Farmers' personal irrigated Sawah systems to realize green revolution and Africa's rice potential

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SMART IV kickoff workshop from 16-17th August 2010, Africa Rice, Cotonou

African farmers can develop their personal irrigated sawah systems by themselves to realize green revolution and Africa's rice potential

Development business: UN Millenium villages /World Bank/AfD Bank/JBIC/USAID/JICA /NGOs

Agroforestry trials using both Indigenous & Exotic trees

Sustainable self-support Sawah development & management. The creation of Africa SATOYAMA model, Village based watershed development & management

New land systems for enhance sustainable Sawah development in present diverse landuse systems under diverse socio-economy and history

Practices of Eco-technology development of various sustainable Sawah system options in 50-100ha in Ghana and Nigeria

Target of this Action Research

Main Goal: Sustainable production of 100million tons of paddy through 20 million ha of lowland Sawah development. The restoration of 100million ha of forest to combat Global Warming

IITA: Farming systems

AfricaRice (SMART-IV)

JIRCAS

IWMI Hydrology

collaboration

Ghana: SRI/CRI/FoRIG/WRRI Forest transition zone

Nigeria:NCAM/FadmaIII

Major Agroecosystems

Extremely diverse lowland ecosystems

Spring

Ground water

Suitable Sawah

Upland-like Draught prone

Flood prone

Suitable Sawah

Rainfall

Various Sawah system options suitable for diverse lowland ecosystems were carried out by participating farmers' self-support efforts with trials and errors approach (Results of previous long-term action research

Functional humified organic fertilizer

Watershed Agroforestry

Africa SATOYAMA

Intensive upland farmings need Integration with livestock raising

Upland:500 - 50,00ha (95%)

Nutrient cycling

Geological fertilization

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Irrigation canal

Fish pond

Supply of nutrients by animals

Nutrient rich water

Topsoil erosion & sedimentation

Rock weathering, soil Formation,nutrient release

Discharge

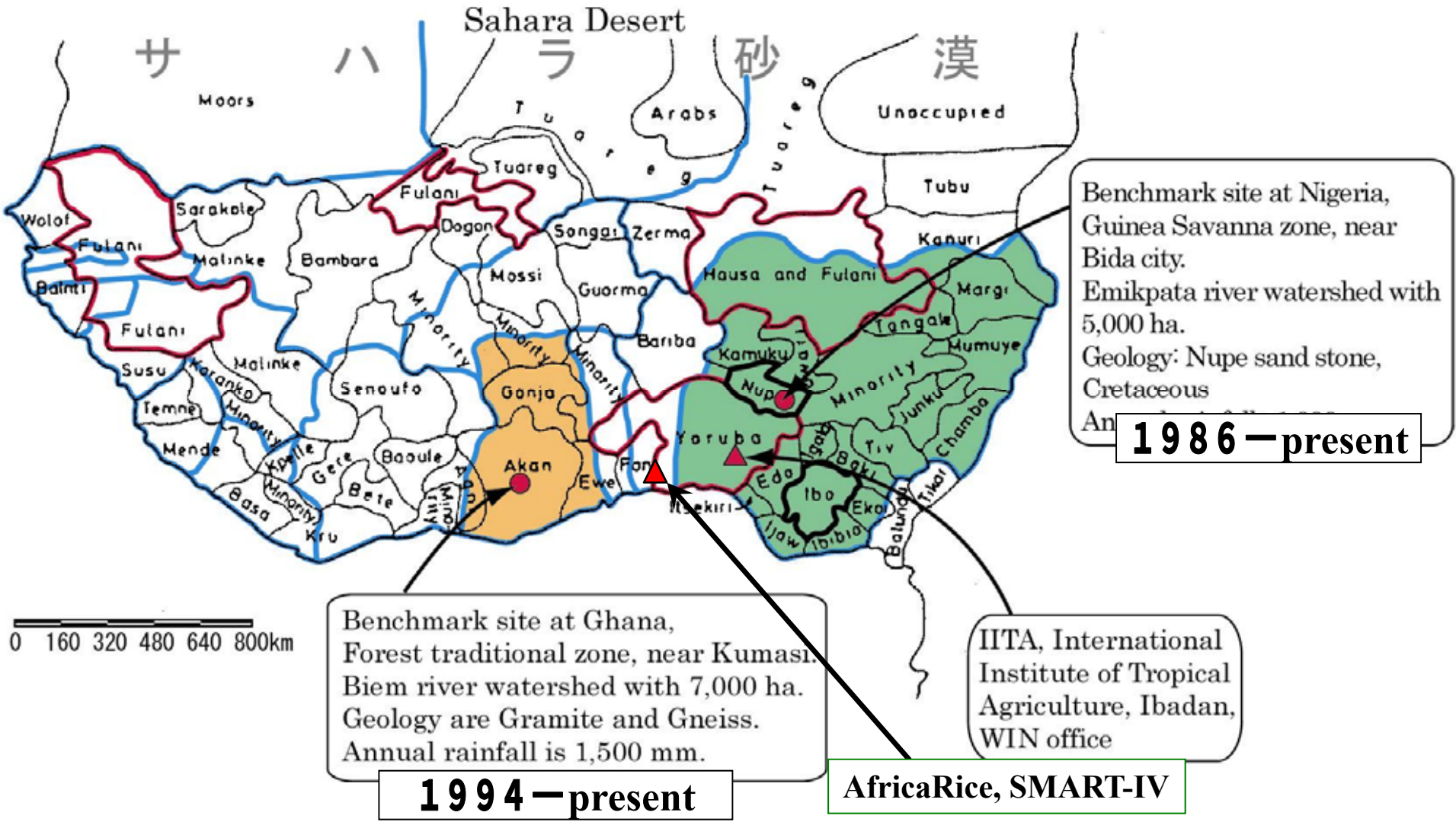
Sawah hypothesis(I) Lowalnd (5%)

The prerequisite of Green revolution is sawah fields which improve rice ecology

Sawah hypyhesis(II): Sustainable productivity 1ha Sawah equivalents 10-15ha upland fields

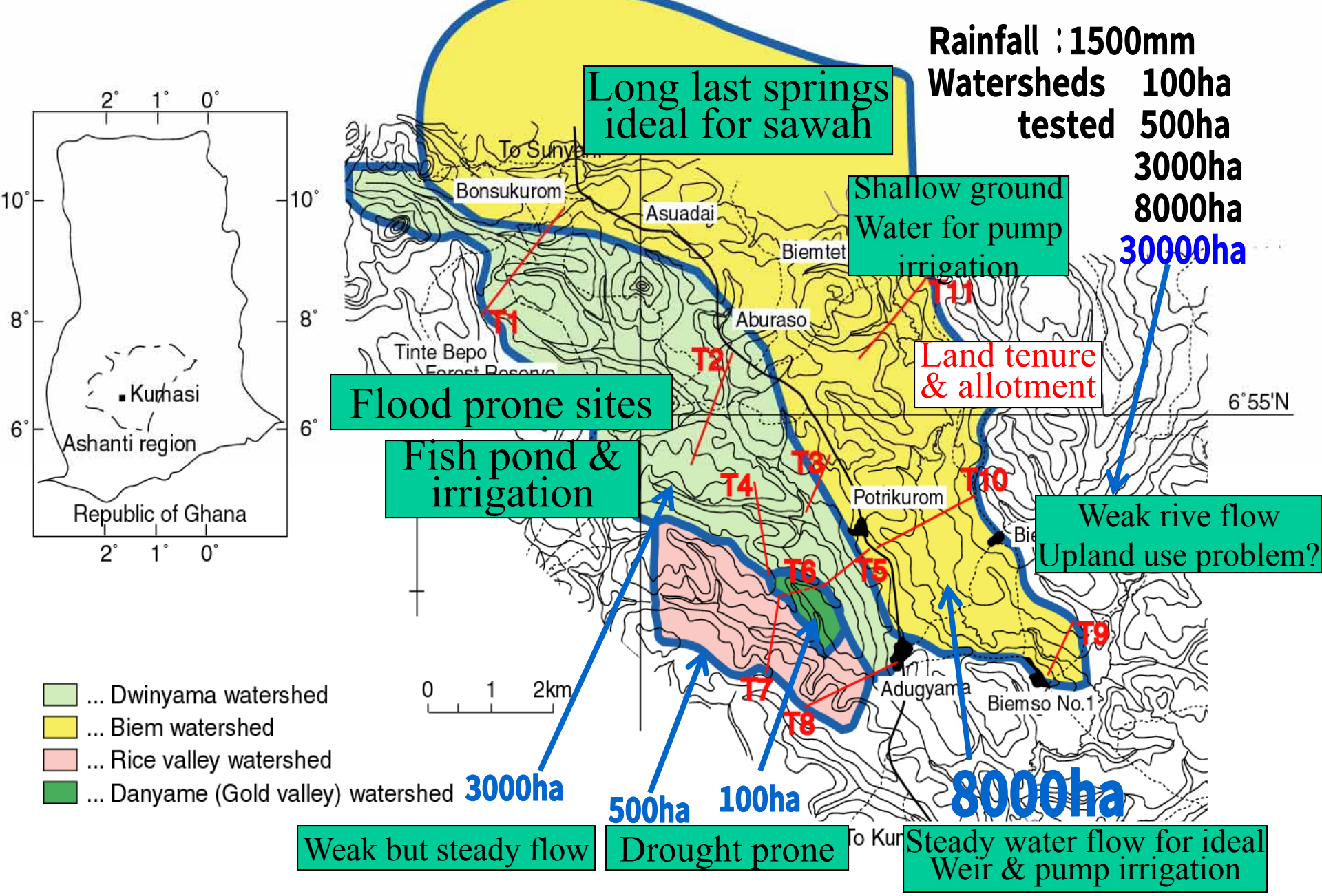
Action Research on Materialization of Green Revolution by Sawah Eco-technology and the Creation of Africa SATOYAMA watershed model to combat the global warming (MEXT assisted scientific research project, 2007-2011)

Experiences and examination of Sawah hypothesis I & II through long term action researches in Ghana and Nigeria



Core benchmark sites with various sized watersheds in Ghana & Nigeria. The action research sites were expanded in 2008-2010.

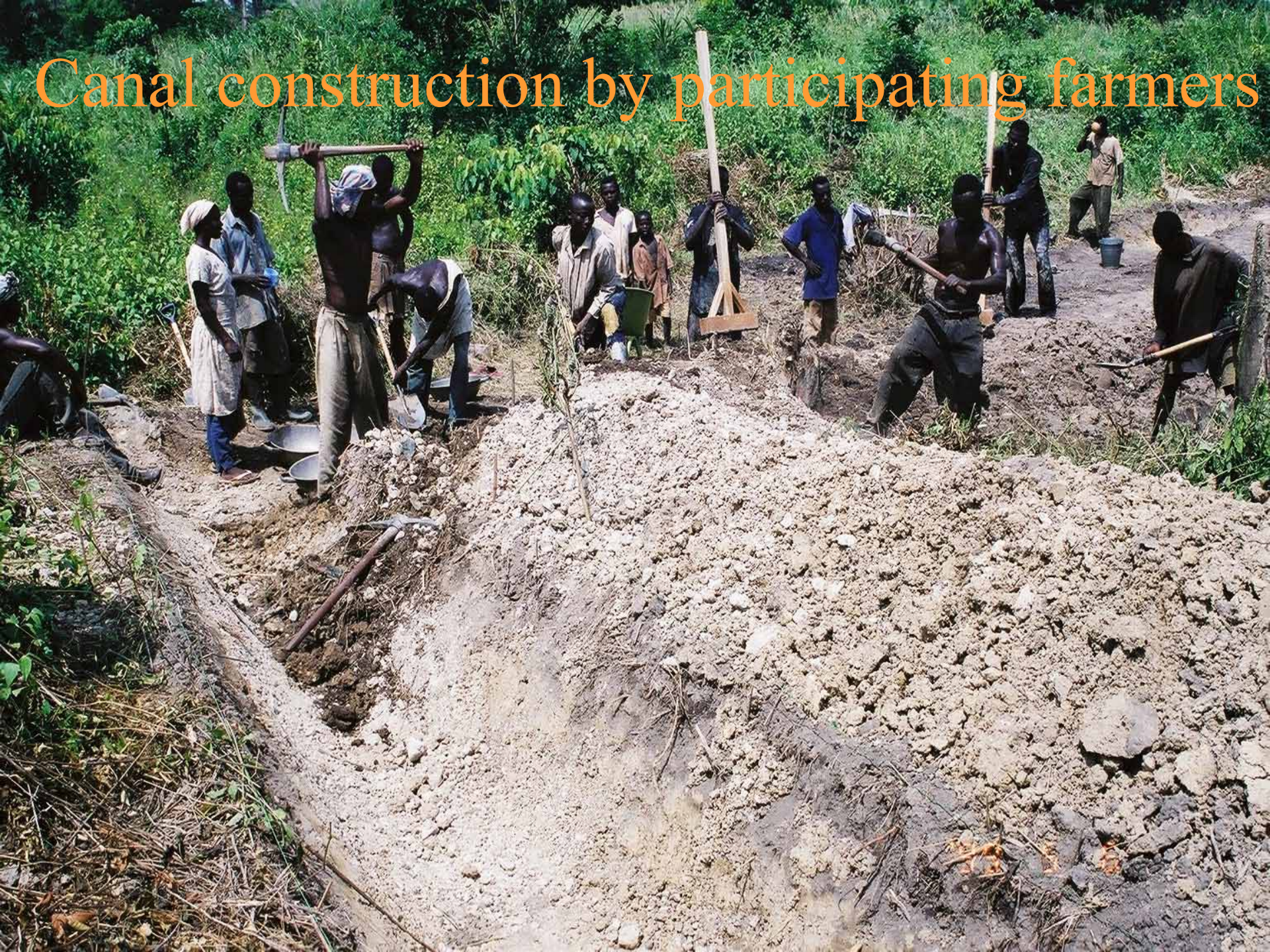
CRI/SRI/WRI/FoRIG-CSIR/JICA Sawah project for Integrated watershed management, 1997-2001



Farmer based Site Specific Sawah Development and Management through On-The-Job Training are the key (Sawah project phase I)

Toposurvey

Canal construction by participating farmers




Soil and Wooden Weir, because of farmers' self-support management under no rocks available

Photo. 3-25. Compaction to create impermeable layer on the front of dyke, March 2000

Photo. 3-23. Excavation of river bottom and jute bags

JICA/CRI Sawah project

Photo. 3-26. Dyke was covered with sand bags after compaction of permeable layer

Photo. 3-17. Flooding over dyke


Sand bag weir by farmers and SRI Sawah team, Aug.2009, Nsutem, Ghana

Partially intercepted irrigation canal at Gadabiu, FCT FadamaIII, 26 Sep 10

On the job training
Sawah bunding

river

Sawah construction can be done by participated farmers' self-support efforts

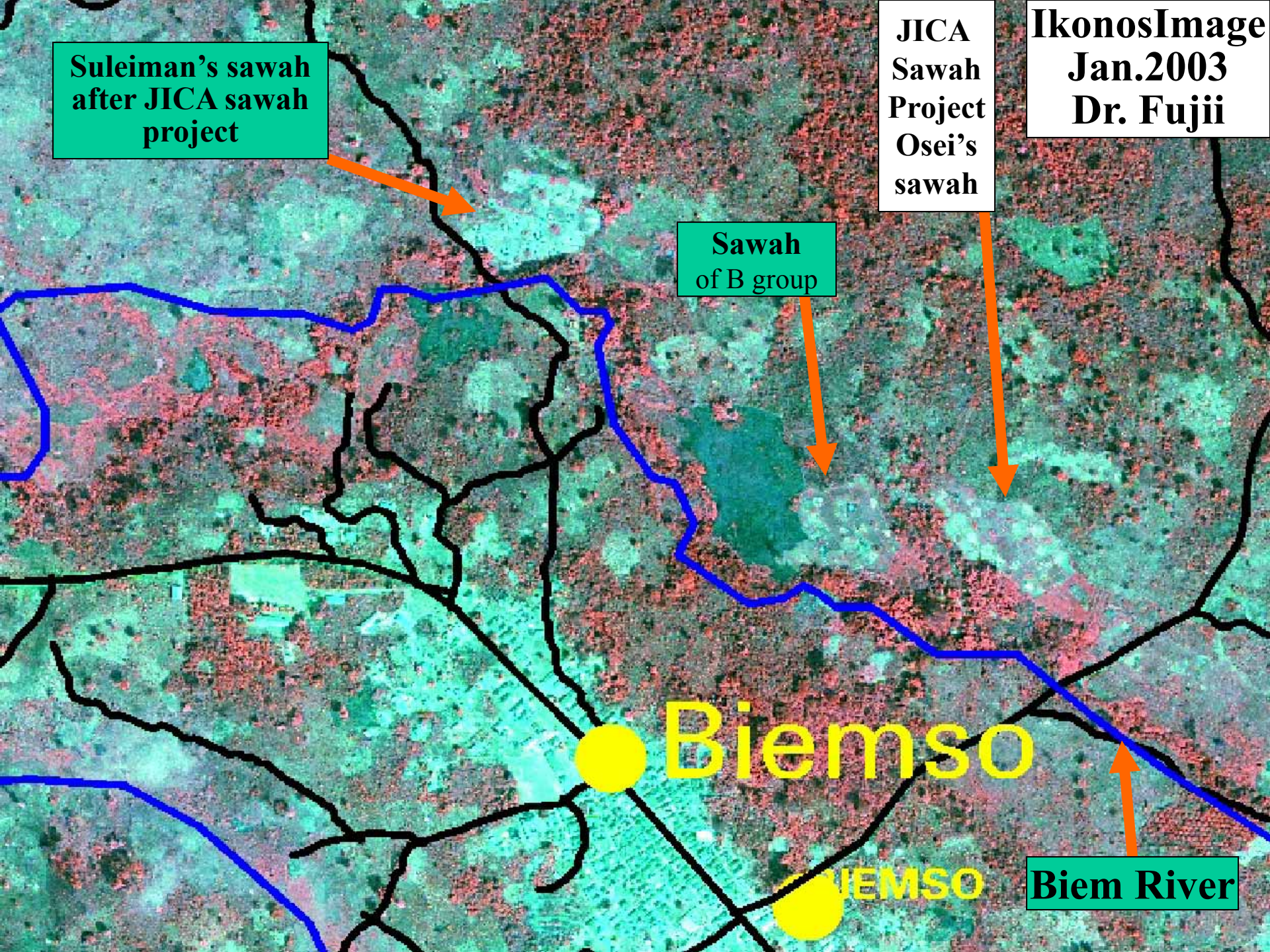

Sokwae Sawah development
by CRI sawah team, June 2008

Sokwae Sawah development by farmers July 2008

Manual Leveling needs hard-works for Sawah system construction


Biemso No.1, Zongo site in 2002
Pudling, soil moving & leveling

Sawah is ecotechnology based Multi-Functional constructed Wetland: Production, Environment, and Cultural landscape


Suleiman's sawah after JICA sawah project
JICA Sawah Project Osei's sawah
IkonosImage Jan.2003 Dr. Fujii
Sawah of B group
Biemso
BIEMSO
Biem River


New Sawah development in Biemso No.1 by
Farmer to farmer with SRI backstopping

SAWAH FIELDS

2008

LOCATION: BIEMSO No. 1 BIEM RIVER SITES, A

SCALE 1:2500 AREA: A=7.3ha

JICA sawah project site, 0.5ha developed by Aug 1999 (Mr. Tewaih site)

Mr. Tawiah developed about 4ha sawah by Sep. 07 surrounding his 1.5ha of fish pond. Total paddy production was more than 20ton annually, which gave gross revenue about $10,000. Power tiller loan is $1500 per year for four years


Mr. Tawiah and his rice, growing on sawah about 4ha developed by himself, with CRI/SRI, and JIRCAS scientists, August 2009. This original site of JICA/CRI sawah project in 1997-1999

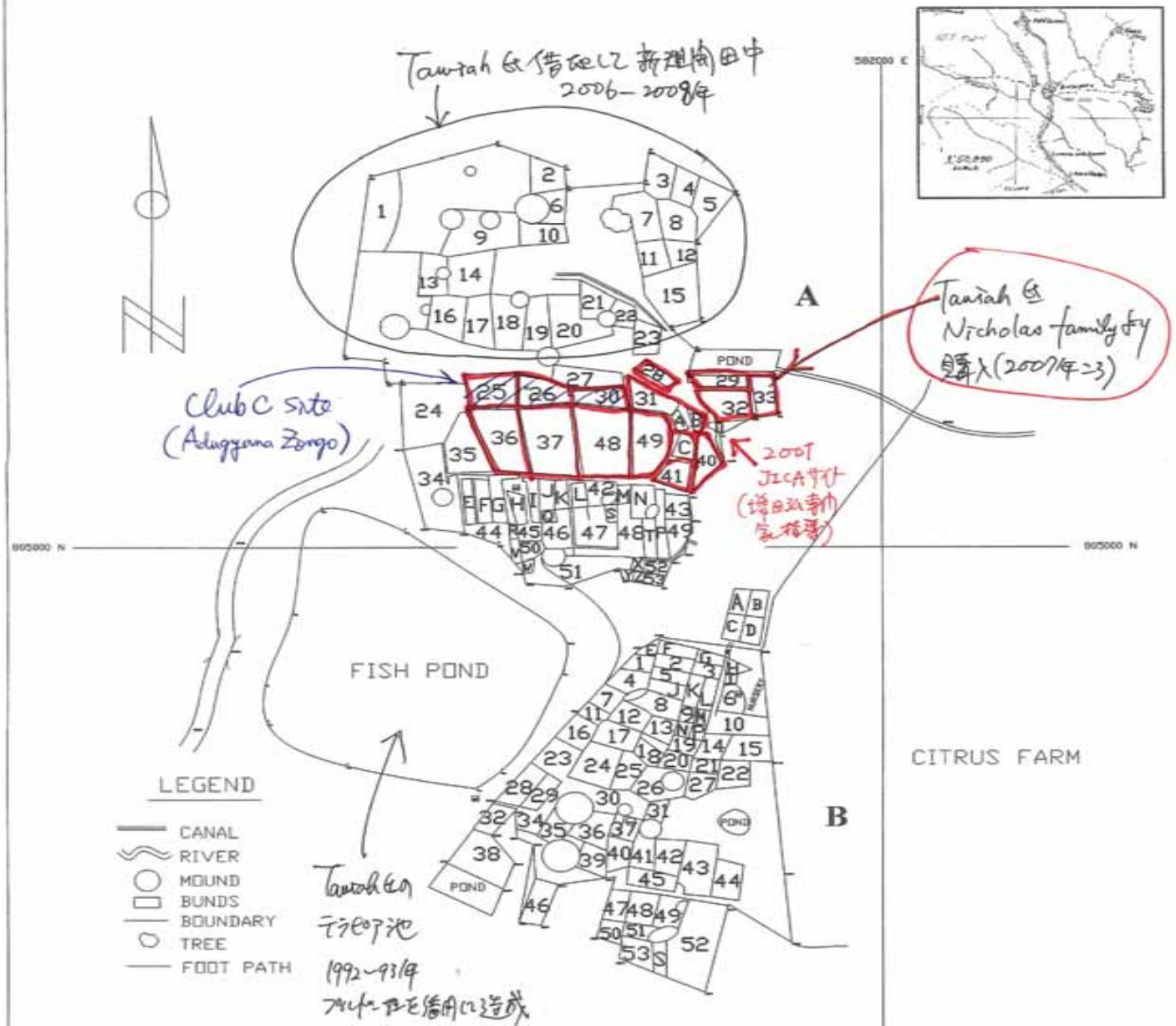
SAWAH FIELDS

Now Mr. Tawiah Adu 所有

LOCATION: ADUGYAMA, CLUB C AND NICHOLAS SITES

SCALE 1:2500

AREA: A=2.2, B=1.2 ha



Farmers' to farmers sawah technology transfer, SRI site, Ghana, Jan 2010

Mr. Tawiah trained another farmer to develop 3ha of sawah using small spring water source. Only local farmers know such water source.

(1) Site Selection and Sawah system design
(a) Water sources for site selection (>10liter/sec, > 5months)
Stream/River, Spring, Seepage, Flood, Rainfed
(b) Topography and soil for site selection
Potential area
Slope and surface roughness
Soil
(c) Socio-economic for site selection
Participating farmers
Land tenure
(d) Sawah system design
Sawah layout and total potential area
Mean sawah size(ha)
Water intake, distribution and control
Spring and sawah to sawah & diversion canal
Stream/Seepage and sawah to sawah & diversion canal
Simple dyke& diversion canal
Weir & Canal
Fish pond or dam lake
Pump
Interceptal canal
Contour bud system
Flood control by drainage/dam
Drought control by pond/waterharvest
Soil movement(t/ha)
Contour bund system
Flood control by drainage/dam
Drought control by pond/waterharvest
Soil movement(t/ha)

At first local farmers never know sawah technologies, they know site specific hydrological conditions which are the most important for site selection

On the job collaboration between farmers and Scientists, engineers, as well as extension office is essentially important

(2) Development skills and cost ($/ha)

(a) Skils for development

Skill for power tiller operations

Plowing and Puddling

Soil Moving

Surface leveling & smoothing

Skill for power tiller management

(b) Cost ($/ha) or (Cedi/ha)

Power tiller for development

Powertiller spare parts

Fuel for development

Bush clearing destamping

Bunding and surface teatment

Canal construction

Dyke construction

Additional hired labours

Tools and materials

Scientist and engineers cost

Extension officer cost

Farmers' training

Action research and on the job training of site specific sawah development and management

(1) Cots of Power tiller for Sawah development: at least 10ha per one power tiller ($5000/10ha)

(2) Cost of scientists, engineers, extension officers, and leading farmers

(3) Target cost: 2000-4000/ha

(4) Agronomic Sawah system management

Rice mono cropping
Rice and other 2nd season cropping
Rice double cropping
Overall Water Control
Water sources
Water distribution
Leveling & smoothing
Bunding
Puddling
Weed control
water consumption (ton/season)
water requirment(mm/day)
Water quality
Soil fertility
Fertilzation(N-P2O5-K2Okg/ha)
Variety
Yield (ton/ha)

(1) Immediate target Paddy yield >4t/ha

(2) 3t/ha is not enough to sustain sawah development

(3) >5t/ha will accelerate Sawah development

(4) Basic research on sustainable paddy yield >8t/ha is important

(3) Farmers Group Quality

Leader and group collaboration

No. of farmers

Ethnic composition

Skills and incentives

Gender composition

(6) Training

Trainer

Trainee

International scientists

National scientists

Extention officers

Leading farmers & farmers

To train

(1) Sawah farmers who can develop Sawah and manage Sawah based rice farming by themselves,

(2)Leading sawah farmer and farmers' group who can train another new sawah Farmer and farmers' groups

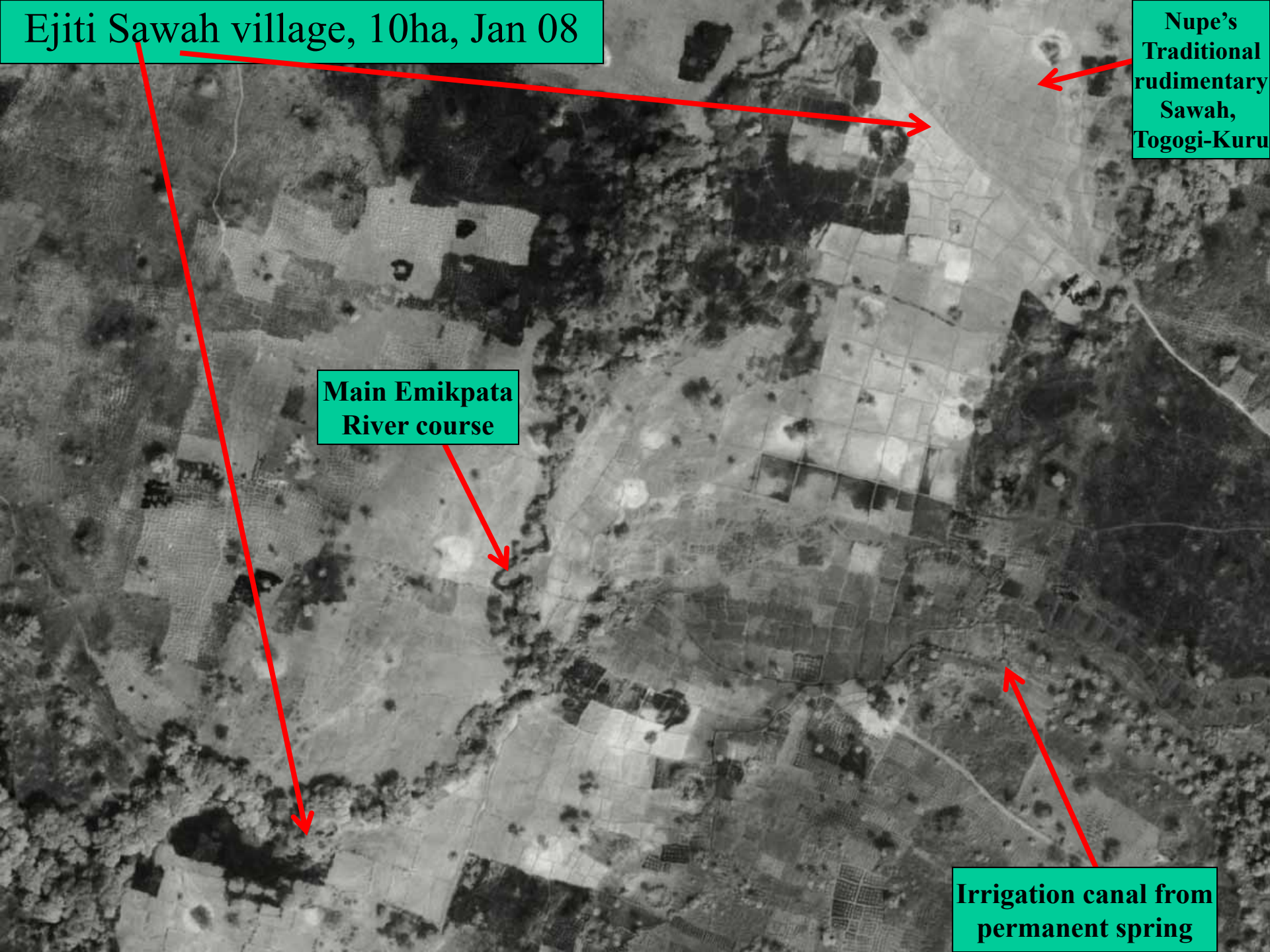
Sawah technology training under MAFF and Nagoya/Kinki Universty with NCAM, National Center of Agricultural Mechanization, and NCRI, National Cereals Research Institute, August to September 2009. PhD program included

(1) Field fact comes the first:>2ha sawah with >8t paddy

(2) Academic papers are also necessary

(3) Research results should be incorporated into rice promotion policy

Mr. Yakubu, Leading farmer, Dr. Abe and Segun. Sawah technology training at Ejiti Sawah village


Ejiti Sawah village, 10ha, Jan 08
Nupe's Traditional rudimentary Sawah, Togogi-Kuru
Main Emikpata River course
Irrigation canal from permanent spring

On the job training at Shabamaliki village, Bida, Nigeria, Sep 09

On the job training at Shabamaliki village, Bida, Nigeria, Sep 09
Paradoxically, leading farmers can master the skill within one to two seasons, but extension officers needs more than three seasons

Power tiller sinked: operations need good skills

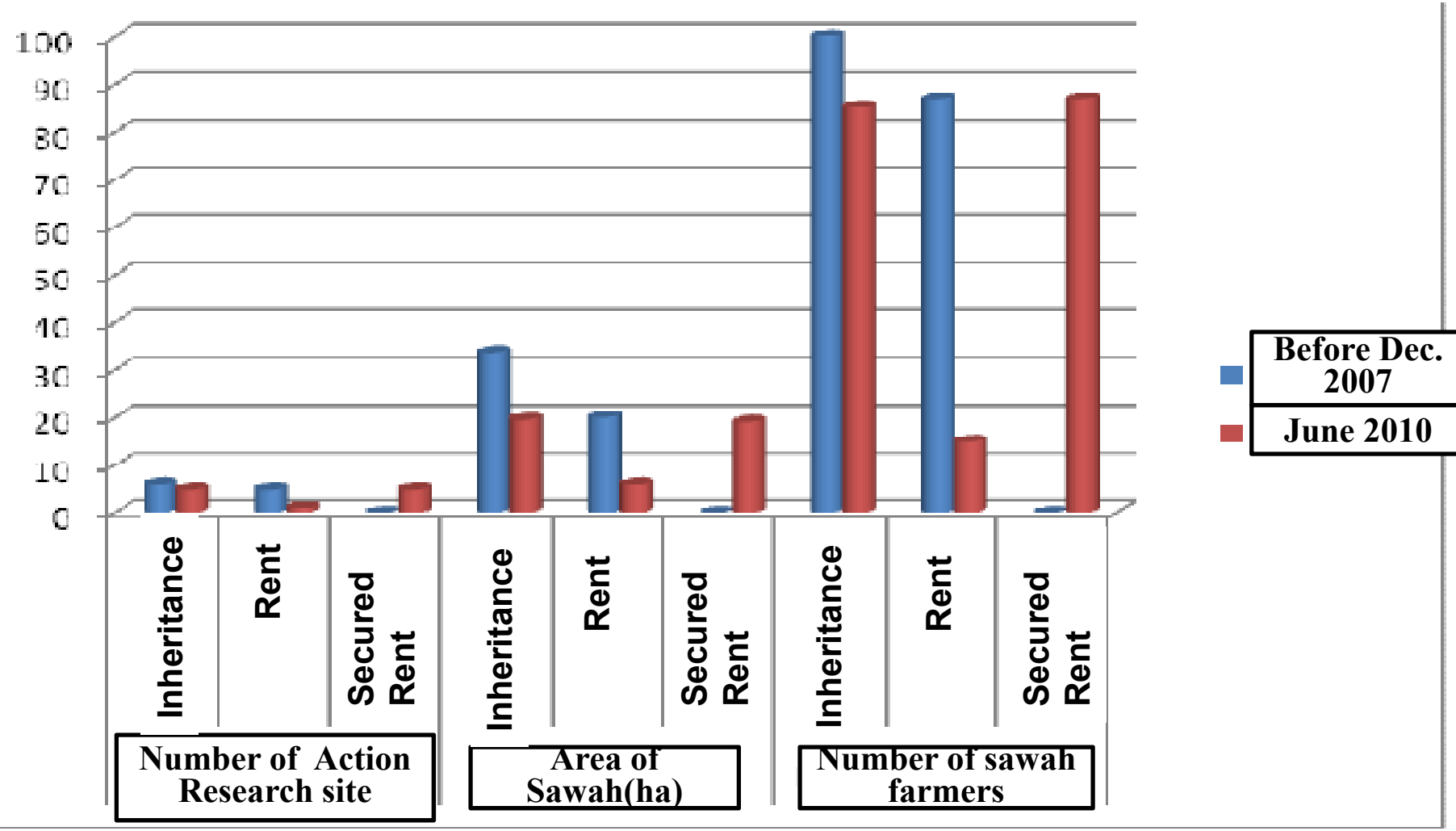

Sawah, Sep10
Traditional, Bida, Sep10


Sawah, Sep10
Traditional, Bida, Sep10

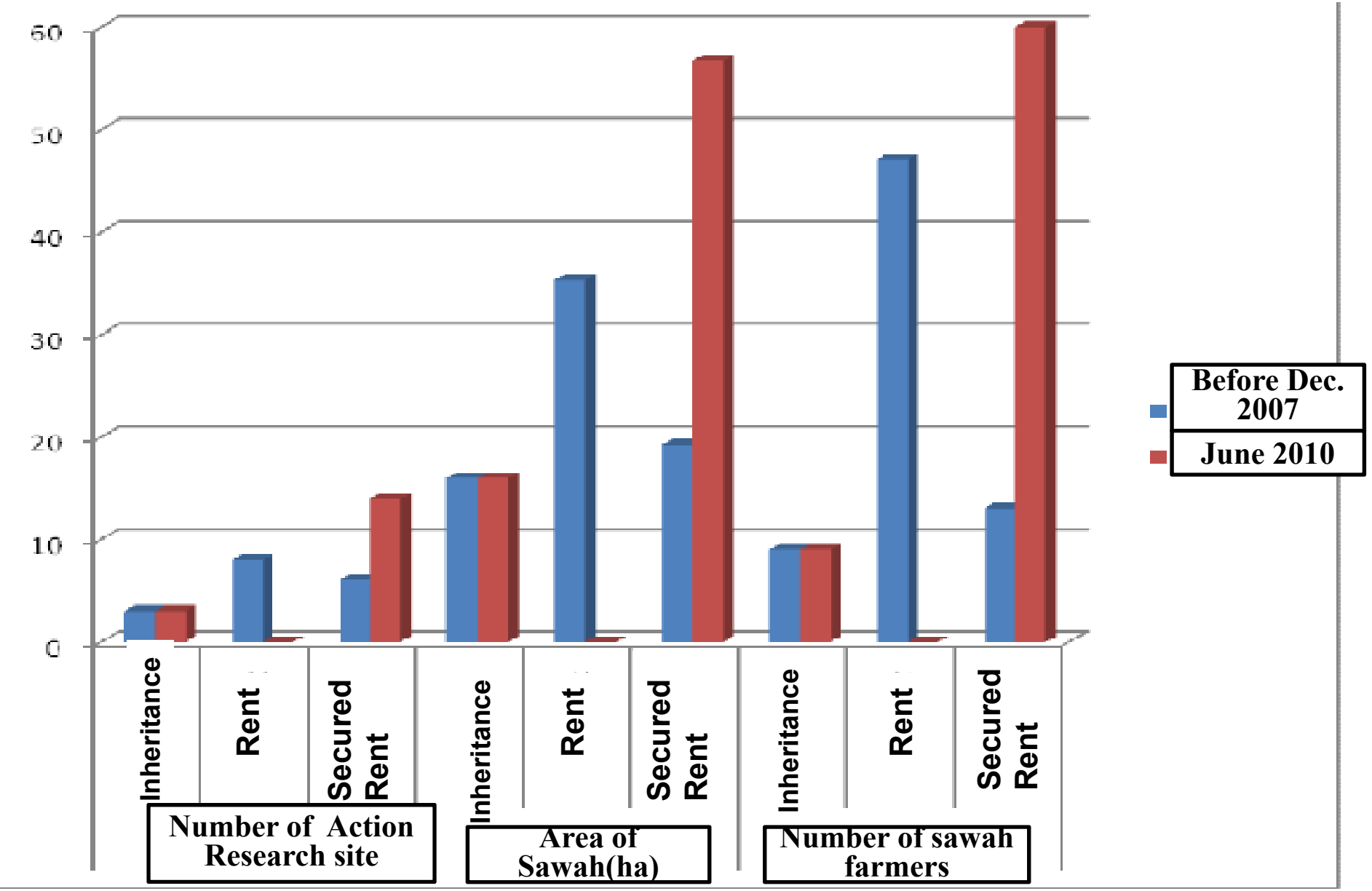
Akure Sawah site、2ha, Farmer, extension and sawah staffs, Sep. 08

Change of Land Tenure during the adoption of Sawah technology in Nigeria

<surveyed by Prof. Oladele>



Change of Land Tenure during the adoption of Sawah technology in Ghana <surveyed by Prof. Oladele>



Conclusion

1, Sub Sahara Africa has huge potential for sawah based rice farming to increase food production and to combat global warming. However lowland ecology and socio economic settings are not the same to Asian.

2, While Asian countries developed their sawah systems during their history in thousand years, Sub Sahara Africa has to develop within 50 years from now. However ten million rice farmers have no skill and experiences of sawah ecotechnology

3, Paradoxically, African topography gives very easy Sawah system development, if farmers mastered all necessary skills (2-3ha/one season per one powertiller)

4, Land tenure issue is critically important to avoid "Land Grab, then Development". African traditional way of "Secured Rent" may be enough to encourage personal sawah development at the moment. Otherwise another load map for African Green Revolution may came?

Cost and Income of Site Specific Personal Irrigated Sawah Development and Sawah Based Rice Cultivation (Ghana and Nigeria 2009)

		Spring based (mean slope 1.5%)	Flood plain like (mean slope 0.5%)	Stream dyke based (mean slope 1%)	Pond based (mean slope 1%)	Pump based (mean slope 1%)	Non-Sawah (mean Slope 2%)
Sawah development activities (First year only, per ha)							
Clearing & Destumping	10-20 mandays@3.5$permanday	70$	70$	70$	70$	70$	35$
Bunding	20-30mandays@3.5$per manday	100$	70$	85$	85$	85$	NA
Ploughing	20-30mandays@ 3.5$permanday	100$	70$	85$	85$	85$	NA
Puddling, soil movement, leveling	30-50 mandays @ 3.5$ per manday	200$	135$	170$	170$	170$	NA
Pumping machine cost	**3ha/year,@15%depreciation, Spare parts 10%**	NA	50$	NA	30$	200$	NA
Powertiller cost($5000, 3-5 years life)	**2-3ha/year, 6-15ha/life @20%depreciation, Spare parts 10-20%**	700$	500$	600$	600$	600$	NA
Main canal	@1000$/100m/ha	NA	NA	100$	100$	NA	NA
Branch canal	@35$/100m/ha	70$	35$	70$	70$	70$	NA
Interceptor canal	@35$/100m/ha	35$	NA	35$	35$	35$	NA
Dyke/Weir	@400$/20x5x3m/3ha/3	NA	NA	150$	NA	NA	NA
Pump fuel	3-20 days @20$/day/	NA	100$	NA	60$	400$	NA
Flood control	@700$/150x2x2m/3ha/3	NA	270$	70$	NA	NA	NA
Pond contruct.	@1400$/20x20x2m/3ha/3				500$	NA	NA
Total cost of Development		1275$	1300$	1435$	1805$	1715$	35$

Initial sawah development claims heavy load on powertiller, which cost occupy 50% of development

		Spring based (mean slope 1.5%)	Flood plain like (mean slope 0.5%)	Stream dyke based (mean slope 1%)	Pond based (mean slope 1%)	Pump based (mean slope 1%)	Non-Sawah (mean Slope 2%)
Sawah based rice farming cost (First year only, per ha)							
Nursery bed	1mandays @3.5$manday	5$	5$	5$	5$	5$	45
Seed cost	30-90kg @5kg/10$	40$	40$	40$	40$	40$	120$
Sawah water Management	20-50mandays @3 per manday	60$	60$	60$	60$	150$	NA
Transplanting	15mandays @3$permanday	45$	45$	45$	45$	45$	NA
Rope & marker	5bundles @2$/bundle	10$	10$	10$	10$	10$	NA
Weeding labor	7mandays@3$permanday	20$	20$	20$	20$	20$	50$
Herbicide	5litres@8$/litre	40$	40$	40$	40$	40$	NA
Fertilizer cost	5bags@20$/50kg	100$	100$	100$	100$	100$	NA
Fertilizing cost	3mandays @3$permanday	10$	10$	10$	10$	10$	NA
Bird scaring	15-45 mandays @1.5$ per manday	20$	20$	20$	20$	20$	40$
Harvest cost	15 mandays @4$ per manday	60$	60$	60$	60$	60$	30$
Threshing	10 mandays @3.5 per manday	35$	35$	35$	35$	35$	15$
Sawah based rice farming cost		440$	440$	440$	440$	530$	255$
Total cost in the first year		1715$	1740$	1875$	2245$	2245$	290$
Yield	4-4.5tha^{-1}	4.5tha^{-1}	4.0tha^{-1}	4.5tha^{-1}	4.5tha^{-1}	4.0tha^{-1}	1.5tha^{-1}
Gross Income	500$/t Paddy	2250$	2000$	2250$	2250$	2000$	750$
Net Income/ha		535$	260$	375$	5$	-245$	460$

Although sawah approach give sustainable low cost personal irrigated sawah system development, which is about one tenth (10%) of ODA based irrigated sawah development, there may be special subsidization to encourage farmers sawah development in first year.

		Spring based (mean slope 1.5%)	Flood plain like (mean slope 0.5%)	Stream dyke based (mean slope 1%)	Pond based (mean slope 1%)	Pump based (mean slope 1%)	Non-Sawah (mean Slope 2%)
Sawah based rice farming cost (Subsequent year, per ha)							
Pump cost	2-15 days @20$	NA	50$	NA	30$	150$	NA
Ploughing	5-7mandays@3.5$per manday	20$	15$	20$	20$	20$	NA
Puddling, leveling	7-12mandays@3.5per manday	40$	30$	40$	40$	40$	NA
Powertiller cost	**10ha/years, life 5-7 years**	100$	90$	100$	100$	100$	NA
Maintenance of canal, dyke, & pond	15% of new construction	15$	70$	70$	90$	15$	NA
Nursery bed	1-3mandays @3.5$manday	10$	10$	10$	10$	10$	35$
Seed cost	30-90kg @5kg/10$	40$	40$	40$	40$	40$	120$
Water Mgt	20-50mandays @3 per manday	60$	60$	60$	60$	150$	NA
Transplanting	15mandays @3$permanday	45$	45$	45$	45$	45$	NA
Rope etc	5bundles @2$/bundle	10$	10$	10$	10$	10$	NA
Weeding labor	7mandays@3$permanday	20$	20$	20$	20$	20$	50$
Herbicide	5litres@8$/litre	40$	40$	40$	40$	40$	NA
Fertilizer cost	5bags@20$/50kg	100$	100$	100$	100$	100$	NA
Fertilizing cost	3mandays @3$permanday	10$	10$	10$	10$	10$	NA
Bird scaring	15-45mandays@1.5$permanday	20$	20$	20$	20$	20$	40$
Harvest cost	15 mandays@4$permanday	60$	60$	60$	60$	60$	30$
Threshing	10mandays@3.5permanday	35$	35$	35$	35$	35$	15$
Sawah based rice farming cost		625$	705$	680$	730$	865$	290$
Yield	4-4.5tha^{-1}	4.5tha^{-1}	4.0tha^{-1}	4.5tha^{-1}	4.5tha^{-1}	4.0tha^{-1}	1.5tha^{-1}
Gross Income	500$/t Paddy	2250$	2000$	2250$	2250$	2000$	750$
Net Income/ha		1625$	1295$	1570$	1520$	1135$	460$

Once sawah developed, powertiller cost for rice farming will not be major problem. Since farmers were well trained during the first year difficult sawah development, sawah based rice farming will be more sustainable than old style ODA based irrigation projects

Table 1. Comparison of site specific farmers' personal irrigated sawah system development with ODA based large scale and small scale development and traditional rice cultivation system in inland valleys of Ghana & Nigeria (1ton paddy=500US$ in 2009)

	Large Scale Development	Small Scale Development	Farmers' personal Irrigated sawah	Traditional System
Development cost per hectare	10,000-30,000 US$/ha	10,000-30,000 US$/ha	1,500-3,000 US$/ha	30-60 US$/ha
Gross revenue in US$ & Yield in t/ha	2,000-3,000 US$/ha, 4-6t/ha	2,000-3,000 US$/ha, 4-6t/ha	2,000-3,000 US$/ha, 4-6t/ha	500-1,000 US$/ha, 1-2t/ha
Running cost including machinary	Medium to High (500-800$/ha)	Medium to High (500-800$/ha)	Medium (400-700 US$/ha)	Low (200-300 US$/ha)
Farmers participation	Low	Medium to High	High	High
Project ownership	Government	Goverment	Farmer	Farmer
Adoption of Tecnology	Long, Difficult	Short, relatively easy	Medium to short, needs intensive demonstration and On the Job Training (OJT) programme	Low technology transfer
Sustainable development	Low	Low to Midium	High	Medium
Environmental effect	High	Medium	Low	Medium

Heavy machine use & Contractor based

Power tiller (sometimes animal traction) use. Farmer based development Extended agronomy

Road Map to Realize Africa Rice Green Revolution through Site Specific Farmers' Personal Irrigated Sawah Development by Million Farmers' Self-Support Efforts

- **1986-2003 : (10 sites, 10ha of sawah) : 17 years of struggling, Achieved**

  Baisc research on Site Specific Sawah development by farmers' self support efforts at Bida, Nigeria and Kumasi, Ghana

- **2004-2009: (60 sites, 150ha of sawah): Achieved**

  Basic Action research on Site Specific Personal Irrigated Sawah development by farmers at Bida, Zaria, Akure, and Ilorin, Nigeria and Kumasi area, Ghana

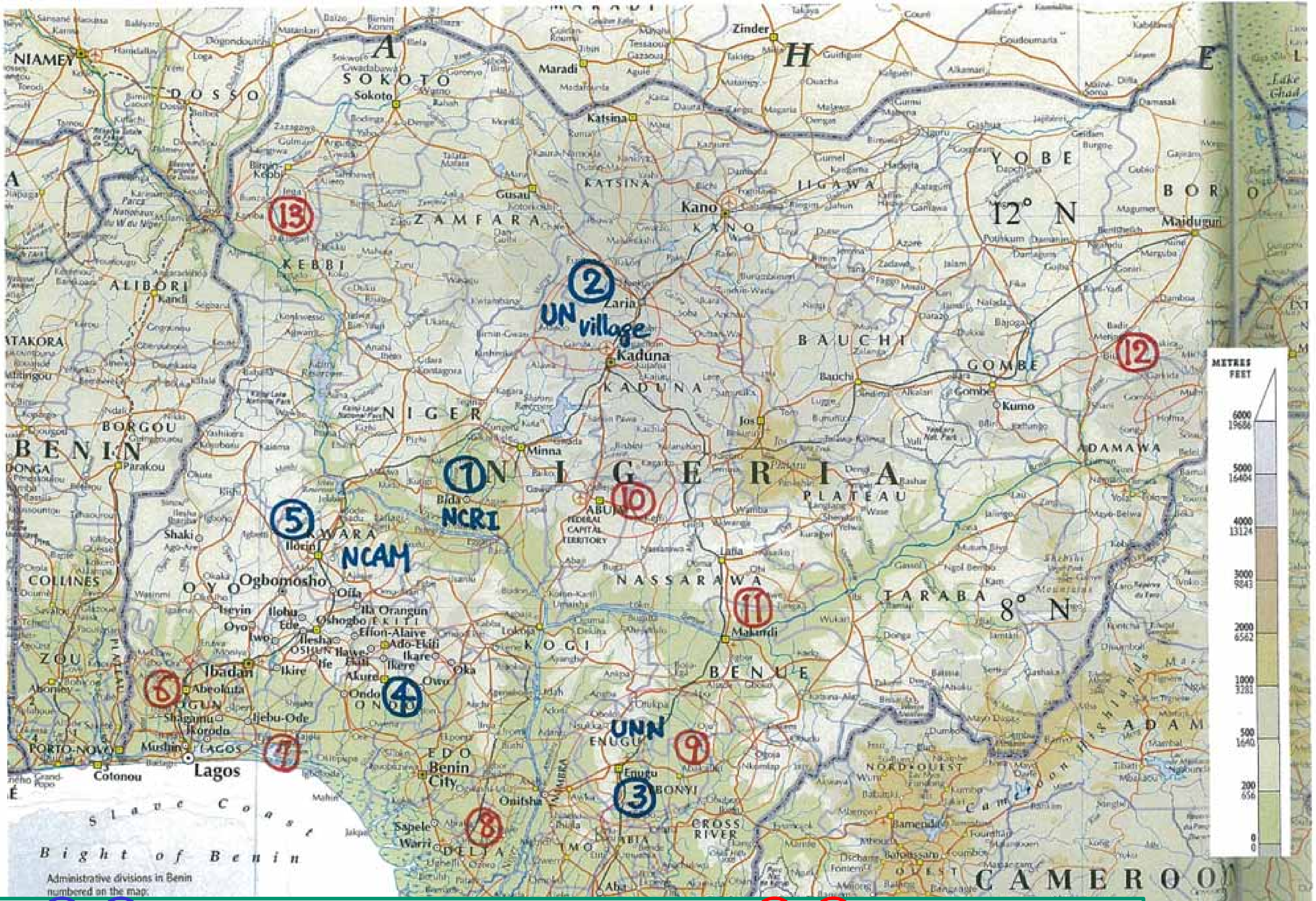
- **2010-2013: (100 sites, 300ha of sawah): Immediate Target for Action Research for Dissemination of Sawah Technology**

  by Kinki Univ/NCAM/FadamaIII/SRI/CRI, JIRCAS, SMART-IV and JICA-CARD; To prepare Large scale Action research on Site Specific Sawah development by farmers at Nigeria, Ghana, Togo, Benin & others

- **2014-2025: (>5000 sites , >25,000ha of Sawah): Large scale**

  Africa wide Action Researcg/dissemination of Site Specific Sawah development by farmers self-support efforts

- **2025-2050: African wide spontaneous sawah expansion and the Realization of African Rice Green Revolution: Realization of Africa's Rice Potential**



①-⑤: Action Research Sites by 2009, ⑥-⑬: New sites in collaboration with NCAM and Fadama III in 2010