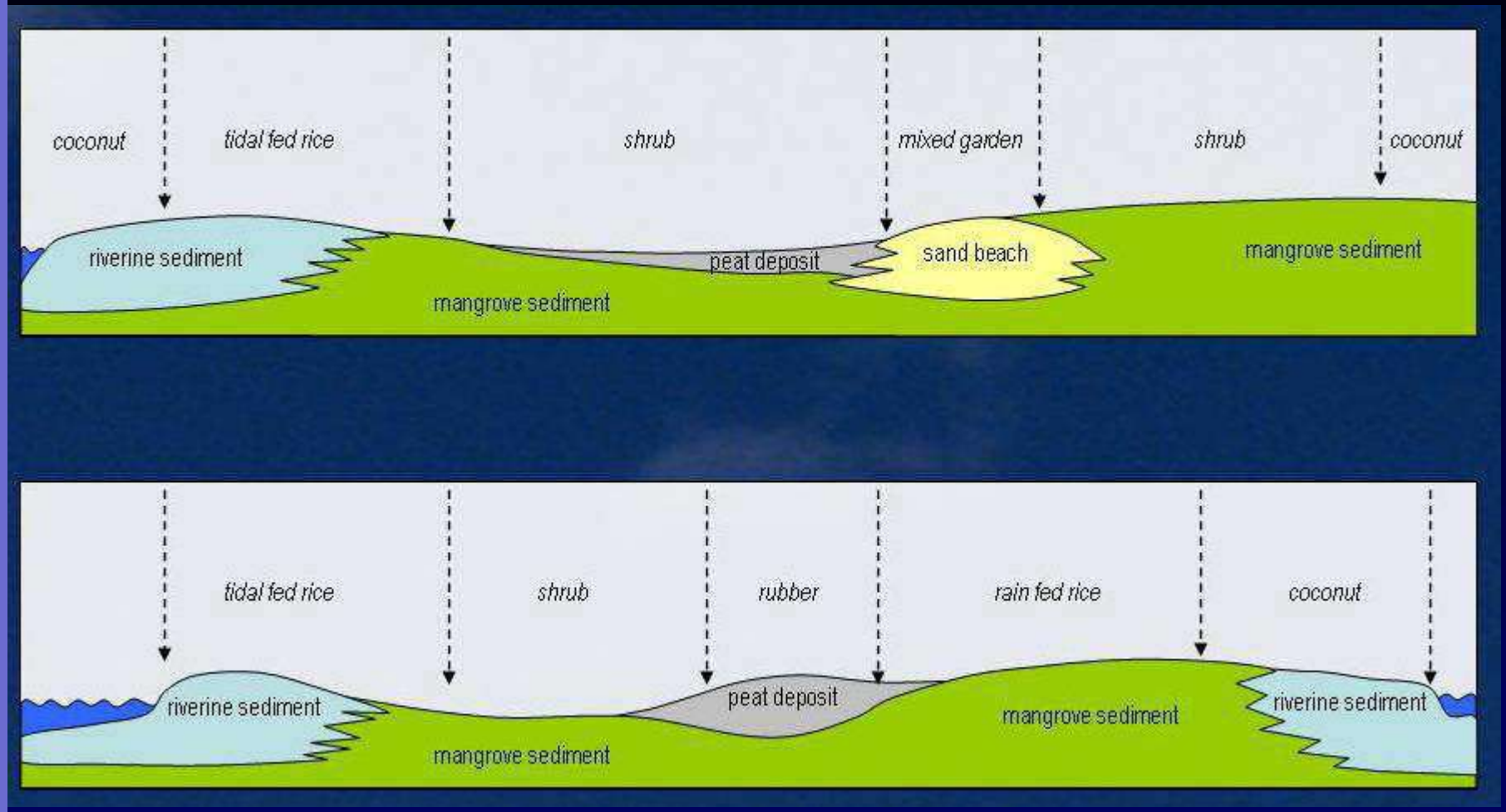
Di Indonesia, lahan rawa gambut biasanya terbentuk sebagai hasil suksesi dari lingkungan rawa mangrove. Maka, Lapisan berpirit biasanya berada dibawah lapisan gambut tipis.

Pembangunan persawahan pada gambut tipis akan mengakibatkan tersingkapnya ke permukaan tanah lapisan berpirit sehingga pirit teroksidasi terbentuklah tanah yang sangat masam yang sering disebut sebagai Tanah sulfat masam



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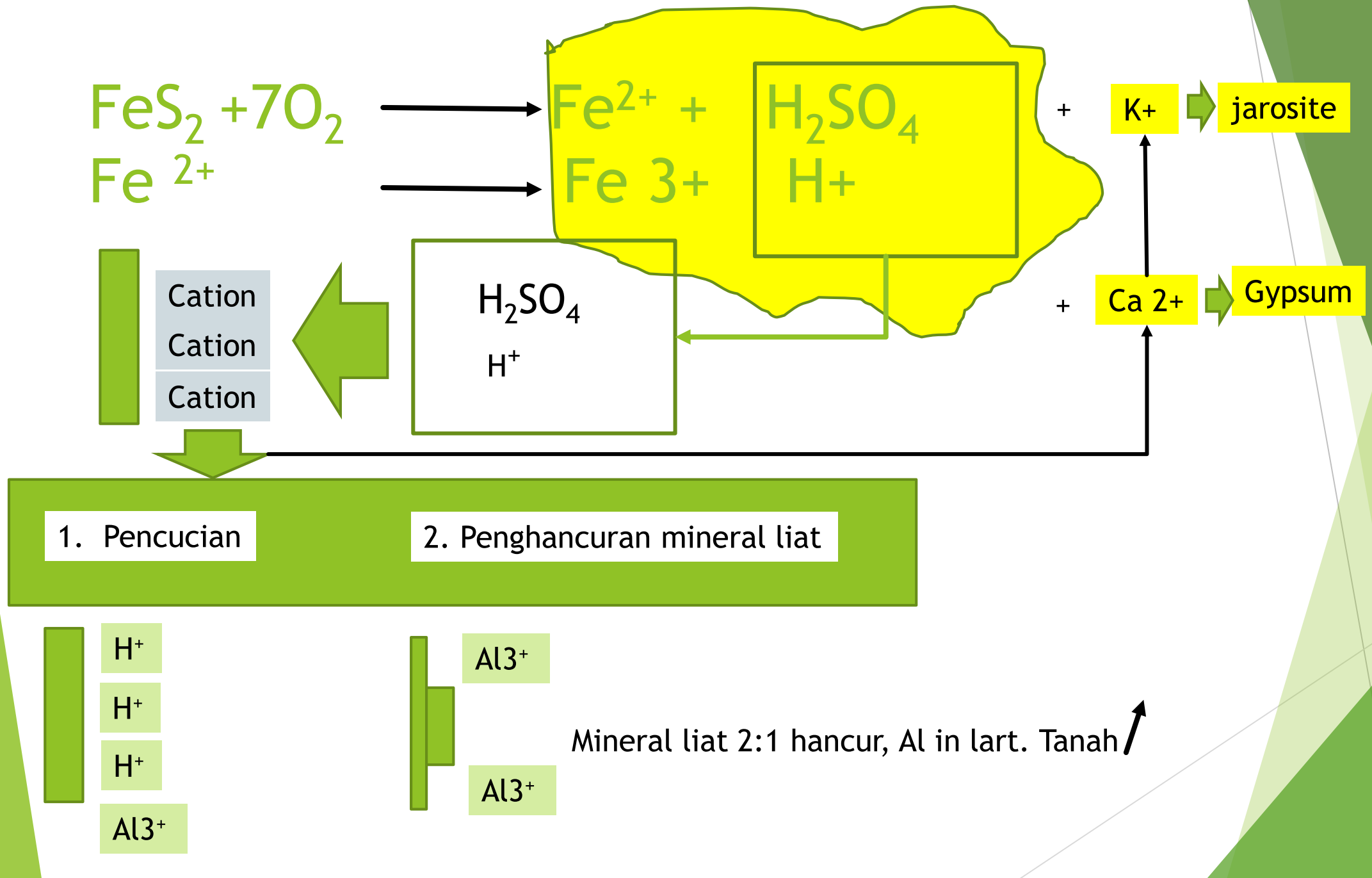
Reaksi biokimia pada *Thiobacillus sp*

- $S^{=} + 2O_2 \longrightarrow 2SO_4^{=} + 2H^{+} + 8e^{-}$
- $12CO_2 + 48H^{+} + 8e^{-} \longrightarrow 2(C_6H_{12}O_6) + 12\ H2O$

Thiobacillus dapat hidup pada pH sangat rendah (pH < 3), Bakeri lainnya senang pada [pH sekitar netral


$FeS_2 + 7O_2$
Fe^{2+}
Fe^{2+} +
Fe^{3+}
H_2SO_4
H^+
+
K+
jarosite
+
Ca 2+
Gypsum
H_2SO_4
H^+
Cation
Cation
Cation
1. Pencucian
2. Penghancuran mineral liat
H^+
H^+
H^+
Al^{3+}
Al^{3+}
Al^{3+}
Mineral liat 2:1 hancur, Al in lart. Tanah

Subsidence,
Peat fire

(ASS)

Peat

Drainage

Dried Mangrove sediments

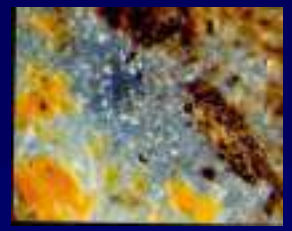
- Low pH ~ pH 3
- High toxic Substances: Al, Sulfate ion,
- High soluble salt (EC > 5 Ms/cm)

Mangrove sediments

Pyrite

Oxidation

Thiobacillus sp



Jarosite

Gypsum

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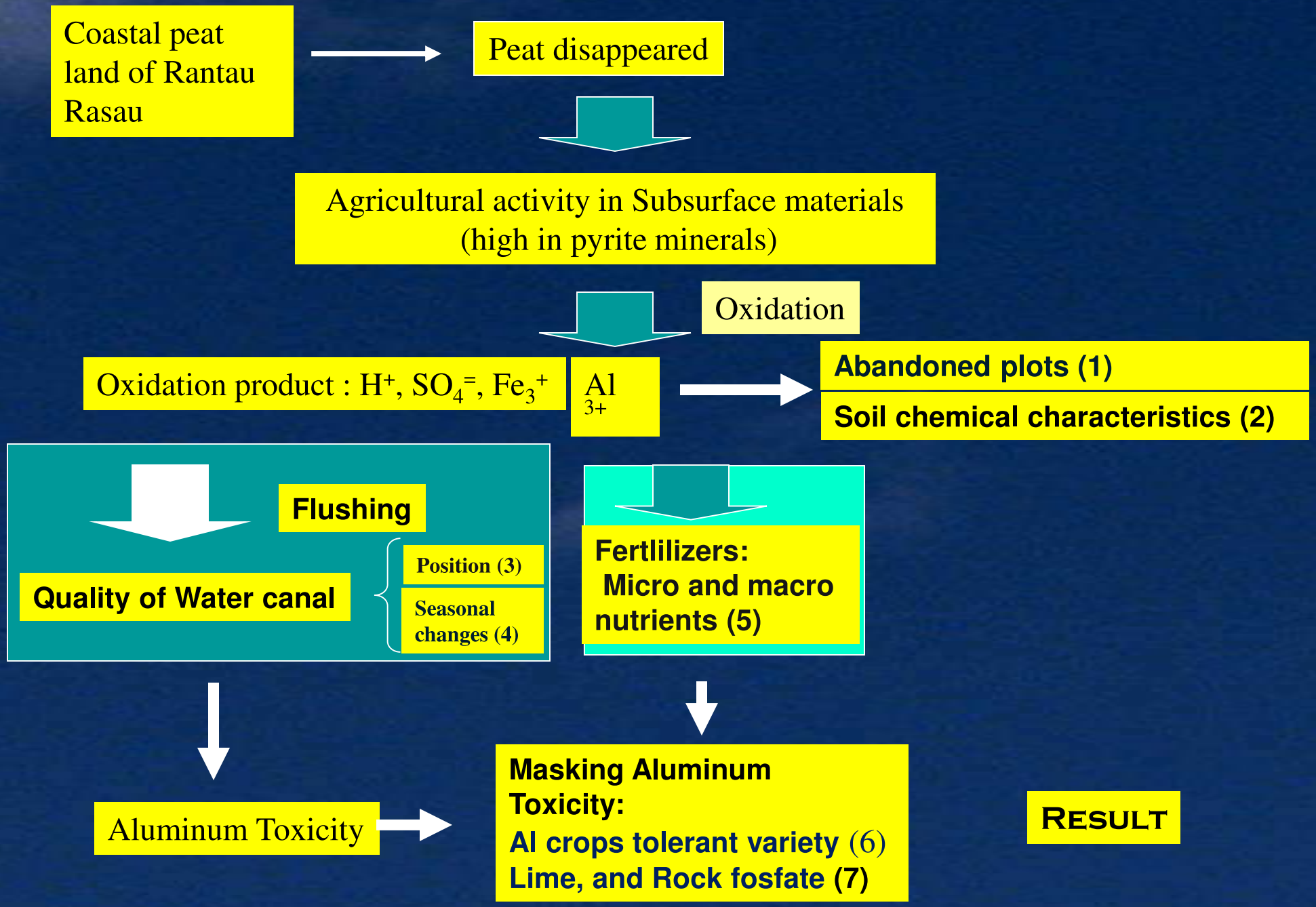
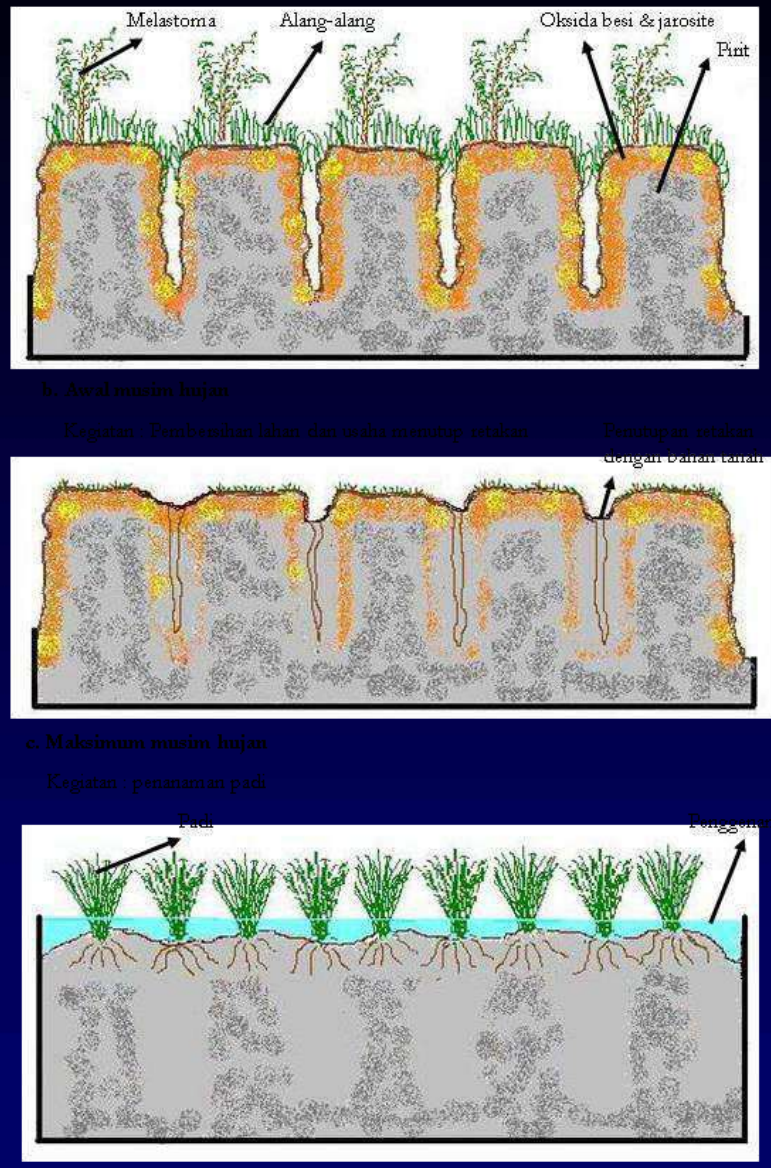

Coastal peat land of Rantau Rasau
Peat disappeared
Agricultural activity in Subsurface materials (high in pyrite minerals)
Oxidation
Oxidation product : H^+, $SO_4^=$, Fe_3^+
Al^{3+}
Abandoned plots (1)
Soil chemical characteristics (2)
Flushing
Quality of Water canal
Position (3)
Seasonal changes (4)
Fertlilizers: Micro and macro nutrients (5)
Aluminum Toxicity
Masking Aluminum Toxicity:
Al crops tolerant variety (6)
Lime, and Rock fosfate (7)
RESULT



Gambar 2. Teknik perbaikan lahan sawah yang retak-retak tak balik (*irreversible cracking*) pada sedimen berpirit

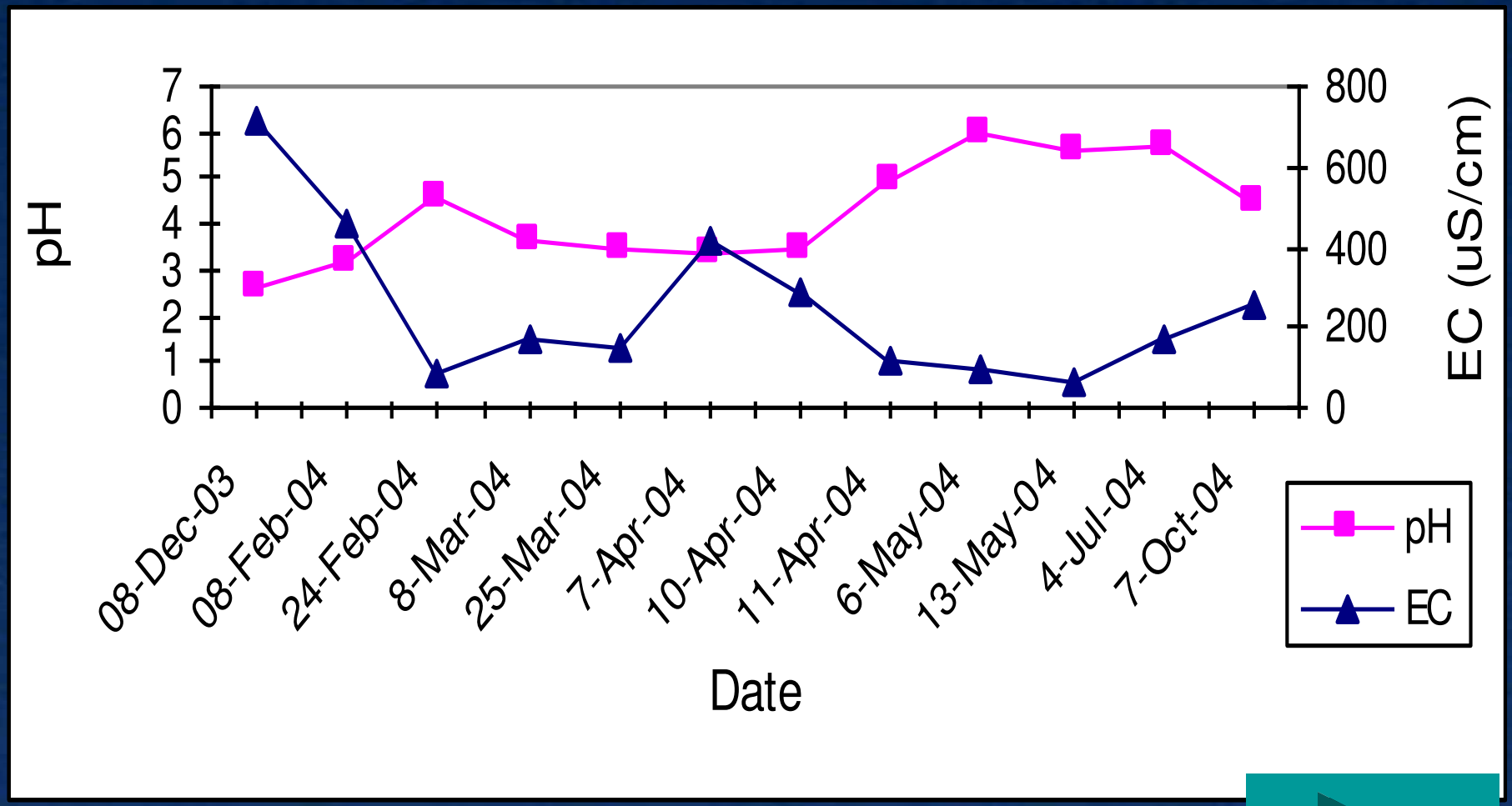
Pada tanah sulfat masam: Retakan retakan tidak menutup walaupun telah terendam.

Pengenangan tidak akan membuat suasana kembali menjadi reduksi karena pH terlalu masam.

Shrub

White colored salts (Al sulfate) can be found during dry seasons at soil surface

Seasonal acidity change of canal water (stagnant section)



Water quality in stagnant section of PC1

SO_4	500.7 ppm
pH	3.26
Al	98 ppm
Ca	1.46 ppm
Mg	1.02 ppm
Na	7.5 ppm
K	8.2 ppm
Fe	11 ppm
Mn	0.6 ppm
Zn	2.3 ppm
Cu	9.7 ppm

Note:

Average value during early rainny season Nov 2004

Water characteristics of stagnant section (II) primary canal

Clear water with red gel flocules of canal at stagnant section of PC1 on october 2004 (early rainny season)

Depth	Analisis Kimia Total (%)									
(cm)	S	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	CuO	ZnO	MnO
0-5	-	56.16	35.31	2.55	0.03	0.13	5.14	nd	nd	0.01
10-15	1.77	54.59	38.20	2.65	0.08	0.17	2.00	nd	nd	nd
15-20	1.72	56.68	33.18	2.35	nd	0.27	2.03	nd	0.02	0.02
20-25	1.77	56.08	37.56	2.10	0.05	0.20	2.11	nd	0.01	0.03
25-30	1.62	58.73	33.30	1.75	nd	0.27	2.14	nd	nd	0.01
30-35	0.92	54.82	34.03	1.63	nd	0.20	2.43	0.06	0.01	nd
35-40	1.11	59.58	32.96	1.67	nd	0.30	2.13	nd	0.01	0.02
40-45	1.13	56.32	34.56	2.13	0.15	0.29	2.21	0.05	0.05	nd
45-50	0.93	60.42	31.51	1.64	nd	0.25	2.42	0.01	0.04	0.07
50-55	1.03	59.54	30.01	1.61	0.21	0.20	2.31	0.02	nd	nd
55-60	0.79	66.49	26.20	1.41	nd	0.13	1.95	nd	0.05	0.05
60-65	1.09	62.90	28.86	2.91	0.09	0.13	2.00	nd	nd	nd
65-70	1.11	66.38	25.83	2.71	0.21	0.18	1.97	nd	0.01	0.05

- : Not determinated

-nd: Not detected

TOTAL IRON OXIDE CONTENT IS LOWER THAN 2.91%,

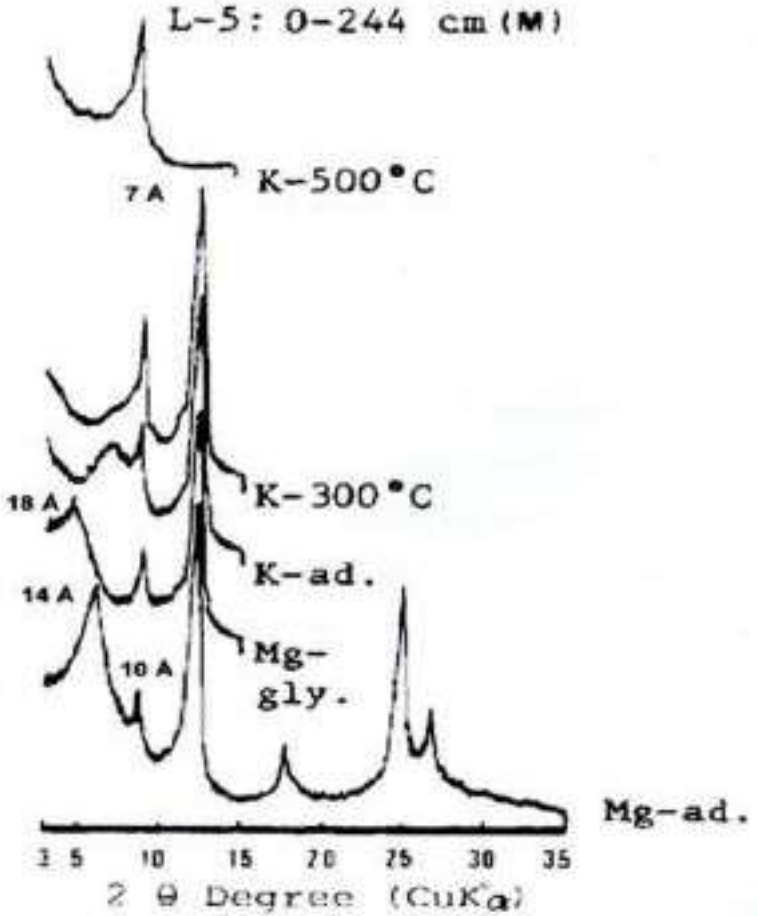
Table 2. Properties of Soil Samples from Rice field on Peaty Clay.

Depth (cm)	pH H_2O	Exchangeable bases (meq/100g)				Exch. Al (meq/ 100g)
		Ca	Mg	K	Na	
0-5	4.19	1.11	3.09	0.08	0.13	15.6
5-9	4.90	1.04	2.75	0.08	0.13	16.8
9-15	4.13	0.92	1.92	0.10	0.15	13.4
15-20	4.21	0.81	1.99	0.07	0.12	12.7
20-25	4.22	0.91	2.38	0.08	0.11	16.9
25-30	4.30	0.82	2.06	0.08	0.11	17.3
30-35	4.29	0.86	1.80	0.09	0.11	14.7
35-40	4.23	0.82	1.94	0.10	0.13	16.2

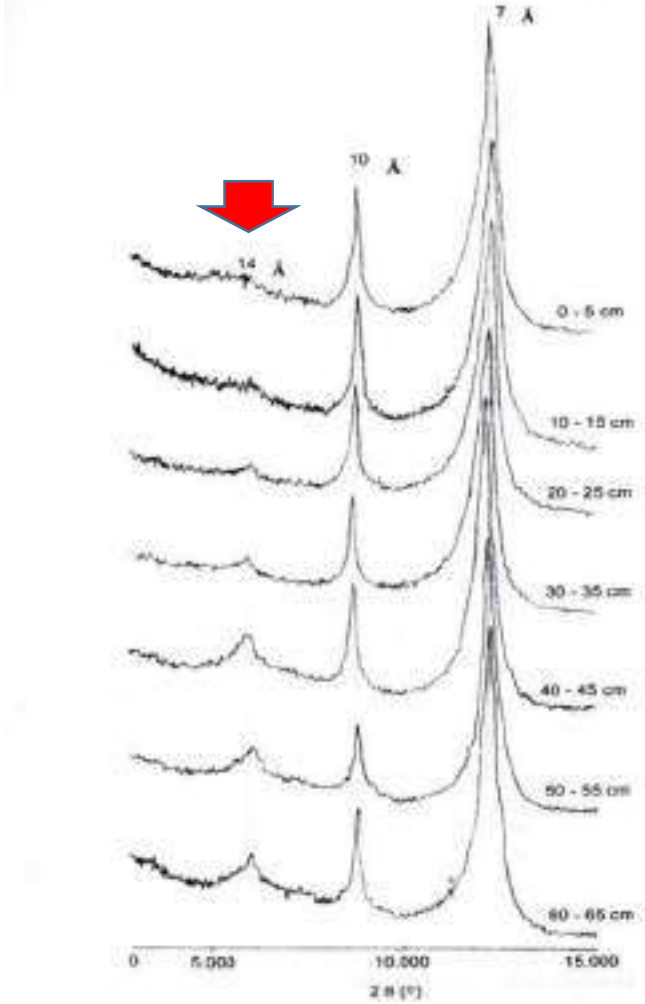
Extractable Fe and Al with NH4OAC and KCl.

Soil Depth (cm)	pH H_2O	Al content (meq/100g)				Fe content (ppm)			
		Unbuff. sol. (KCl)	NH_4OAc pH 4.2	NH_4OAc pH 4.8		Unbuff. sol. (KCl)	NH_4OAc pH 4.2	NH_4OAc pH 4.8	NH_4OAc pH 7.0
0-5	4.19	15.6	20.4	6.41		386.1	227.0	172.3	58.9
5-9	4.09	16.8	27.4	7.29		231.7	133.4	94.8	28.5
9-15	4.13	13.4	28.2	7.65		256.7	155.9	144.6	37.6
15-20	4.21	12.7	29.6	8.01		198.3	151.2	146.5	36.4
20-25	4.22	16.9	30.1	9.61		264.9	189.9	198.8	57.7
25-30	4.30	17.3	29.3	9.56		200.7	165.1	136.9	34.9
30-35	4.29	14.7	26.3	10.02		136.1	183.4	130.4	21.0
35-40	4.23	16.2	29.0	7.18		169.6	184.2	213.6	32.4
40-45	4.32	16.1	34.5	9.30		190.6	345.8	197.5	40.1
45-50	4.32	14.8	33.7	9.40		273.5	500.2	132.4	74.0
50-55	4.41	13.8	28.8	9.30		256.9	469.1	286.1	69.6
55-60	4.94	10.8	32.0	10.08		230.2	512.1	352.0	71.0
60-65	4.73	9.3	31.8	9.15		348.3	1346.3	704.7	167.3
65-70	5.08	7.3	37.2	9.46		262.1	1337.4	710.1	141.6

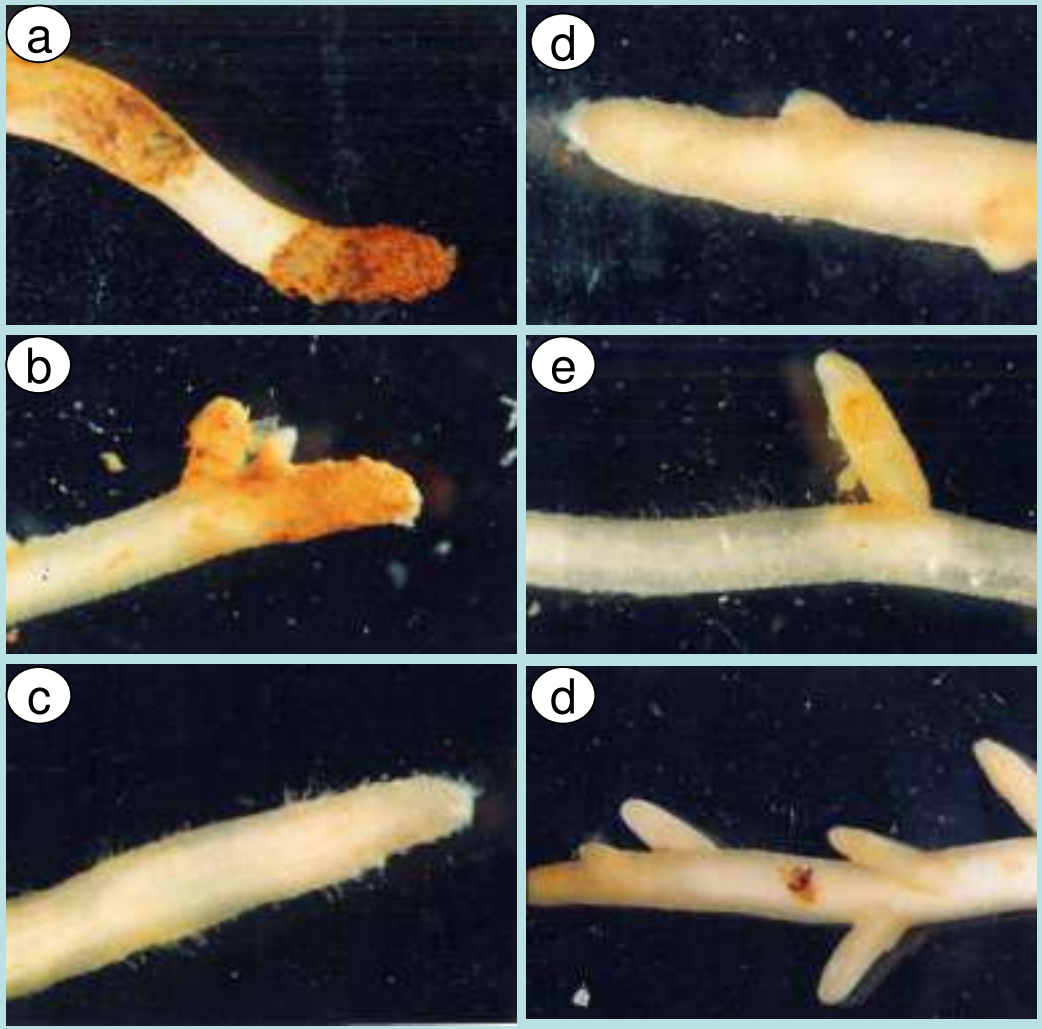
The lower the pH of extractant the higher the extracted aluminum



Gambar 1. Hasil *X-Ray Diffractogram* Mineral Liat Tanah Sulfat Masam Rantau Rasau Jambi dengan Penambahan Glycerol (Sabiham dan Sumawinata, 1989



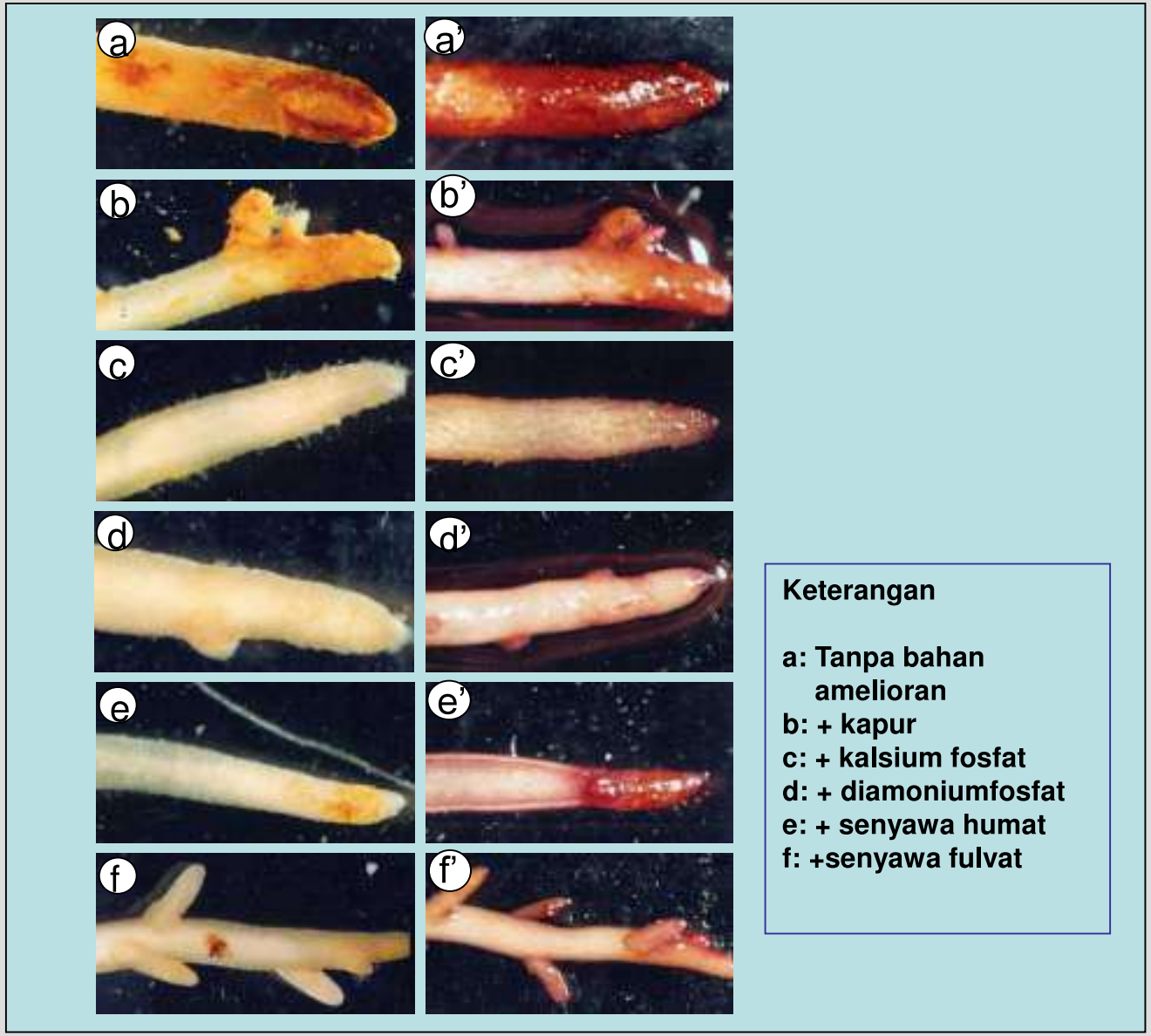
Gambar 2. Hasil *X-Ray Diffractogram* Mineral Liat Tanah Sulfat Masam Rantau Rasau Jambi Pada Kedalaman 0 - 65 cm (Sumawinata*, et.a*l., 2009).



Keterangan

a: Tanpa bahan amelioran
b: + kapur
c: + kalsium fosfat
d: + diamoniumfosfat
e: + senyawa humat
f: + senyawa fulvat

Gambar 8. Fotomikrograph pengaruh pemberian bahan amelioran terhadap akar tanaman padi yang ditanam pada tanah sulfat masam



Gambar 9. Fotomikrograph Pengaruh pemberian bahan amelioran terhadap akar padi sebelum diberi indikator aluminon (sebelah kiri) dan sesudah diberi indikator aluminon (sebelah kanan).

Fertilizers and Lime

Material	Dosage (/ha)
Dolomite	300 kg
Urea	100 kg
KCl	100 kg
SP 36	100 kg
$MgSO_4$	50 kg
Micro nutrients	3 liter

Experimental plots

No improvement

With improvement

Rice harvest by the Governor of Jambi Province

Yield

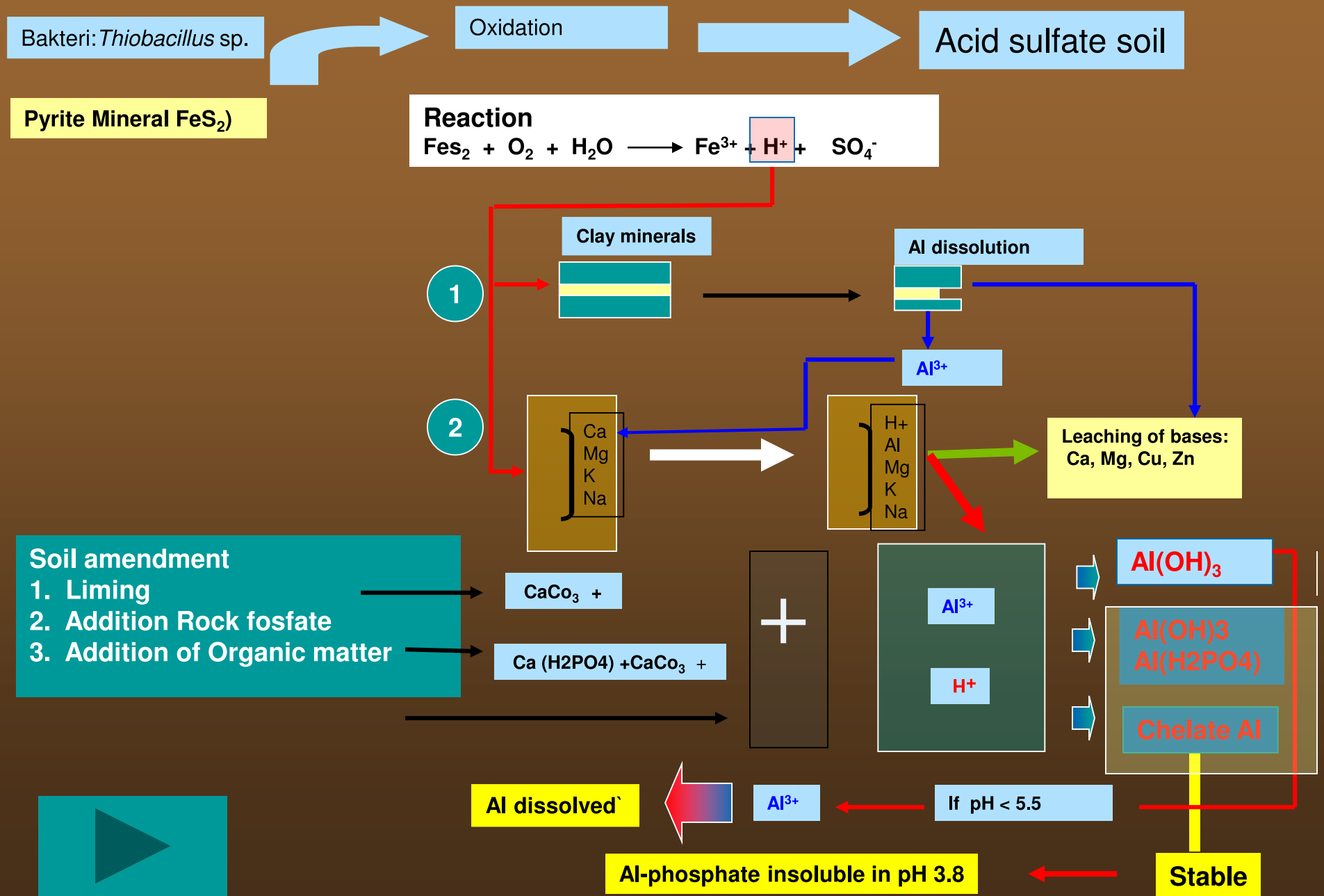
Variety	Planting Area (ha)	Average Yield (ton/ha)	Plant Height (cm)
IR 42	75.3	3.5	97
Batanghari	10.5	3.1	89
Semut	5.8	2.7	139

Pant Analysis

Plant Part	Na	K	Ca	Mg	Fe	Cu	Zn	Mn	Al
	.....ppm.....				.....ppm.....				
Young Leaf of IR-42	0.18	1.29	0.30	0.11	459	6	47	51	382
Young Leaf of Semut	0.14	1.14	0.21	0.12	280	1	29	38	93
Old Leaf IR-42	0.12	0.81	0.30	0.13	340	1	38	38	191
Optimum Value		1.80-2.60	0.20-0.60	0.15-0.30		7-15	20-50	40-700	
Root of IR 42	0.08	0.24	0.11	0.02	5401	15	125	6	1053
Root of Semut	0.05	0.19	0.09	0.03	6061	25	101	23	4112
Optimum Value								50-150	16-18
Toxicity value									>100

Local variety more tolerant to aluminum toxicity than IR variety

Pyrite oxidation process and soil amendment for masking Al Toxicity




2015/08/20 14:20


-2°42'3", 114°53'39", 51.0m,
Aug 2, 2017 14:16:05


2°42'1", 114°53'39", 48.0m, 70°
Aug 2, 2017 14:18:38


-2°33'54", 114°51'47", 35.0m, 53°
Aug 2, 2017 15:28:02


-2°32'13", 114°51'44", 55.0m, 224°
Aug 2, 2017 15:34:59

Kesimpulan

1. Tanah sulfat masam mengandung Al-dd yang sangat tinggi sangat menghambat pertumbuhan tanaman

2. Meredam pengaruh buruk dari keracunan Aluminum dengan pemberian kapur dan menanam varietas padi yang toleran thd keracunan Al terbukti cukup baik, akan tetapi pemberian rock fosfate dan unsur hara lainnya sangat membantu.

3. Inokulasi agen hayati pada tanah sulfat masam yang telah diperbaiki kondisinya diharapkan akan memberikan efek yang cukup nyata terhadap produksi pertanian