SOIL FERTILITY POTENTIAL FOR THE "SAWAH" SYSTEM OF RICE PRODUCTION IN WEST AFRICA WETLANDS

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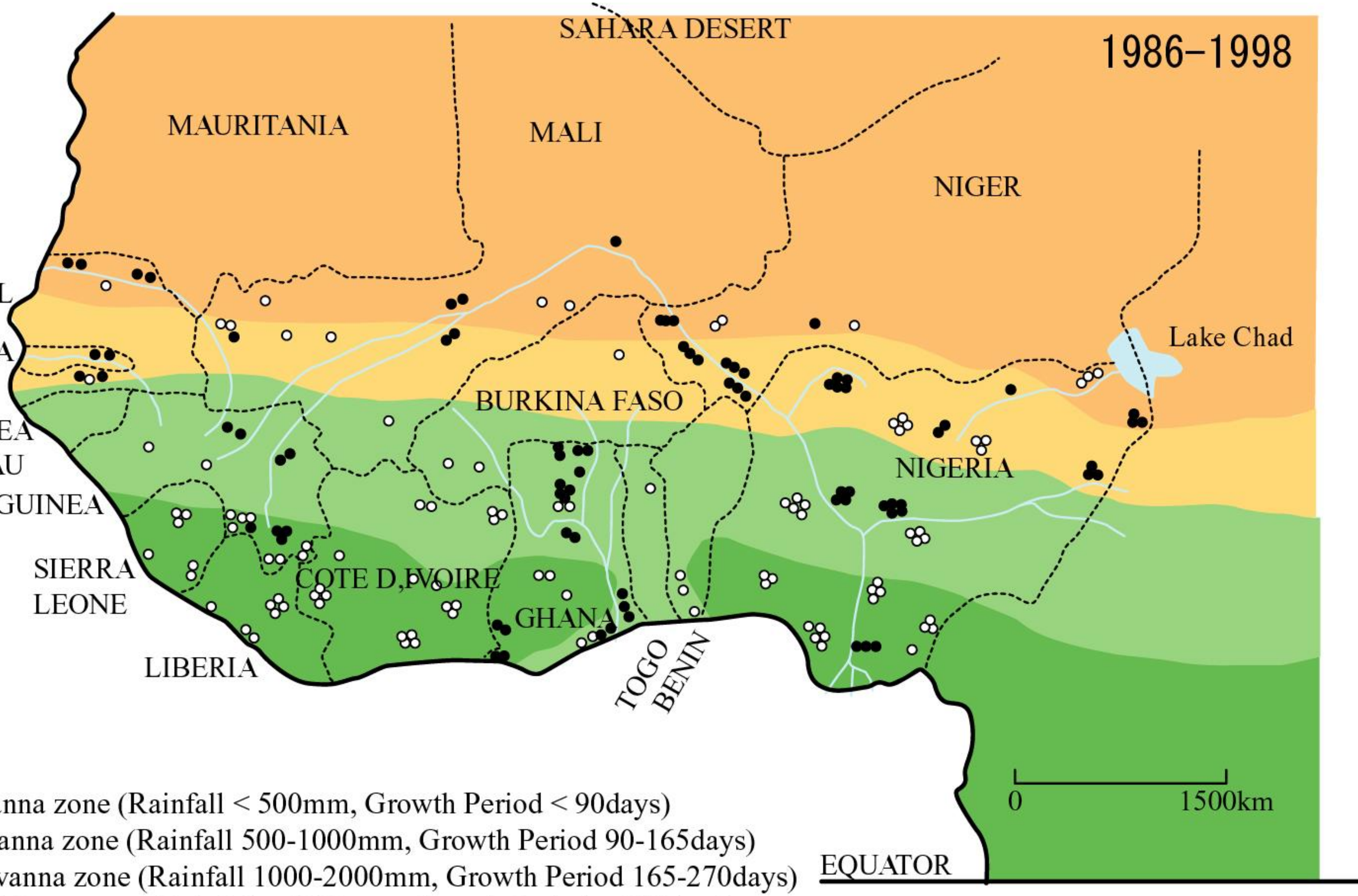
Order of presentation

1. General distribution and fertility status of wetlands (Inland valleys/floodplains) in West Africa

2. Fertilizer use and rice response to fertilizer application in Ghana

3. “Sawah” experience in Ghana

4. Suggestions on the way forward



Sahel savanna zone (Rainfall < 500mm, Growth Period < 90days)
Sudan savanna zone (Rainfall 500-1000mm, Growth Period 90-165days)
Guinea savanna zone (Rainfall 1000-2000mm, Growth Period 165-270days)
Equatorial forest zone (Rainfall > 2000mm, Growth Period > 270days)
● River flood plains sampling sites (70 sites)
○ Inland valley swamps sampling sites (200 sites)
--------- International boundry

Extent and proportions of wetlands in tropical sub-Saharan Africa

Wetland type	Area (Km^2)	Proportion of total wetland (%)	Proportion of arable land (%)
Coastal wetlands	165,000	6.9	1.5
Inland Basins	1,075,000	45.0	9.7
River flood plains	300,000	12.6	2.7
Inland valleys	850,000	35.6	7.7

Andreessen, 1986

Relative importance of rice production systems in West and Central Africa

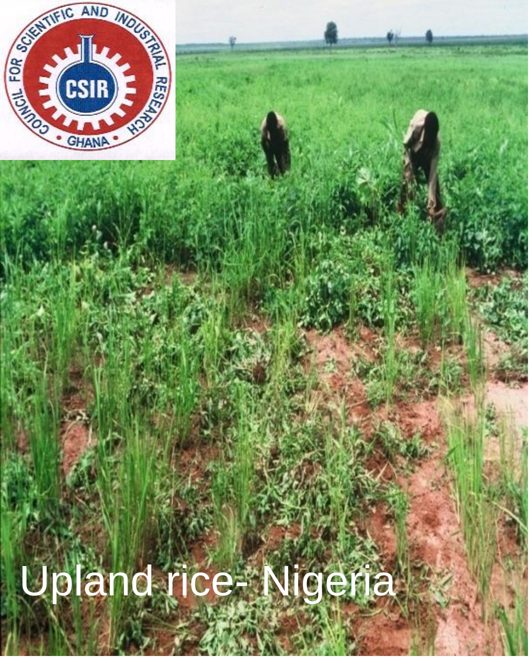
Rice Production systems	Area (%)	Production (%)
Rain-fed lowlands	44	36 (77)
Rain-fed uplands	31	25 (8)
Irrigated systems	12	28 (15)
Deep water or floating rice	9	5
Tidal water (mangrove swamps, coastal plains)	4	4

(WARDA, 1997)   Figures in parenthesis are only for Ghana-MoFA, 2009

Objectives

1. To highlight the general fertility status of inland valleys and river floodplains within the sub-region

2. To bring to the fore, the urgent need for the development and adoption of improved soil fertility and water management options for the sustainable use of these environments for rice production


Upland rice- Nigeria


Inland valley- Nigeria


Shifting cultivation- Guinea


Flood plain - Mali

Lowlands are spread across the sub-region and can be found in almost all agro-ecologies


Inland Valley - Sierra Leone


Inland valley - Ghana


Flood plain - Burkina Faso


Inland valley – SierraLeone

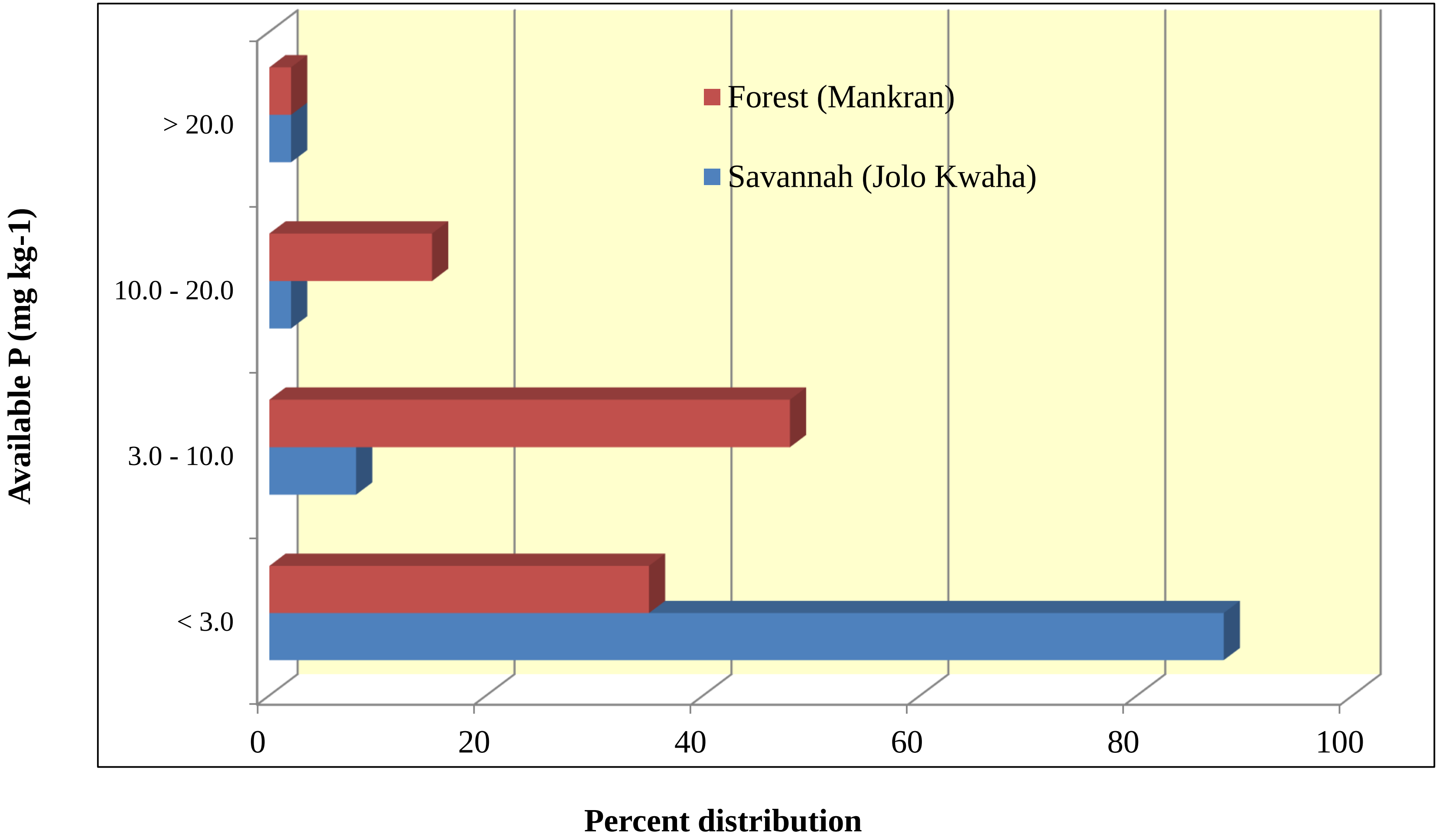
Wet lands are composed of heterogeneous soils with different characteristics that require different fertility management options

Mean nutrient levels of topsoil (0-30cm) of major rice growing environments of Ghana in comparison to Japan

Parameter	Forest zone	Savannah zone	Ghana (Mean)
No. of samples	122	90	212
pH (H_2O)	5.7	4.6	5.2
TC (g kg^{-1})	12.0	6.0	9.0
TN (g kg^{-1})	1.1	0.6	0.85
Av. P (mg kg^{-1})	4.9	1.5	3.2
Ex. K {cmol (+) kg^{-1}}	0.4	0.2	0.3
Ex. Ca {cmol (+) kg^{-1}}	7.5	2.1	4.8
Ex. Mg {cmol (+) kg^{-1}}	4.1	1.0	2.6
eCEC {cmol (+) kg^{-1}}	12.7	4.4	8.5
Clay (g kg^{-1})	127	66	96

Buri et al., 2010

Available P distribution in two major rice growing ecological zones of Ghana



Buri et al., 2010

Average general fertility levels of topsoils (0-15cm) of West Africa Lowlands in comparison with paddy soils of South East Asia

	No	(H_2O)	gkg^{-1}	g kg^{-1}	mg kg^{-1}	Exchangeable	Cations	{	cmol (+) kg^{-1}		}	(%)
Location	sam	pH	TC	TN	Av. P	Ca	Mg	K	Na	Ex. Ac	eCEC	Clay
Inland Valleys	185	5.3	12.8	1.11	8.7	1.9	0.9	0.3	0.2	1.0	4.2	16
Flood plains	62	5.4	11.0	0.98	7.7	5.6	2.7	0.5	0.8	0.8	10.3	30
W. A. lowlands	247	5.3	12.3	1.08	8.4	2.8	1.3	0.3	0.3	0.9	5.8	23
Pad. Fields (S.E. Asia)	410	6.0	14.1	1.30	17.6	10.4	5.5	0.4	1.5	ND	17.8	28

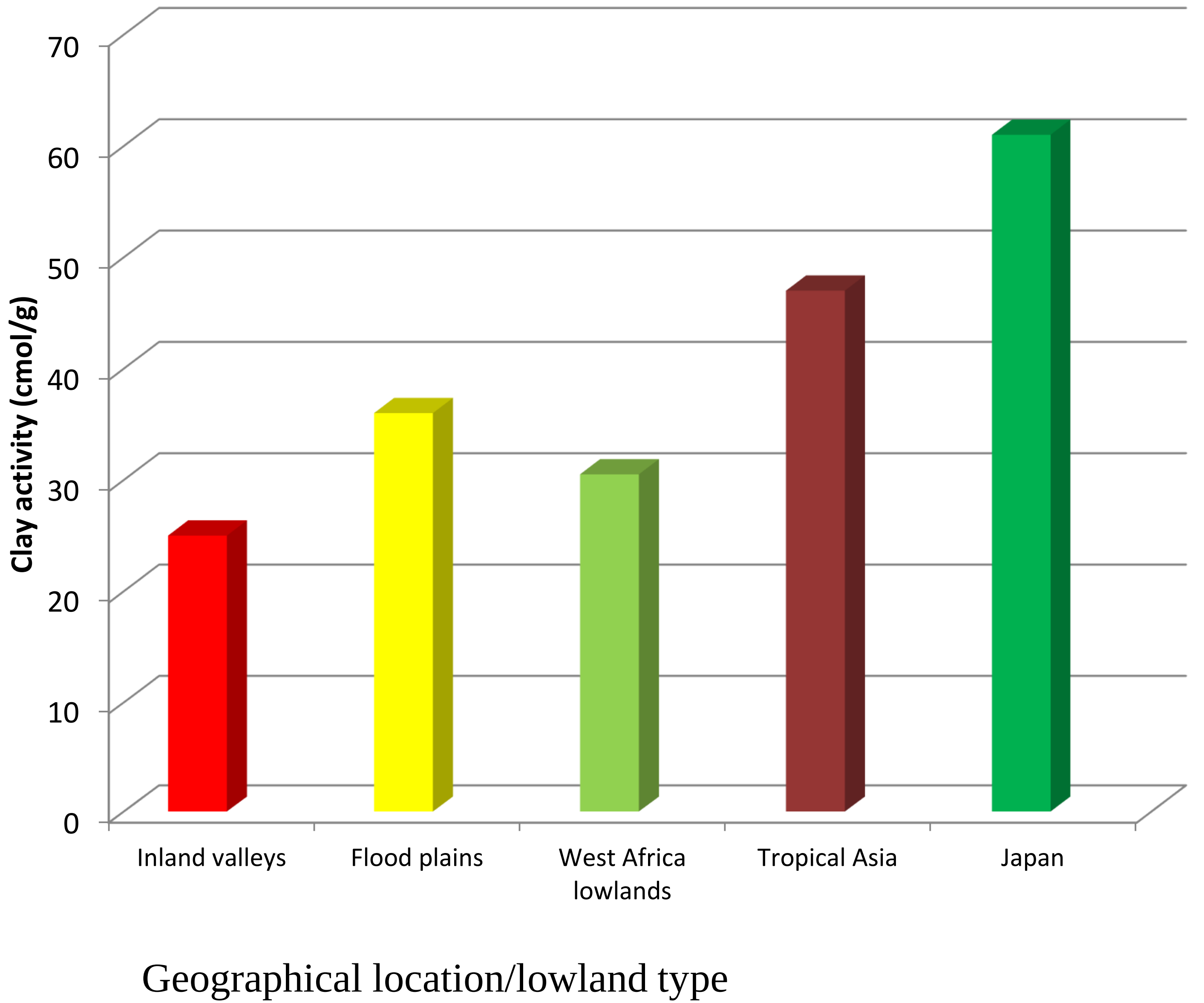
Kawaguchi & Kyuma, 1977; Issaka et al, 1997, Buri et al., 1999, 2000)

Mean abundance of 7, 10 and 14 A minerals of surface soils (0-15cm) of inland valleys and flood plains of West Africa in comparison with paddy soils of S. E. Asia

Location	No samples	7-A minerals (%)		10-A minerals (%)		14-A minerals (%)	
		Mean	SD	Mean	SD	Mean	SD
Inland Valleys	47	68.2	25.8	5.6	6.0	26.2	24.8
Flood pains	40	68.5	21.6	4.5	3.8	27.0	21.2
W. Africa lowlands	87	68.4	23.8	5.1	5.1	26.6	23.1
Paddy fields tropical Asia	410	46.6	23.3	13.9	14.4	39.7	23.8

Abe et al., 2006; Kawaguchi & Kyuma, 1977

Clay activity of soils of West African lowlands in comparison with Tropical Asia and Japan

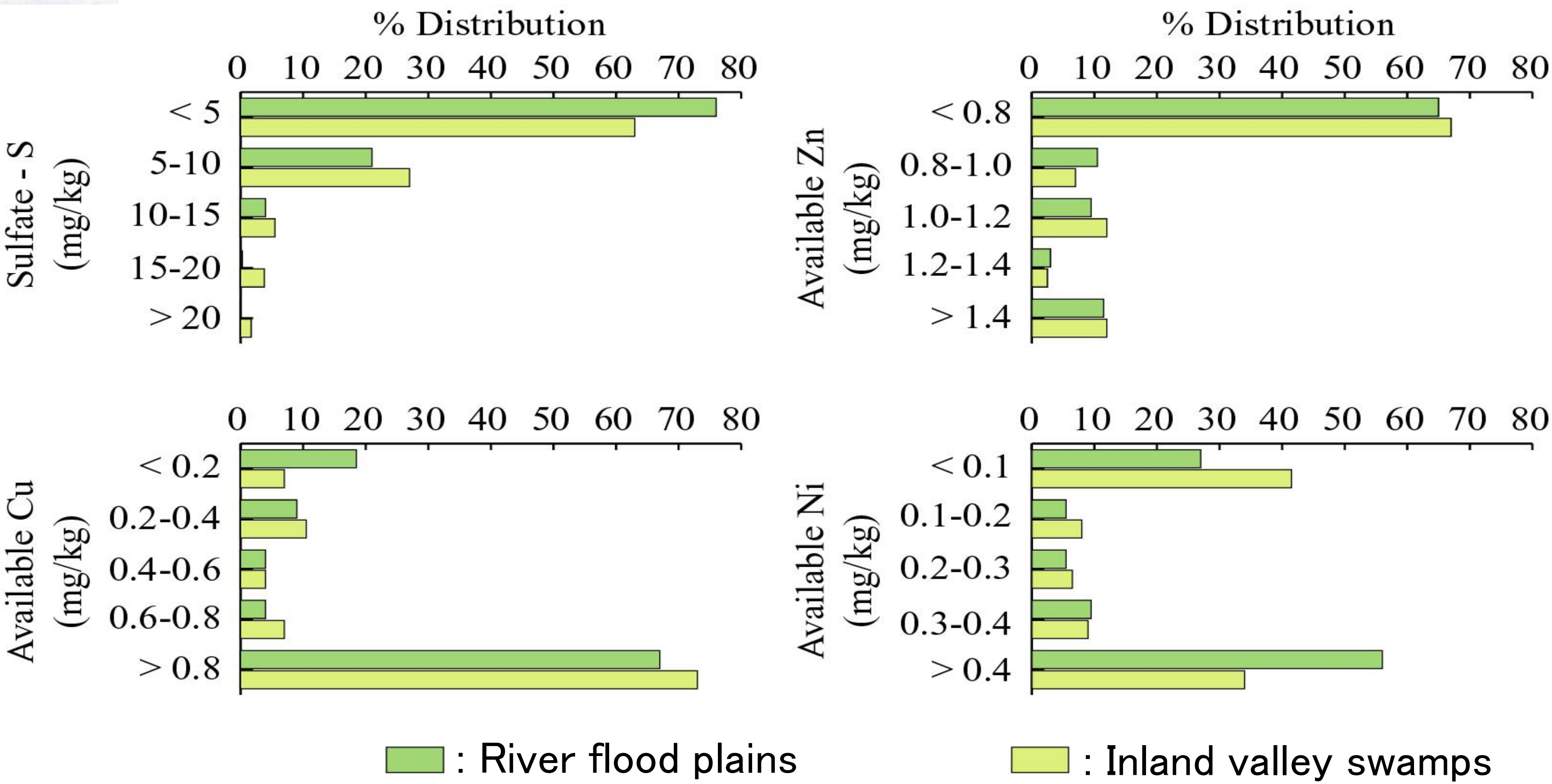


Average content of sulfate–S and available micronutrients of surface (0-15cm) soils of inland valleys and flood plains in West Africa

Location	Sulfate S (mg kg-1)	Av. Zinc (mg kg-1)	Av. Fe (mg kg-1)	Av. Mn (mg kg-1)	Av. Cu (mg kg-1)	Av. Ni (mg kg-1)
Inland Valleys	4.9	1.6	220	58	2.5	1.4
Equat. forest	6.3	1.6	238	72	2.7	2.1
Guinea sav.	4.1	1.9	203	45	1.6	0.7
Sudan/Sahel sav.	1.4	0.6	128	28	3.9	0.5
Flood pains	3.4	1.2	163	67	3.4	1.7
Equat. forest	3.1	1.0	121	100	3.3	1.7
Guinea sav.	3.2	1.6	185	82	3.2	2.0
Sudan/Sahel sav.	3.7	0.9	160	34	3.6	1.3

Buri et al, 2000

Frequency distribution of topsoil (0-15cm) available nutrients in West Africa lowlands.



S & Zn are relatively deficient in most lowland soils across the subregion

Buri et al, 2000

Mean elemental oxides composition of topsoils (0-15cm) of inland valleys and flood plains in West Africa in comparison with paddy fields of tropical Asia)

	Elemental Oxides composition (%)								
Location	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	K_2O_3	P_2O_5	MnO_2	Na_2O
Inland Valleys	78.4	4.3	14.4	0.40	0.43	0.93	0.08	0.06	0.19
Flood pains	72.3	8.3	13.4	0.51	0.54	0.77	0.07	0.04	0.71
West Africa lowlands	75.3	6.3	13.9	0.45	0.48	0.85	0.075	0.05	0.45
Paddy fields of tropical Asia	72.2	5.9	16.3	1.42	0.92	1.83	0.13	0.12	ND

Kawaguchi & Kyuma, 1977; Issaka et al, 1997; Buri et al, 2000

Effect of non-inclusion of N, P, or K on paddy grain yield (t ha^{-1})

Kg ha^{-1} ($N-P_2O_5-K_2O$)	Adugyama 2004	Adugyama 2005	Biemso 2004	Biemso 2005
0 – 90 - 90	1.29	1.48	1.39	1.47
90 - 0 - 90	2.03	2.08	1.99	2.04
90 – 90 - 0	3.09	2.31	2.75	2.53
90 – 90 - 90	6.84	6.89	7.07	7.11
SE	1.232	1.246	1.287	1.292

Buri et al, 2007

Effect of organic amendments and inorganic fertilizers on rice grain yield (t/ha) in inland valley soils in Ghana

Treatment	Paddy	Grain	Yield
	Potrikrom	Biemso I	Biemso II
Control (no manure, no mineral fertilizer)	1.68	3.59	1.50
N-P_2O_5-K_2O (120-90-90) kg/ha	6.77	8.37	4.03
N-P_2O_5-K_2O (90-60-60) kg/ha	6.57	7.09	3.90
Poultry manure – 7.0t/ha	5.96	6.36	3.82
Poultry manure + mineral fertilizer (I/2 rate)	6.25	7.30	4.15
Cattle manure – 7.0t/ha	4.54	6.25	3.05
Cattle manure + mineral fertilizer (I/2 rate)	4.86	6.49	3.72
LSD (0.05)	0.99	2.14	0.84
Mean (site)	5.23	6.09	3.58
LSD (site)		0.52	

Buri et al, 2001. Soil pH (water) – 5.5, TN = 0.016%, Av. P = 2.88mg/kg

What factors are militating against soil fertility management/improvement ?

1. Low fertilizer (organic & inorganic) usage due to poverty

2. Ineffective fertilizer management under traditional system

3. Ineffective water management

4. Luck of improved technologies

5. Unfavorable land tenure systems

Traditional system of rice farming

High weed infestation

Poor fertilizer management is poor

Poor water management- no water control structures

FERTILIZER USE FOR SELECTED COUNTRIES IN COMPARISON WITH WEST AFRICA.

Country	Quantity used(kg/ha)
Japan	301.0
United kingdom	285.8
China	255.6
Germany	228.2
Mali	11.1
Cote d’ Ivoire	9.9
Burkina Faso	8.8
Togo	7.5
Nigeria	6.1
Guinea	2.2
Ghana	2.0
Niger	1.0

F.A.O., 2008

Fertilizer use ratio of developed to undeveloped countries in West Africa. 1:44

Annual estimates of soil amendments available for soil fertility improvement in Ghana which are not fully utilized.

Type of soil amendment	Quantity Prod. (Mt)	Nutrient Content (Mt)				
		N	P_2O_5	K_2O	CaO	MgO
Plant sources						
Rice straw	366975	1835	587	5138	-	-
Rice husk	63016	693	403	321	353	895
Animal sources						
Poultry manure	222228	5778	3111	2911	18778	15556
Cow dung	1848798	20706	31614	8874	14420	127012
Sheep manure	449388	8763	31457	3146	4988	-
Goat manure	551354	10751	3859	3859	5513	-
Pig manure	118282	2697	2153	2129	378	-
Total	**3,620,041**	**51,223**	**73,184**	**26,378**	**44,430**	**143463**

Issaka et al., 2010

What do we do?

Need for the development and introduction of technologies that will help:

(1) conserve water

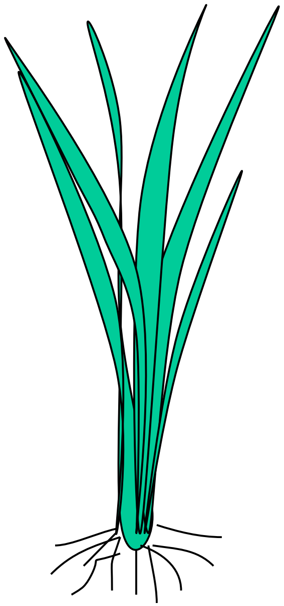
(2)nutrient build up

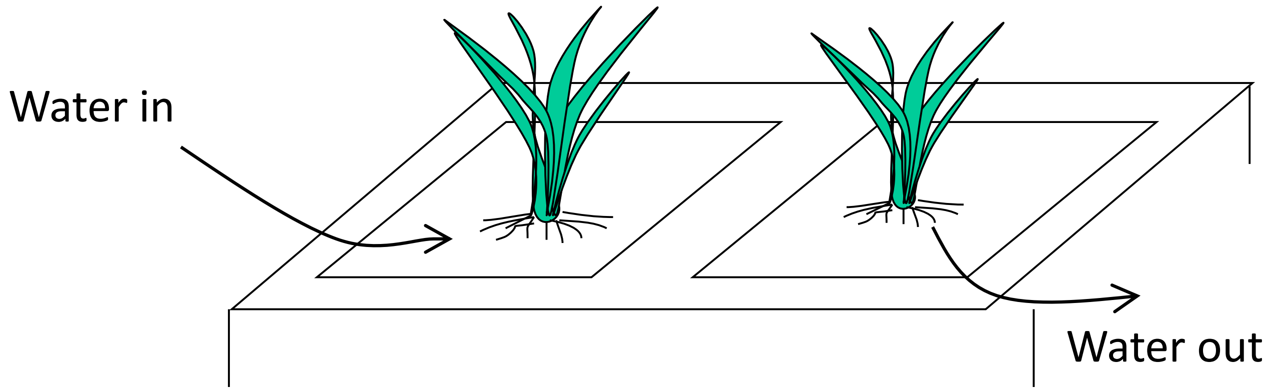
→ Increased use-efficiency

(3) Ecologically/environmentally friendly

Balancing Bio-technology with Eco-technology

Improved rice variety and improved growing environment

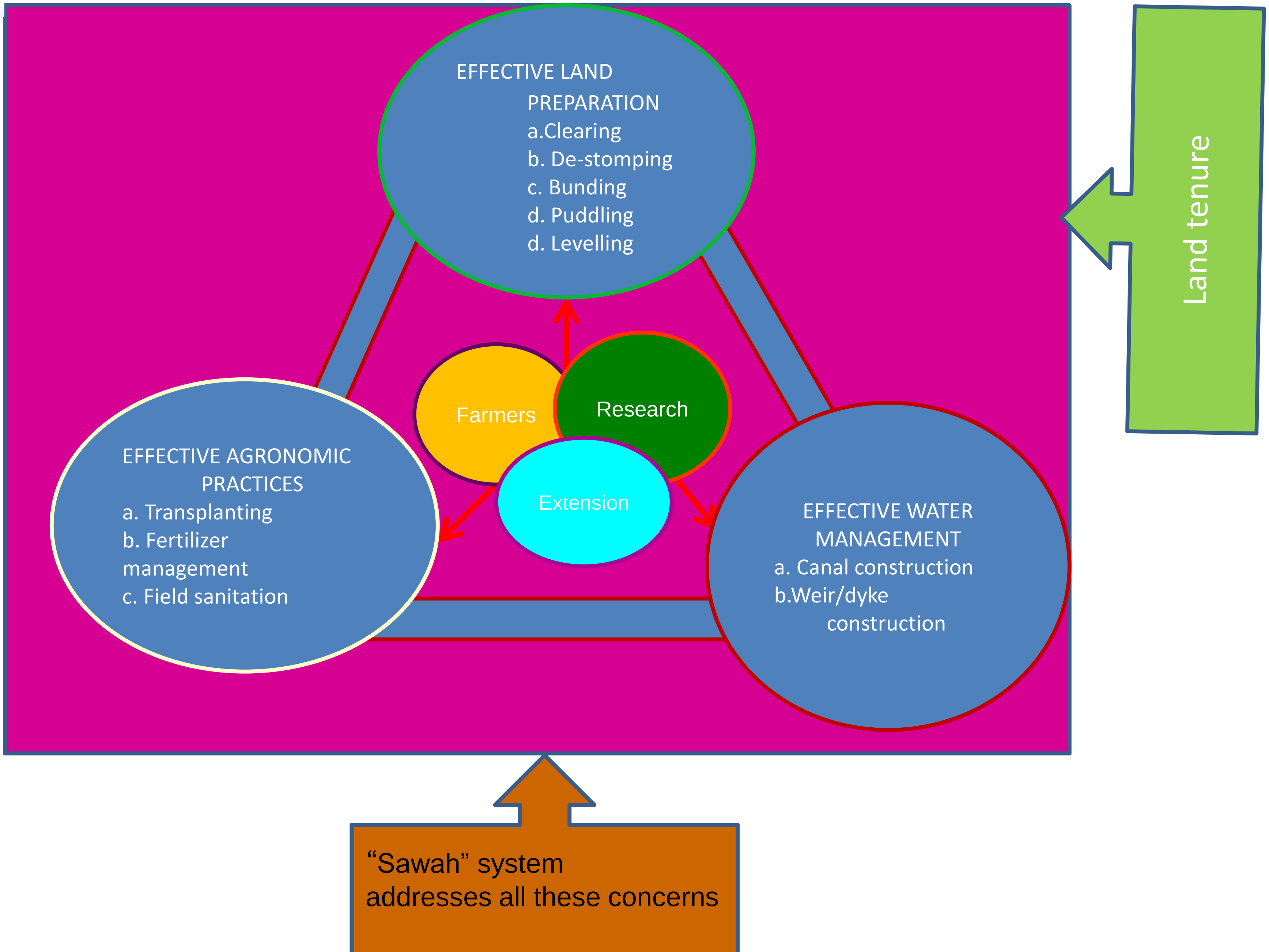




Creating the right micro-environment for rice growth (“Sawah” systems

Sawah is a man-made, improved rice-growing environment with demarcated, bunded, leveled, and puddled fields, for water control. Sawah is soil based eco-technology

PRACTICES FOR EFFECTIVE SOIL FERTILITY MANAGEMENT AND INCREASE PRODUCTIVITY IN RICE



MEETINGS WITH FARMERS (GROUP FORMATION)

Farmers assisted with basic tools

De-stumping – removal of tree stumps, roots and shrubs

To facilitate:

- power tiller operations,
- nutrient management,
- water management and
- effective area to be transplanted