CHAPTER 8

ECONOMIC ANALYSIS OF 'SAWAH' ECO-TECHNOLOGY AND PROPOSED ROUTE FOR A RICE REVOLUTION IN AFRICA

Proposed road map to realize Africa Rice Green Revolution through the "Sawah" Eco-technology (site specific farmers' personal irrigated "sawah" development by farmers' self-support efforts)

(1) 1994-2002 : (10 sites, 6ha of 'sawah'): JICA/CRI & MEXT assisted 'Sawah' Project: West African wide survey on traditional rice farming and basic research on Site Specific 'Sawah' development by farmers' self support efforts at Bida in Nigeria and Kumasi in Ghana

(2) 2003-2007: (20 sites, 30ha, benchmark watershed): MEXT assisted basic research: Basic Action Research to develop Site Specific Personal Irrigated 'Sawah' development by farmers at Bida in Nigeria and Kumasi area in Ghana

(3) 2007-2011:(>100 sites, > 200ha, 'Sawah' Eco-technology): MEXT assisted specially promoted research: Kinki Univ./NCAM/Fadama III/SRI/CRI,JIRCAS,and SMART-IV:'Sawah' eco-technology establishment and to prepare large scale action research on 'Sawah' eco-technology dissemination in Nigeria, Ghana, Togo and Benin

(4) 2012-2016: (> 500 sites, > 5000ha of 'sawah' in Nigeria and Ghana respectively): 'Sawah' eco-technology and Marketable Rice Farming(SERIF) project proposal under JICA Yen /World bank loan: NCAM/Fadama/Kinki & Shimane Univ. in Nigeria, SRI/CRI/MOFA in Ghana, JIRCAS, SMART-IV and JICA-CARD; To start national and West Africa as well as SSA wide dissemination of 'Sawah' eco-technology

(5) 2017-2026: (>100,000ha of 'Sawah'): Establishment of Institutional organizations for Africa wide dissemination and endogenous 'Sawah' Eco-technology development

(6) 2027-2036: (> million ha of 'Sawah'): African wide spontaneous and rapid 'sawah' expansion and the Realization of African Rice Green Revolution: Realization of Africa's Rice Potential and Rice exportation to Asia and other part of the world (a reverse of the current situation.

Table 1 Comparison of farmers' site-specific personal irrigated 'sawah' system development and 'sawah' based rice farming ('sawah' technology) with large- and small-scale ODA-based developments, and traditional rice cultivation system in inland valleys of Ghana and Nigeria.

Item/Activity	Large-scale development	Small-scale development	'Sawah' Eco-technology	Traditional system
Development cost (US $/ha)	10000 – 30000	10000 – 30000	1000 - 3000 (10 years ago 3000-7000)	30 – 60
Gross revenue (US $/ha)†	2000 – 3000	2000 – 3000	2000 – 3000	500 –1000
Yield (t/ha)	4 – 6	4 – 6	4 – 6	1–2
Running cost, including machinery (US $/ha)	600 – 800	600 – 800	400 – 600	200 – 300
Farmer participation	Low	Medium–High	High	High
Project ownership	Government	Government	Farmer	Farmer
Adaptation of technology	Long,	Medium – short	Medium to short, needs intensive demonstration and on-the-job training (OJT) program	-
Technology transfer	Difficult	Difficult	Easy	No technology transfer
Sustainable development	Low (heavy machinery used by contractors in development)	Low – medium	High (farmer-based and small power-tiller used in development and management)	Medium
Management	Difficult	Difficult	Easy	Difficult
Adverse environmental effect	High	Medium	Environmental friendly	Medium

† Assuming 1 ton paddy is worth US$ 500; one power-tiller costs $3000-9000 in West Africa depending on the brand quality and accessories (2009 values). Selling prices, however, are $1500-$3500 for farmers in Asian countries.

Table 2 **Cost and Income (US $) of New 'Sawah' development and rice farming (Ghana and Nigeria, 2009).**

Activity	Cos/income elements, performance or durability o	Spring-based (slope 1.5%)	Floodplain-like (mean slope 0.5%)	Stream dike-based (slope 1%)	Pond-based (mean slope 1%)	Pump-based (mean slope 1%)	Non-'sawah' (mean slope 2%)
A. Sawah development activities (first year only, per ha)							
Clearing, Bunding	30–50 work-days†	200	150	150	150	150	50
Plow, Puddling, leveling	14-21 days powertiller operation	300	200	250	250	250	NA
Pumping cost	3 ha/year‡	NA	150	NA	100	450	NA
Powertiller cost §	2–3 ha/year, 6–15 ha/life	700	500	600	600	600	NA
Canal	$1000 for 100 m per ha	100	50	200	200	100	NA
Dike/weir	$400 for 20 m x 5 m x 3 m per 3 ha / 3	NA	NA	150	NA	NA	NA
Flood control	$700 for 150 m x 2 m x 2 m per 3 ha / 3	NA	300	100	NA	NA	NA
Pond construction	$1400 for 20 m x 20 m x 2 m per 3 ha / 3	NA	NA	NA	500	NA	NA
Personnel cost for on the Job training ($/ha)		Scientists/engineer ($1000/ha) , Extension officer ($500/ha), Leading farmers($250/ha)					
Cost		2300-1550	2350-1600	2450-1700	2800-2050	2550-1800	50

† 1 work-day costs $3.5.
‡ Pumping machine: 7 years life, 15% depreciation, 20% spare parts.
§ Power-tiller cost: $5000 for 3–7-year life, 20% depreciation, 20% spare parts; initial 'sawah' development claims heavy load on power-tiller, which comprises 50% of cost of development.

Table 2 continued Cost and Income (US $) of new 'sawah' development and rice farming (Ghana and Nigeria, 2009) continued

Activity	Cost/income elements, performance or durability	Spring-based (slope 1.5%)	Floodplain-like (mean slope 5%)	Stream/ dyke-based (slope 1%)	Pond based (slope 1%)	Pump based (slope 1%)	Non-sawah (slope 2%)
B. "Sawah"-based rice farming cost (first year only, per ha)							
Nursery, seed	3 work-day, 60-90kg	90	90	90	90	90	130*
Water management	20–50 work-days†	50	50	50	50	150	NA
Transplanting	15 work-days	50	50	50	50	50	NA
Weed control Herbicide	5-7 work-days	50	50	50	50	50	50
Fertilizing	3 work-days	120	120	120	120	120	NA
Bird-scaring Harvesting	20-30 work-days	80	80	80	80	80	70
Threshing	15 work-days†	50	50	50	50	50	20
"Sawah"-based rice farming cost except for training		490	490	490	490	590	270
Total cost in the first year		1790	1840	1990	2290	2290	320
Yield	4–5 t/ha	4.0	4.5	4.5	4.5	5.0	1.5
Gross income	$500/t of paddy	2000	2250	2250	2250	2500	750
Net income		210	410	310	-40	210	430

† 1 work-day costs $1.5-3.5,

*direct sowing and/ or dibbling

Although "sawah" approach gives sustainable low-cost personal irrigated "sawah" system development, which costs about 10% of ODA-based irrigated development, there may need to be special subsidization to encourage "sawah" development by farmers in the first year.

Table 3 Cost and Income (US $) of new 'sawah' development and rice farming (Ghana and Nigeria, 2009) continued

Activity	Cos/income elements, performance or durability	Spring-based	Floodplain-like (mean slope 5%)	Stream dyke	Pond-based	Pump-based	Non-'sawah ' (slope 2%)
C. 'Sawah'-based rice farming cost (subsequent year, per ha)							
Pump	2–10days ($15/day)	NA	50	NA	30	200	NA
Power-tiller, Plow, Puddling	10 days per powertiller 10 ha/year, life 5–7 years	150	150	150	150	130	NA
Maintenance, canal,dyke	15% of new construction	20	70	70	90	20	NA
Water management	20 –50 work-days ($3/work-day)	50	50	50	50	35	NA
Transplanting, Seed, nursery	15 work-days	100	100	100	100	100	130*
Weeding, Herbicide	5-7 work-days	50	50	50	50	35	50
Fertilizing	3 work-days	120	120	120	120	120	NA
Bird-scaring	30 - 40 work-days	50	50	50	50	50	50
Harvesting	20 - 30 work-days	60	60	60	60	60	40
**Harvester	3 - 5 work-days	100	100	100	100	100	NA
Threshing	15 - 20 work-days†	50	50	50	50	50	20
Sawah-based rice farming cost		650	750	700	750	800	250
Yield	4 - 5 t/ha	4.0	4.5	4.5	4.5	5.0	1.5
Gross income	$500/t paddy	2000	2250	2250	2250	2500	750
Net income		1350	1500	1550	1500	1700	460

† 1 work-day costs $1.5-3.5. In case of Non-'Sawah,' threshing day is less than half
*direct sowing and/ or dibbling = higher seed rate
** if harvester available we can save $10 (Harvester = Harvesting + threshing + winnowing) and get high quality market competitive grains
Once 'sawah' developed, power-tiller cost for rice farming will not be a major problem. Since farmers were well trained during the first year in difficult 'sawah' development, 'sawah'-based rice farming will be more sustainable than old-style ODA-based irrigation projects.

Table 4 Financial Analysis (US $) on 'Sawah' Eco-technology for Rice farming. (NB: Training Allowance Cost is not included.)

Items	Year 1	Year 2	Year 3	Year 4	Year 5
A. Revenue:					
4 t/ha @ US $500 per ton	2000	2000	2000	2000	2000
A. Cost of Production					
Development	1300	-	-	-	-
Operation	490	630	630	630	630
Total cost of production	1790	630	630	630	630
Gross profit/Loss (A-B)	210	1370	1370	1370	1370
Projected Cash flow					
Items	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue	2000	2000	2000	2000	2000
Total	2000	2000	2000	2000	2000
Funds application					
Cost of development	1300	-	-	-	-
Cost of operation	490	630	630	630	630
Replacement cost (Dep.)	-	-	-	-	-
Total	1790	630	630	630	630
Net cash flow	210	1370	1370	1370	1370
Cumulative cash flow	210	1580	2950	4320	5690

NPV @ 25%	Develop.	Operating	Receipt
Year	Cost	Cost	210
1	1300	490	1370
2	-	630	1370
3	-	630	1370
4	-	630	1370
5	-	630	1370

Summary data on past various irrigation projects in Sub-Saharan Africa funded by ODA through JICA and possibility of a dramatic reform under 'Sawah' Eco-technology

1. Lower Anambra, Nigeria: Total 22 billion Yen,≒ US $100million, 17 billion was Yen loan. Huge pump irrigation of 3850ha developed by Japanese companies, full mechanization during 1981-1989. JICA grant for technical cooperation,1989-1993. **High development cost of $30,000/ha,** Malfunction of both irrigation & mechanization since 1993. Both management and endogenous development are difficult

.2. Mwea, Kenya: 3000ha of new irrigation and 5860ha of rehabilitation during 2011-2016, 14 billion Yen loan, including planning consultancy cost of 0.7billion Yen in 1993-1996. Technical cooperation in 1989-1998 with 4billion Yen grant for rehabilitation of 5860ha. **High development cost of over $20,000/ha** and management. Difficult endogenous development.

3. JICA/MoFA Sustainable Development of Rain-fed Lowland Rice Production Project. Results so far only seem encouraging with yields of over 5t ha^{-1} recorded because it is on a micro-scale where demonstration sites are only micro-plots (0.1ha) with high cost. Net returns will therefore be very low and its economic impact negligible. Scaling up using 'sawah' eco-technology and effective collaboration in technology transfer is necessary to achieve the desired results

The target is the improvement of ODA projects by the application of 'Sawah' Technology (reduced cost and increased efficiency)

4. Proposal JICA 1billion Yen ≒ $15million, loan for 5000 ha of irrigation development within 5 years by 'Sawah' Eco-technology: 100-500 core sites, each 50-10ha 'sawah' development. Total 5,000ha, 20,000 ton of annual paddy production which is equivalent to US $10 million/year, within 5 years. 700 sets of power tillers at a cost of US $ 3million, 170 sets of small harvesters at a cost of US $ 2 million, Development logistics at a cost of $ 2.5 million, farmers training at a cost of US $ 2.5 million, Youth training at a cost of US $2.5 million, Vehicles and transport at a cost of US $ 1.5 million and Project management & consultancy at a cost of US $ 1 million.

Development cost is less than $3000/ha. Since the core sites attract 3-5 new sites, then new sites will be expand to 1500- 2500 sites. Thus endogenous development will expand at an accelerated rate.

5 Over 100,000ha of 'Sawah' development will take place from 2017-2026 through Africa wide dissemination.

6. Millions of ha of 'Sawah' development will then occur from 2027-2050 under the African wide rapid expansion and program and Realization of African Rice Green Revolution

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Principles and Practices of "SAWAH" ECO-TECHNOLOGY